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STRUCTURAL DOCUMENTATION PACKET

DATE: 3/5/2024
PROJECT NUMBER: 23-TAM001

PROJECT:
Tamarack 3 & 4 Module Solar Ground Mount
Comprehensive Racking Analysis

State of California

CLIENT:
Tamarack Solar Products
288 F Street
Arcata, CA 95521

PREPARED BY:
Rachel Keith
Engineered Power Solutions, Inc.

ENGINEER OF RECORD:
Matthew B. Gilliss, P.E., LEED AP
Engineered Power Solutions, Inc.

3/5/2024

PACKET EXPIRES ON 12/31/24 AND IS SUBJECT TO ANNUAL REVIEW AND RENEWAL

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T.2 – TABLE OF CONTENTS

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1.0 – RESULTS & SCOPE OF WORK

1.1 – Overview of Analysis & Results

- Governing Building Code:

  2022 California Building Code (CBC)

  Based on the 2021 *International Building Code (IBC)* and referencing the 2016 *Minimum Design Loads for Buildings and Other Structures* by the American Society of Civil Engineers (ASCE 7-16)

- Project Description:

  The project consists of the structural analysis of a ground mounted photovoltaic (PV) racking structure based on a number of set design conditions as listed in this packet. The Tamarack Single Post Ground Mount racking structure consists of steel and aluminum racking components which support (3) or (4) PV modules. The racking structure resists wind uplift loads using a combination of self-weight and concrete pier foundations embedded into the ground.

  Tamarack Solar Products (Tamarack) has hired Engineered Power Solutions, Inc. (EPS) to address the structural design of the racking components, connections, and to design the concrete pier foundations required. This packet provides a summary of the acceptable conditions and parameters based on the structural analysis for each of the design parameters and combinations listed in the design charts in Section 3.0 of this packet.

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- Specific Design Requirements and Features of the Tamarack Single Post Ground Mount

    - Each specific project shall be reviewed by the Engineer of Record (EOR) to ensure the site-specific design conditions (wind speed, exposure, snow load, seismic accelerations, etc.) are within the scope of this packet. An approval memo for each specific project shall be submitted by the EOR to validate the use of this packet. This packet is not valid without a site-specific approval memo and EPS (and the project EOR) take no responsibility for any projects installed without a valid (stamped and signed) site-specific approval memo.

    - Risk Category: The Single Post Ground Mount is a ground mounted, non-building, non-habitable monoslope rack used to support solar PV modules. It is reasonable to conclude that it represents a lower hazard to human life in the event of failure than a habitable building such as a storage facility or agricultural barn, both of which are defined as Risk Category I structures per Table 1604.5 of the IBC. It is also to be noted that these units are typically used to offset power costs to an accessory structure (residence, commercial building, etc.) but that the accessory structure is not dependent on the Single Post Ground Mount for power and would not experience a loss of power/function if the units were to be impaired. Therefore, the Single Post Ground Mount is considered a Risk Category I structure unless required otherwise (in writing) by the building official or if another structure would experience a loss of function due to a failure of the units to produce power. However, these tables can be used considering the unit as a Risk Category II structure at the discretion of the EOR. See each Site-Specific Memo for details.

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- Module Sizes: The analysis in this packet is based on modules which have a size of approximately 83" x 43". The unit size tables provided can also be used for smaller modules, as both of those have less area and therefore would be conservative.

- Geotechnical Report: As this is a generic packet, EPS has not been provided with a geotechnical report and therefore has used the code minimum soil values presented in IBC Table 1806.2 – Presumptive Load-Bearing Values. It is assumed that the soil type is clay, silt, sand, or gravel and concrete piers are a viable foundation type. EPS shall be notified if bedrock, cobbles/boulders, or if any other soil conditions are encountered that do not allow the concrete piers to be installed to their required depth. If the site has the potential for unique geotechnical conditions (shallow bedrock, deep frost depth, frost jacking forces, etc.) EPS recommends the owner obtain a geotechnical report prior to project design. EPS recommends defaulting to Class 5 foundation depths if the soil type is unknown however, corresponding foundation depths for Class 3 and 4 soils have been provided. To use the foundation depths for Class 3 or 4, EPS recommends having someone with adequate knowledge on soil classification (ex. Geotechnical Engineer) classify the soil at the site. EPS is NOT responsible for the classification of the soil or the decision to use foundation depths from Class 3 or 4.

- Special Inspection: "Special Inspections" as defined in Chapter 17 of the IBC are not required for the Single Post Ground Mount per the Exemptions listed in Section 1704.2 unless required otherwise (in writing) by the building official.

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- Lateral Loads: The Single Post Ground Mount resists lateral loads imposed by wind and seismic through the concrete pier foundations. See Section 3.0 for additional anchorage information.

- Ground Slope: The designs given in this packet assume a negligible (flat) ground slope. A site-specific analysis is required for sites with a significant slope.

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- Scope of Work:
  - Determination of the structural requirements for the Single Post Ground Mount racking system according to the governing building code (*International Building Code* (IBC) and ASCE 7) and based on the following parameters:
    - 10˚, 20˚, 30˚, 40˚, 50˚, and 60˚ Racking Tilt Angle
    - Post height range up to 6 ft. maximum (from grade to centerline of beam)
    - Risk (Occupancy) Category I Structure
    - Design Wind Speeds as defined in the Summary Charts (Typical ASCE 7-16 (3) second gust wind speeds)
    - Wind Exposure Category "C"
    - No Topographic Features (K_{zt} = 1.00)
    - Ground Snow Loads (p_g) as defined in the Summary Charts
    - Seismic acceleration factor S_{DS} equal to 2.000g or less.
  - Structural design of the racking components for the beam and post.
  - Racking connection loads and capacities.
  - Concrete pier foundation design.
  - General Notes and Structural Specifications.

- <u>Not</u> within EPS's Scope of work:
  - Design and Structural Justification of the module capacity, module to end/mid clamp connection, and end/mid clamp capacity.

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- Referenced As-Built Documents:
    - Various Part Details and Drawings by Tamarack Solar Products (See Appendix)

- Results: EPS has determined that if the Single Post Ground Mount racking system is built in accordance with the requirements given in Tamarack's Plans/Drawings, Tamarack's installation instructions, and the summary tables/requirements listed in this packet, then the ground mounted racking system will be structurally adequate to support the imposed design loads listed in the summary tables of this packet.

  EPS (or the EOR) shall supply a site-specific approval memo, stamped and signed by a licensed Professional Engineer (P.E.), for each individual project confirming the application of this packet to the project under consideration. This packet is not valid without the site-specific approval memo.

  Please note that this Structural Documentation Packet is part of the construction documents and the project shall be constructed in accordance with the approved plan set and the requirements in this packet.

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- Limitations and Assumptions:

  Construction documents, details, plans, and product information regarding the proposed ground mount racking has been provided to EPS by Tamarack. Any changes to the installation requirements given in Tamarack's plans must be approved in writing by EPS prior to implementation. All non-structural issues including but not limited to waterproofing, corrosion protection, electrical, drainage, and mechanical issues are not the responsibility of EPS and must be addressed by the solar designer, installer, and/or owner before PV installation begins. EPS is not responsible for water intrusion issues, corrosion, other external sources of damage, or any failures due to water damage, material defects, other external sources of damage, incorrect construction issues, or improper inspection/maintenance.

  Although this packet may be used to confirm design load limitations, it shall be noted that a site-specific analysis to determine the site-specific design parameters and local code requirements is required by a qualified entity for individual projects. Sites with design scenarios which differ and/or are outside the scenarios specified in this packet must be addressed by a licensed design professional on a site-specific basis. Any changes to the required design results given in this packet such as changes to framing member sizes, module sizes and quantity, differing tilts, installation requirements, etc. must be approved in writing by EPS (or the Engineer of Record (EOR)) prior to implementation.

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1.2 – General Notes and Structural Specifications

- General Notes:
  - The purpose of this structural documentation packet is to provide the items listed in the scope of work with a minimum level of resistance to the code prescribed forces (gravity and lateral) based on the requirements given in the governing building code.
  - The contractor is responsible for construction means and methods and the safety of personnel on site. EPS does not have control of site procedures and construction means and methods and therefore is not responsible for those means and methods and/or site safety.
  - Any changes to the approved plans and details for any reason must have written approval of the Engineer of Record before being implemented.
  - All inspection reports filed by a building official or special inspector shall be provided to the Engineer of Record.
  - See the "Limitations and Assumptions" in section 1.1 for additional requirements.
  - All drawings and details are not to be scaled.

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- Material Specifications:

    - Concrete (if required):
        - All concrete work shall conform to ACI standards and specifications.
        - 3500 psi Compressive Strength min. (f'c) at 28 days (2500 psi conservatively used in design)
        - Type II Cement
        - Maximum slump of 5"
        - Concrete shall be air entrained in accordance with IBC Section 1904.2 and ACI 318
        - Special Inspection is not required unless required by the Building Department/Official.
        - Aggregates shall be per ASTM C33 (Max. size 1-1/2")
        - The mix design is to be adjusted for local soil and exposure conditions and shall be approved by the Engineer of Record.

    - Reinforcing Steel (f Required):
        - Shall be per ASTM A615 Grade 60 (deformed)
        - Min Fy = 60 ksi for #4 bars and up; Fy = 40 ksi for #3 bars
        - Shall be free of rust and dirt
        - Rebar splices shall have a lap no less than 48 bar diameters unless noted otherwise.
        - All clear cover distances shall be 3" unless noted otherwise.

    - ITW Buildex TEKS screws shall be installed per their corresponding ICC Report (ESR-1976).

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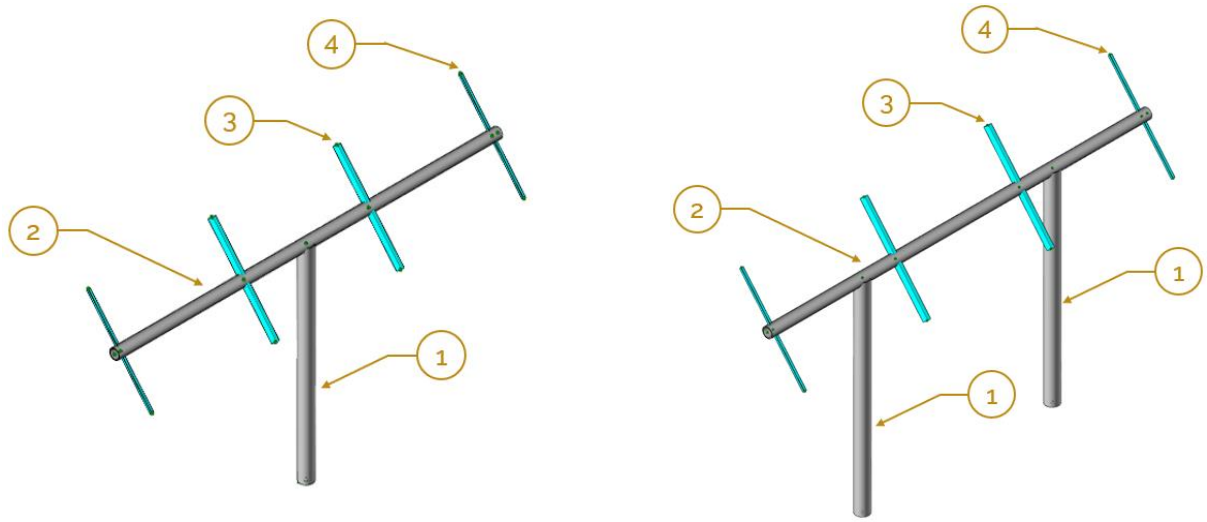
2.0 – UNIT TYPES

3 Module Unit



Unit Designations are as follows: #C/##

Where the first number (**#**C/##) designates the number of Schedule 40 Pipe Columns, the presence or absence of the letter C (#**C**/##) indicated if that column is filled with concrete, and the last two numbers (#C/**##**) indicate the thickness of the beam pipe, either "40" for Schedule 40 Pipe or "80" for Schedule 30 Pipe.

Keyed Notes:

1. Column(s) – 4" Schedule 40 Pipe (35 ksi yield stress)
2. Beam – 3" Schedule 40 or Schedule 80 Pipe (35 ksi yield stress)
3. Module Mid Clamp – by others
4. Module End Clamp – by others

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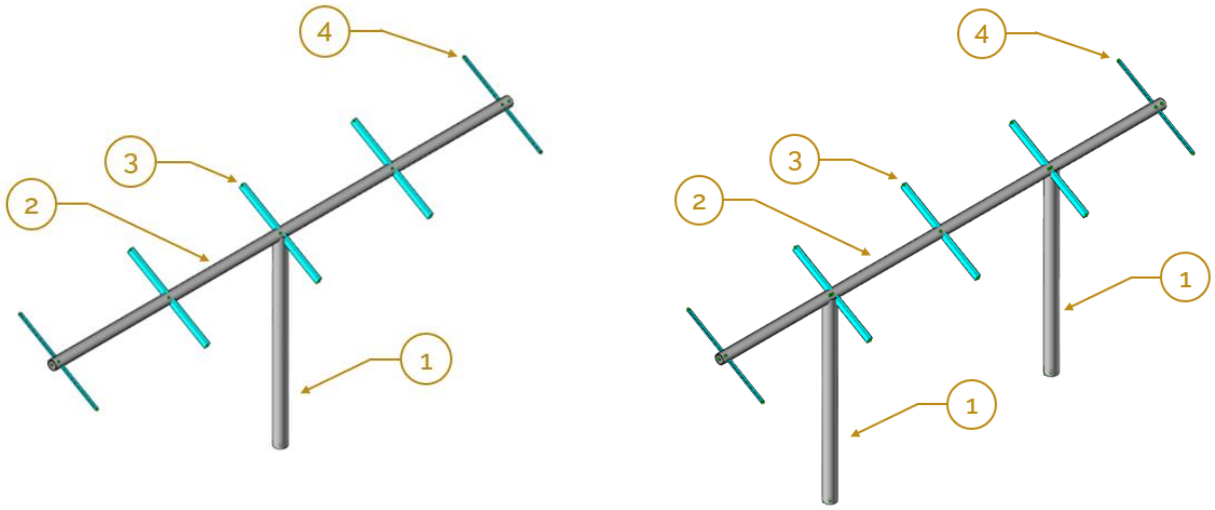
4 Module Unit



Unit Designations are as follows: #C/##

Where the first number (**#**C/##) designates the number of Schedule 40 Pipe Columns, the presence or absence of the letter C (#**C**/##) indicated if that column is filled with concrete, and the last two numbers (#C/**##**) indicate the thickness of the beam pipe, either "40" for Schedule 40 Pipe or "80" for Schedule 30 Pipe.

Keyed Notes:

1. Column(s) – 4" Schedule 40 Pipe (35 ksi yield stress)
2. Beam – 3" Schedule 40 or Schedule 80 Pipe (35 ksi yield stress)
3. Module Mid Clamp – by others
4. Module End Clamp – by others

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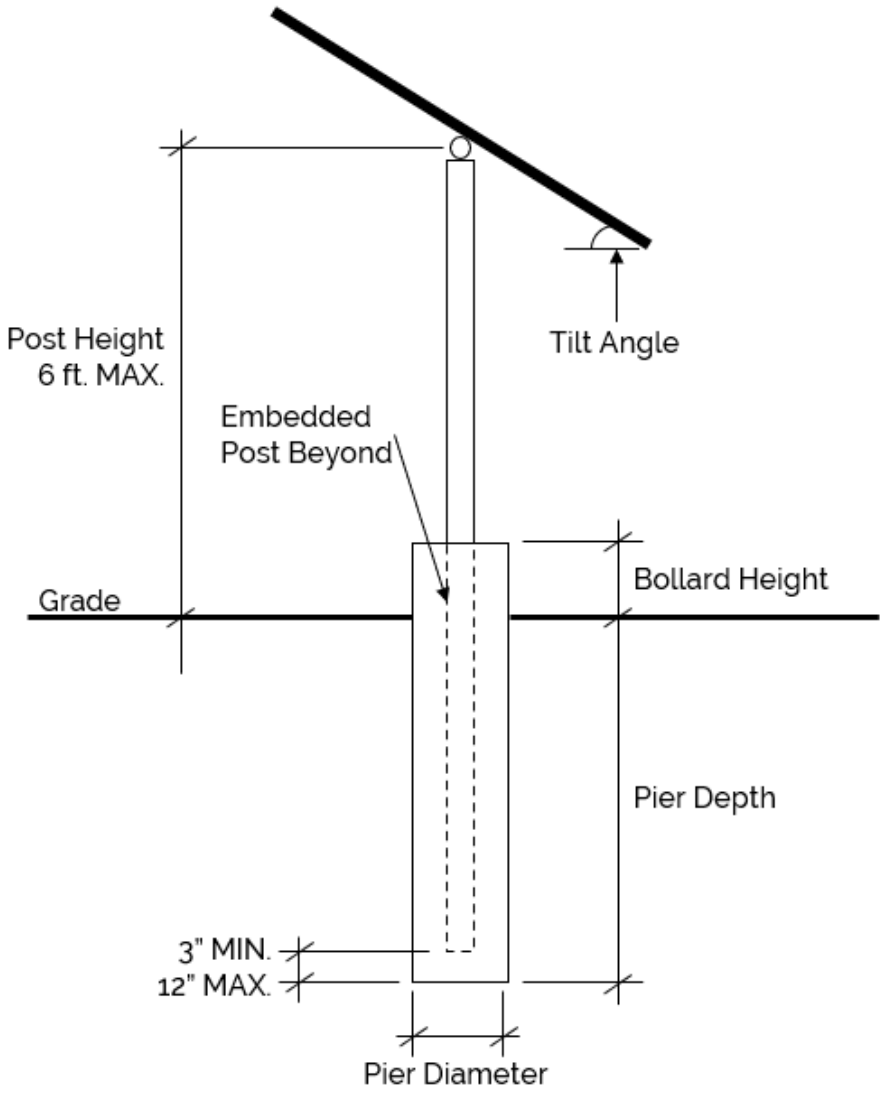

Image depicting the definitions of various terms used to describe components or dimensions of the Single Post Ground Mount

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3.0 – SUMMARY TABLES

- Summary Table Notes:

  - It is the responsibility of the individual or company using the summary tables to ensure that the site-specific design parameters being used are correct as required by the local permitting jurisdiction. EPS is not responsible for incorrect use of these tables.

  - Interpolation (or extrapolation) between (or beyond) categories in any of the summary tables is not permitted without written approval from EPS.

  - Unit Types shown correspond with the unit types shown in Section 2.0 and shall use the component sizes, pipe schedules, yield stresses, and unit configurations listed in Section 2.0.

  - It is acceptable to use a higher strength unit than those listed for the specific conditions shown if desired. Unit strengths increase from:

1 Column → 1 Column, Concrete Filled → 2 Columns → 2 Columns, Concrete Filled
and
Schedule 40 Pipe Beam → Schedule 80 Pipe Beam

  - Snow loads are given as "Ground Snow Loads" defined as (p_g) in Chapter 7 of ASCE 7. The EOR shall be notified if the local jurisdiction defines snow loads being used for a specific project as "roof snow loads" (p_f or p_s) or does not allow adjustment of ground snow loads as allowed by Chapter 7 of ASCE 7.

  - Wind loads are given as ASCE 7-16 wind speeds. It is critical that the correct building code is referenced for each project as adopted by that local jurisdiction (or state) to ensure the correct wind speed is used.

  - All wind loads are based on Exposure Category "C". The values shown may also be used for Exposure Category "B" as the values would be conservative. For sites in Exposure Category "D" a site-specific analysis is required.

  - For sites where a topographic factor may apply (upper half of isolated hills, bluffs, or escarpments) a site-specific analysis is required.

  - The designs given in this packet assume a negligible (flat) ground slope. A site-specific analysis is required for sites with a significant slope.

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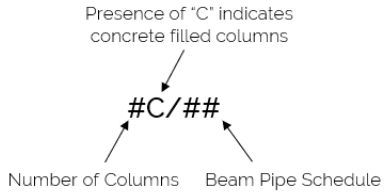
3 MODULE GROUND MOUNT SUMMARY TABLES

Allowable Unit Type Based on Loading, 10 Degrees (3 Modules)

10 Degrees		Ground Snow Loads (P_g)										
		0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf	100 psf
ASCE 7-16 Wind Speeds (V)	90 MPH	1/40	1/40	1/40	1/40	**1/80**	2/40	2/40	2/40	2/40	2/40	2/40
	95 MPH	1/40	1/40	1/40	1/40	**1/80**	2/40	2/40	2/40	2/40	2/40	2/40
	100 MPH	1/40	1/40	1/40	1/40	**1/80**	2/40	2/40	2/40	2/40	2/40	2/40
	105 MPH	1/40	1/40	1/40	1/40	**1/80**	2/40	2/40	2/40	2/40	2/40	2/40
	110 MPH	1/40	1/40	1/40	**1/80**	**1/80**	2/40	2/40	2/40	2/40	2/40	2/40
	130 MPH	1/40[B]	1/40[B]	**1/80[B]**	**1/80[B]**	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	150 MPH	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]

[A] For all units installed in wind speeds above 130 MPH, (1) 3/8" TEK screw shall be used in place of the (1) ¼" TEK screw to connect the module clamp to the beam.

[B] For single column units installed in wind speeds above 110 MPH, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap.



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10 Degree Tilt, Concrete Pier Requirements (3 Modules)

Tilt	Unit Type	Pier Diameter	Soil Class	Depth
10˚	1 Column	18"	Class 3	5 ft.
			Class 4	6 ft.
			Class 5	6 ft.
		24"	Class 3	5 ft.
			Class 4	5 ft.
			Class 5	6 ft.
	2 Columns	18"	Class 3	5 ft.
			Class 4	5 ft.
			Class 5	5 ft
		24"	Class 3	4 ft.
			Class 4	5 ft.
			Class 5	5 ft.

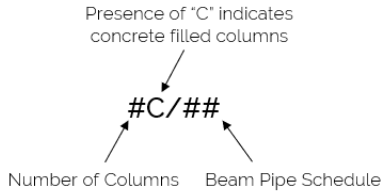
Soil Class is to be determined by a geotechnical engineer or individual with experience in classifying soils. EPS is not responsible for determining the class of the soil. The Soil Class shall be determined in accordance with the soil descriptions stated in the 2022 CBC Table 1806.2.

Allowable Unit Type Based on Loading, 20 Degrees (3 Modules)

20 Degrees		Ground Snow Loads (P_g)										
		0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf	100 psf
ASCE 7-16 Wind Speeds (V)	90 MPH	1/40	1/40	1/40	1/40	**1/80**	**1/80**	2/40	2/40	2/40	2/40	2/40
	95 MPH	1/40	1/40	1/40	1/40	**1/80**	**1/80**	2/40	2/40	2/40	2/40	2/40
	100 MPH	1/40[B]	1/40[B]	1/40[B]	1/40[B]	**1/80[B]**	**1/80[B]**	2/40	2/40	2/40	2/40	2/40
	105 MPH	1/40[B]	1/40[B]	1/40[B]	**1/80[B]**	**1/80[B]**	2/40	2/40	2/40	2/40	2/40	2/40
	110 MPH	1/40[B]	1/40[B]	1/40[B]	**1/80[B]**	**1/80[B]**	2/40	2/40	2/40	2/40	2/40	2/40
	130 MPH	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]
	150 MPH	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]

[A] For all units installed in wind speeds above 110 MPH, (1) 3/8" TEK screw shall be used in place of the (1) ¼" TEK screw to connect the module clamp to the beam.

[B] For single column units installed in wind speeds above 95 MPH, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap. For (2) column units installed in wind speeds above 130 MPH, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap.



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20 Degree Tilt, Concrete Pier Requirements (3 Modules)

Tilt	Unit Type	Pier Diameter	Soil Class	Depth
20˚	1 Column	18"	Class 3	7 ft.
			Class 4	7 ft.
			Class 5	8 ft.
		24"	Class 3	6 ft.
			Class 4	7 ft.
			Class 5	7 ft.
	2 Columns	18"	Class 3	5 ft.
			Class 4	6 ft.
			Class 5	6 ft.
		24"	Class 3	5 ft.
			Class 4	5 ft.
			Class 5	6 ft.

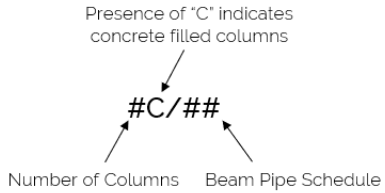
Soil Class is to be determined by a geotechnical engineer or individual with experience in classifying soils. EPS is not responsible for determining the class of the soil. The Soil Class shall be determined in accordance with the soil descriptions stated in the 2022 CBC Table 1806.2.

Allowable Unit Type Based on Loading, 30 Degrees (3 Modules)

30 Degrees		Ground Snow Loads (P_g)										
		0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf	100 psf
ASCE 7-16 Wind Speeds (V)	90 MPH	1/40	1/40	1/40	1/40	1/40	**1/80**	**1/80**	2/40	2/40	2/40	2/40
	95 MPH	1/40	1/40	1/40	1/40	**1/80**	**1/80**	**1/80**	2/40	2/40	2/40	2/40
	100 MPH	1/40[B]	1/40[B]	1/40[B]	1/40[B]	**1/80[B]**	**1/80[B]**	2/40	2/40	2/40	2/40	2/40
	105 MPH	1/40[B]	1/40[B]	1/40[B]	1/40[B]	**1/80[B]**	**1/80[B]**	2/40	2/40	2/40	2/40	2/40
	110 MPH	1/40[B]	1/40[B]	1/40[B]	**1/80[B]**	**1/80[B]**	**1/80[B]**	2/40	2/40	2/40	2/40	2/40
	130 MPH	**1C/80[A, B]**	**1C/80[A, B]**	**1C/80[A, B]**	**1C/80[A, B]**	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]
	150 MPH	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]

[A] For all units installed in wind speeds above 110 MPH, (1) 3/8" TEK screw shall be used in place of the (1) ¼" TEK screw to connect the module clamp to the beam.

[B] For single column units installed in wind speeds above 95 MPH, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap. For (2) column units installed in wind speeds above 130 MPH, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap.



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30 Degree Tilt, Concrete Pier Requirements (3 Modules)

Tilt	Unit Type	Pier Diameter	Soil Class	Depth
30˚	1 Column	18"	Class 3	7 ft.
			Class 4	8 ft.
			Class 5	9 ft.
		24"	Class 3	7 ft.
			Class 4	7 ft.
			Class 5	8 ft.
	2 Columns	18"	Class 3	6 ft.
			Class 4	7 ft.
			Class 5	8 ft.
		24"	Class 3	6 ft.
			Class 4	6 ft.
			Class 5	7 ft.

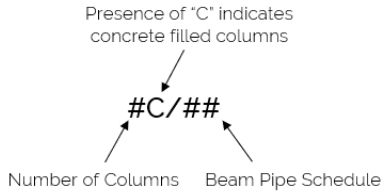
Soil Class is to be determined by a geotechnical engineer or individual with experience in classifying soils. EPS is not responsible for determining the class of the soil. The Soil Class shall be determined in accordance with the soil descriptions stated in the 2022 CBC Table 1806.2.

Allowable Unit Type Based on Loading, 40 Degrees (3 Modules)

40 Degrees		Ground Snow Loads (P_g)										
		0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf	100 psf
ASCE 7-16 Wind Speeds (V)	90 MPH	1/40	1/40	1/40	1/40	1/40	1/40	**1/80**	**1/80**	**1/80**	2/40	2/40
	95 MPH	1/40	1/40	1/40	1/40	1/40	1/40	**1/80**	**1/80**	**1/80**	2/40	2/40
	100 MPH	1/40	1/40	1/40	1/40	1/40	**1/80**	**1/80**	**1/80**	2/40	2/40	2/40
	105 MPH	1/40	1/40	1/40	1/40	1/40	**1/80**	**1/80**	**1/80**	2/40	2/40	2/40
	110 MPH	**1C/80[B]**	**1C/80[B]**	**1C/80[B]**	**1C/80[B]**	**1C/80[B]**	**1C/80[B]**	**1C/80[B]**	**1C/80[B]**	2/40	2/40	2/40
	130 MPH	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]
	150 MPH	2C/40[A]	2C/40[A]	2C/40[A]	2C/40[A]	2C/40[A]	2C/40[A]	2C/40[A]	2C/40[A]	2C/40[A]	2C/40[A]	2C/40[A]

[A] For all units installed in wind speeds above 110 MPH, (1) 3/8" TEK screw shall be used in place of the (1) ¼" TEK screw to connect the module clamp to the beam.

[B] For single column units installed in wind speeds above 105 MPH, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap.



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40 Degree Tilt, Concrete Pier Requirements (3 Modules)

Tilt	Unit Type	Pier Diameter	Soil Class	Depth
40˚	1 Column	18"	Class 3	7 ft.
			Class 4	8 ft.
			Class 5	9 ft.
		24"	Class 3	7 ft.
			Class 4	7 ft.
			Class 5	8 ft.
	2 Columns	18"	Class 3	7 ft.
			Class 4	8 ft.
			Class 5	9 ft.
		24"	Class 3	6 ft.
			Class 4	7 ft.
			Class 5	8 ft.

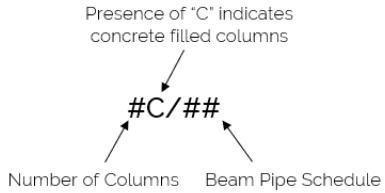
Soil Class is to be determined by a geotechnical engineer or individual with experience in classifying soils. EPS is not responsible for determining the class of the soil. The Soil Class shall be determined in accordance with the soil descriptions stated in the 2022 CBC Table 1806.2.

Allowable Unit Type Based on Loading, 50 Degrees (3 Modules)

50 Degrees		Ground Snow Loads (P_g)										
		0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf	100 psf
ASCE 7-16 Wind Speeds (V)	90 MPH	1/40	1/40	1/40	1/40	1/40	1/40	1/40	1/40	1/40	**1/80**	**1/80**
	95 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	100 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	105 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	110 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	130 MPH	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40
	150 MPH	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard

[A] For all units installed in wind speeds above 130 MPH, (1) 3/8" TEK screw shall be used in place of the (1) ¼" TEK screw to connect the module clamp to the beam.

The bollard is to encase the post and is extended upward from grade. The table above illustrates the necessary height of the bollard measured from grade.



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50 Degree Tilt, Concrete Pier Requirements (3 Modules)

Tilt	Unit Type	Pier Diameter	Soil Class	Depth
50˚	1 Column	18"	Class 3	7 ft.
			Class 4	8 ft.
			Class 5	9 ft.
		24"	Class 3	6 ft.
			Class 4	7 ft.
			Class 5	8 ft.
	2 Columns	18"	Class 3	8 ft.
			Class 4	9 ft.
			Class 5	10 ft.
		24"	Class 3	7 ft.
			Class 4	8 ft.
			Class 5	9 ft.

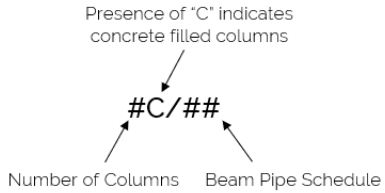
Soil Class is to be determined by a geotechnical engineer or individual with experience in classifying soils. EPS is not responsible for determining the class of the soil. The Soil Class shall be determined in accordance with the soil descriptions stated in the 2022 CBC Table 1806.2.

Allowable Unit Type Based on Loading, 60 Degrees (3 Modules)

60 Degrees		Ground Snow Loads (P_g)										
		0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf	100 psf
ASCE 7-16 Wind Speeds (V)	90 MPH	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40
	95 MPH	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40
	100 MPH	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40	1C/40
	105 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	110 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	130 MPH	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40
	150 MPH	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard	2C/40[A] 1 ft. Bollard

[A] For all units installed in wind speeds above 130 MPH, (1) 3/8" TEK screw shall be used in place of the (1) ¼" TEK screw to connect the module clamp to the beam.

The bollard is to encase the post and is extended upward from grade. The table above illustrates the necessary height of the bollard measured from grade.



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60 Degree Tilt, Concrete Pier Requirements (3 Modules)

Tilt	Unit Type	Pier Diameter	Soil Class	Depth
60˚	2 Columns	18"	Class 3	8 ft.
			Class 4	9 ft.
			Class 5	10 ft.
		24"	Class 3	7 ft.
			Class 4	8 ft.
			Class 5	9 ft.

Soil Class is to be determined by a geotechnical engineer or individual with experience in classifying soils. EPS is not responsible for determining the class of the soil. The Soil Class shall be determined in accordance with the soil descriptions stated in the 2022 CBC Table 1806.2.

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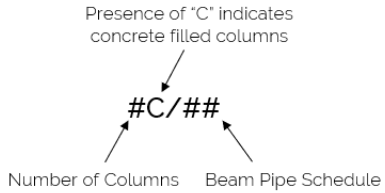
4 MODULE GROUND MOUNT SUMMARY TABLES

Allowable Unit Type Based on Loading, 10 Degrees (4 Modules)

10 Degrees		Ground Snow Loads (P_g)										
		0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf	100 psf
ASCE 7-16 Wind Speeds (V)	90 MPH	1/40	1/40	**1/80**	2/40	2/40	2/40	2/40	2/40	2/40	2/40	**2/80**
	95 MPH	1/40	1/40	**1/80**	2/40	2/40	2/40	2/40	2/40	2/40	2/40	**2/80**
	100 MPH	1/40[B]	1/40[B]	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	**2/80**
	105 MPH	1/40[B]	**1/80[B]**	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	**2/80**
	110 MPH	1/40[B]	**1/80[B]**	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	**2/80**
	130 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	**2/80**
	150 MPH	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	**2/80[A, B]**

[A] For all units installed in wind speeds above 130 MPH, (1) 3/8" TEK screw shall be used in place of the (1) ¼" TEK screw to connect the module clamp to the beam.

[B] For single column units installed in wind speeds above 95 MPH, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap. For (2) column units installed in wind speeds above 130 MPH, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap.



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10 Degree Tilt, Concrete Pier Requirements (4 Modules)

Tilt	Unit Type	Pier Diameter	Soil Class	Depth
10˚	1 Column	18"	Class 3	5 ft.
			Class 4	6 ft.
			Class 5	6 ft.
		24"	Class 3	5 ft.
			Class 4	5 ft.
			Class 5	6 ft.
	2 Columns	18"	Class 3	5 ft.
			Class 4	5 ft.
			Class 5	6 ft.
		24"	Class 3	5 ft.
			Class 4	5 ft.
			Class 5	5 ft.

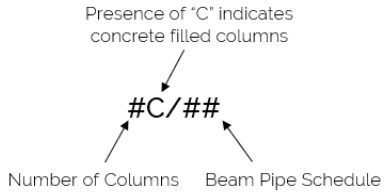
Soil Class is to be determined by a geotechnical engineer or individual with experience in classifying soils. EPS is not responsible for determining the class of the soil. The Soil Class shall be determined in accordance with the soil descriptions stated in the 2022 CBC Table 1806.2.

Allowable Unit Type Based on Loading, 20 Degrees (4 Modules)

20 Degrees		Ground Snow Loads (P_g)										
		0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf	100 psf
ASCE 7-16 Wind Speeds (V)	90 MPH	1/40[B]	1/40[B]	**1/80[B]**	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	95 MPH	1/40[B]	1/40[B]	**1/80[B]**	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	100 MPH	1/40[B]	**1/80[B]**	**1/80[B]**	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	105 MPH	**1/80[B]**	**1/80[B]**	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	110 MPH	**1/80[B]**	**1/80[B]**	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	130 MPH	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]
	150 MPH	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2C/40[A, B]

[A] For all units installed in wind speeds above 110 MPH, (1) 3/8" TEK screw shall be used in place of the (1) ¼" TEK screw to connect the module clamp to the beam.

[B] For single column units, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap. For (2) column units installed in wind speeds above 110 MPH, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap.



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20 Degree Tilt, Concrete Pier Requirements (4 Modules)

Tilt	Unit Type	Pier Diameter	Soil Class	Depth
20˚	1 Column	18"	Class 3	6 ft.
			Class 4	6 ft.
			Class 5	7 ft.
		24"	Class 3	5 ft.
			Class 4	6 ft.
			Class 5	7 ft.
	2 Columns	18"	Class 3	6 ft.
			Class 4	6 ft.
			Class 5	7 ft.
		24"	Class 3	5 ft.
			Class 4	6 ft.
			Class 5	6 ft.

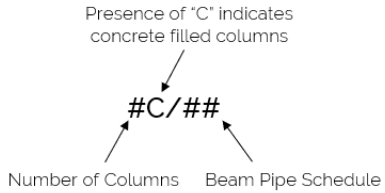
Soil Class is to be determined by a geotechnical engineer or individual with experience in classifying soils. EPS is not responsible for determining the class of the soil. The Soil Class shall be determined in accordance with the soil descriptions stated in the 2022 CBC Table 1806.2.

Allowable Unit Type Based on Loading, 30 Degrees (4 Modules)

30 Degrees		Ground Snow Loads (P_g)										
		0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf	100 psf
ASCE 7-16 Wind Speeds (V)	90 MPH	1/40[B]	1/40[B]	**1/80[B]**	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	95 MPH	**1/80[B]**	**1/80[B]**	**1/80[B]**	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	100 MPH	**1/80[B]**	**1/80[B]**	**1/80[B]**	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	105 MPH	**1/80[B]**	**1/80[B]**	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	110 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	130 MPH	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]
	150 MPH	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]	2/40[A, B]

[A] For all units installed in wind speeds above 110 MPH, (1) 3/8" TEK screw shall be used in place of the (1) ¼" TEK screw to connect the module clamp to the beam.

[B] For single column units, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap. For (2) column units installed in wind speeds above 110 MPH, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap.



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30 Degree Tilt, Concrete Pier Requirements (4 Modules)

Tilt	Unit Type	Pier Diameter	Soil Class	Depth
30˚	1 Column	18"	Class 3	7 ft.
			Class 4	8 ft.
			Class 5	9 ft.
		24"	Class 3	6 ft.
			Class 4	7 ft.
			Class 5	8 ft.
	2 Columns	18"	Class 3	7 ft.
			Class 4	8 ft.
			Class 5	9 ft.
		24"	Class 3	6 ft.
			Class 4	7 ft.
			Class 5	8 ft.

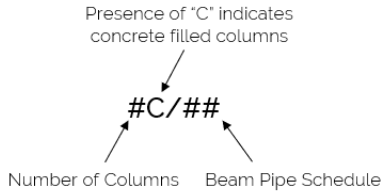
Soil Class is to be determined by a geotechnical engineer or individual with experience in classifying soils. EPS is not responsible for determining the class of the soil. The Soil Class shall be determined in accordance with the soil descriptions stated in the 2022 CBC Table 1806.2.

Allowable Unit Type Based on Loading, 40 Degrees (4 Modules)

40 Degrees		Ground Snow Loads (P_g)										
		0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf	100 psf
ASCE 7-16 Wind Speeds (V)	90 MPH	1/40	1/40	**1/80**	**1/80**	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	95 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	100 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	105 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	110 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	130 MPH	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]
	150 MPH	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]	2C/40[A, B]

[A] For all units installed in wind speeds above 110 MPH, (1) 3/8" TEK screw shall be used in place of the (1) ¼" TEK screw to connect the module clamp to the beam.

[B] For (2) column units installed in wind speeds above 110 MPH, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap.



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40 Degree Tilt, Concrete Pier Requirements (4 Modules)

Tilt	Unit Type	Pier Diameter	Soil Class	Depth
40˚	1 Column	18"	Class 3	7 ft.
			Class 4	8 ft.
			Class 5	9 ft.
		24"	Class 3	6 ft.
			Class 4	7 ft.
			Class 5	8 ft.
	2 Columns	18"	Class 3	8 ft.
			Class 4	8 ft.
			Class 5	10 ft.
		24"	Class 3	7 ft.
			Class 4	8 ft.
			Class 5	9 ft.

Soil Class is to be determined by a geotechnical engineer or individual with experience in classifying soils. EPS is not responsible for determining the class of the soil. The Soil Class shall be determined in accordance with the soil descriptions stated in the 2022 CBC Table 1806.2.

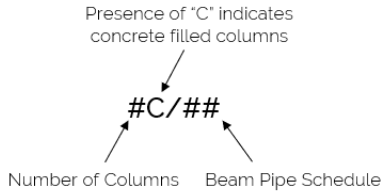
Allowable Unit Type Based on Loading, 50 Degrees (4 Modules)

50 Degrees		Ground Snow Loads (P_g)										
		0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf	100 psf
ASCE 7-16 Wind Speeds (V)	90 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	95 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	100 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	105 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	110 MPH	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40
	130 MPH	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard
	150 MPH	2C/40[A, B] 2 ft. Bollard	2C/40[A, B] 2 ft. Bollard	2C/40[A, B] 2 ft. Bollard	2C/40[A, B] 2 ft. Bollard	2C/40[A, B] 2 ft. Bollard	2C/40[A, B] 2 ft. Bollard	2C/40[A, B] 2 ft. Bollard	2C/40[A, B] 2 ft. Bollard	2C/40[A, B] 2 ft. Bollard	2C/40[A, B] 2 ft. Bollard	2C/40[A, B] 2 ft. Bollard

[A] For all units installed in wind speeds above 130 MPH, (1) 3/8" TEK screw shall be used in place of the (1) ¼" TEK screw to connect the module clamp to the beam.

[B] For (2) column units installed in wind speeds above 130 MPH, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap.

The bollard is to encase the post and is extended upward from grade. The table above illustrates the necessary height of the bollard measured from grade.



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50 Degree Tilt, Concrete Pier Requirements (4 Modules)

Tilt	Unit Type	Pier Diameter	Soil Class	Depth
50˚	2 Columns	18"	Class 3	9 ft.
			Class 4	10 ft.
			Class 5	11 ft.
		24"	Class 3	8 ft.
			Class 4	9 ft.
			Class 5	10 ft.

Soil Class is to be determined by a geotechnical engineer or individual with experience in classifying soils. EPS is not responsible for determining the class of the soil. The Soil Class shall be determined in accordance with the soil descriptions stated in the 2022 CBC Table 1806.2.

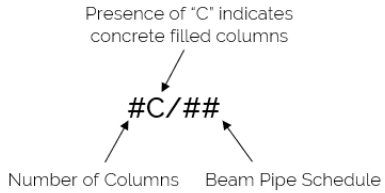
Allowable Unit Type Based on Loading, 60 Degrees (4 Modules)

60 Degrees		Ground Snow Loads (P_g)										
		0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf	100 psf
ASCE 7-16 Wind Speeds (V)	90 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	95 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	100 MPH	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40	2/40
	105 MPH	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40
	110 MPH	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40	2C/40
	130 MPH	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard	2C/40 1 ft. Bollard
	150 MPH	2C/40[A, B] 3 ft. Bollard	2C/40[A, B] 3 ft. Bollard	2C/40[A, B] 3 ft. Bollard	2C/40[A, B] 3 ft. Bollard	2C/40[A, B] 3 ft. Bollard	2C/40[A, B] 3 ft. Bollard	2C/40[A, B] 3 ft. Bollard	2C/40[A, B] 3 ft. Bollard	2C/40[A, B] 3 ft. Bollard	2C/40[A, B] 3 ft. Bollard	2C/40[A, B] 3 ft. Bollard

[A] For all units installed in wind speeds above 130 MPH, (1) 3/8" TEK screw shall be used in place of the (1) ¼" TEK screw to connect the module clamp to the beam.

[B] For (2) column units installed in wind speeds above 130 MPH, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap.

The bollard is to encase the post and is extended upward from grade. The table above illustrates the necessary height of the bollard measured from grade.



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60 Degree Tilt, Concrete Pier Requirements (4 Modules)

Tilt	Unit Type	Pier Diameter	Soil Class	Depth
60˚	2 Columns	18"	Class 3	9 ft.
			Class 4	10 ft.
			Class 5	11 ft.
		24"	Class 3	8 ft.
			Class 4	9 ft.
			Class 5	10 ft.

Soil Class is to be determined by a geotechnical engineer or individual with experience in classifying soils. EPS is not responsible for determining the class of the soil. The Soil Class shall be determined in accordance with the soil descriptions stated in the 2022 CBC Table 1806.2.

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4.0 – GRAVITY AND LATERAL CALCULATIONS

4.1 – Site Design Parameters

- **Ground Mount Geometry:**

Array Size:	1x3 or 1x4
Max. Module Size/Weight:	83"x43" / ≈ 74 lbs.
Max. Post Height:	6 ft.
Array Tilt:	10˚ to 60˚

- **Wind Design Parameters:**

Wind Speed (3 second gust) (V):	Varies (see summary tables)
Exposure Category	C
Wind Directionality Factor (Kd):	0.85
Velocity Pressure Exposure (Kh):	0.85
Topographic Factor (Kzt):	1.00
Risk Category:	I
Guest Factor (G)	0.85

- **Snow Loads:**

Ground Snow Load (p_g):	Varies (see summary tables)

- **Seismic Design Parameters:**

Site Class (Assumed per IBC 1613.2.2):	D
S_{DS}:	2.000g
Seismic Design Category:	D

- **Soil Design Parameters (per Table 1806.2):**
  It is assumed that the soil type is clay, silt, sand, or gravel and concrete piers are a viable foundation type. EPS shall be notified if bedrock, cobbles/boulders, or if any other soil conditions are encountered that do not allow the concrete piers to be installed to their required depth. If the site has the potential for unique geotechnical conditions (shallow bedrock, deep frost depth, frost jacking forces, etc.) EPS recommends the owner obtain a geotechnical report prior to project design. EPS recommends defaulting to Class 5 foundation depths if the soil type is unknown however, corresponding foundation depths for Class 3 and 4 soils have been provided. To use the foundation depths for Class 3 or 4, EPS recommends having someone with adequate knowledge on soil classification (ex. Geotechnical Engineer) classify the soil at the site. EPS is NOT responsible for the classification of the soil or the decision to use foundation depths from Class 3 or 4.

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4.2 – Ground Mount Design Loads

The following pages document the determination of the imposed design loads based on the parameters listed in Section 3.1, the proposed materials, and the requirements given in the governing building code.

4.2.1 – Dead Loads

The modules are assumed to be 72 cell modules. The maximum listed weight is approximately 74 lbs. with a size of 83" x 43". Modules are attached to the rails along a portion of their length with a 35" long rail transferring a maximum load of 10.8 plf per module with a point load on each end (to account for module overhang) of 21.5 lbs. Smaller size modules such as typical 60 cell modules are also acceptable since the larger size used would be conservative.

4.2.2 – Snow Loads

The site Ground Snow Load (p_g) can vary and the allowable wind/snow combinations are shown in the summary tables of this packet. Per ASCE 7 section 7.3, the flat roof snow load is determined by equation 7.3-1 where C_e has conservatively been taken as 1.0 (partially exposed), C_t has been taken as 1.2 (open air structure), and I_s has been taken as 1.0*. Per section 7.4, the sloped roof snow load (p_s) is C_s*p_f where p_f is the flat roof snow load and C_s would be determined per Figure 7.4-1 7-2c for an unobstructed slippery surface. The snow loads have been analyzed for all listed wind/snow load combinations shown in the summary tables.

*Please note that although the Tamarack Single Post Ground Mount is a Risk Category I structure which would correspond to a snow load importance factor (I_s) of 0.8, I_s has conservatively been taken as 1.0 in this analysis for all snow loads.

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4.2.3 – Wind Loads

The maximum wind loads (normal to the module surface) were calculated using the wind factors listed in 3.1 of this packet and per ASCE 7-16 Section 27.3.2 with Figure 27.3-4 for tilt options 10˚, 20˚, 30˚, and 40˚. For tilt options 50˚ and 60˚, the maximum wind loads (normal to the module surface) were calculated using the wind factors listed in section 3.1 of this packet as well as both the section listed previously and Section 29.3 with Figure 29.3-1. The linear forces to the rails represent the distributed loads at each rail with the Back (tall) column representing the line load on the rails on the upper half of the array and the Front (short) representing the line load on the ralis on the lower half of the array. The point loads to the rails represent the loads from the overhanging portion of the module on the rail with the Back (tall) column representing the point load on the rails on the upper half of the array and the Front (short) representing the point load on the rails on the lower half of the array. All (4) wind cases have been analyzed in the structural model as shown later in this packet (example case provided on the following page).

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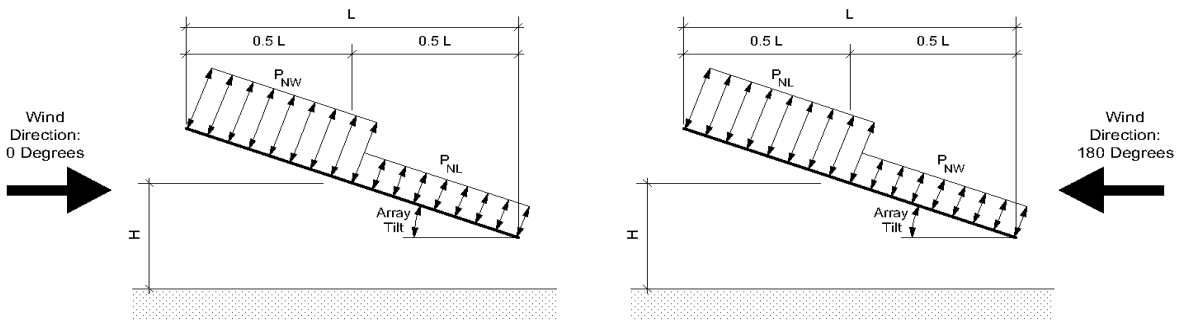
Wind Pressures and Loads for Ground Mounted PV Systems (ASCE 7-16)

Governing Building Code:	2022 CBC	
Wind Speed (3 Second Gust Speed) (V):	110	MPH
Exposure Category:	C	
Wind Directionality Factor (K_d):	0.85	
Velocity Pressure Exposure Coefficient (K_h):	0.85	
Topographic Factor (K_{zt}):	1.00	
Velocity Pressure (q):	**22.38**	**psf**
Gust Effect Factor (G):	0.85	
Module Width:	43.00	in.
Module Length:	83.00	in.
Module Area:	24.78	ft^2
Tributary Width of Rails:	3.58	ft.

GC_N Factors & Design Wind Pressures Normal to Module Face

Array Tilt	Wind Direction	Module Zone	C_{NW}	C_{NL}	Wind Pressures (psf)		Forces on Rails (plf)	
					P_{NW}	P_{NL}	Back (Tall)	Front (Short)
30°	0°	A	-1.8	-1.8	-34.2	-34.2	-122.7	-122.7
		B	-2.5	-0.5	-47.6	-9.5	-170.4	-34.1
	180°	A	2.1	2.1	39.9	39.9	143.1	143.1
		B	2.6	1.0	49.5	19.0	68.2	177.2



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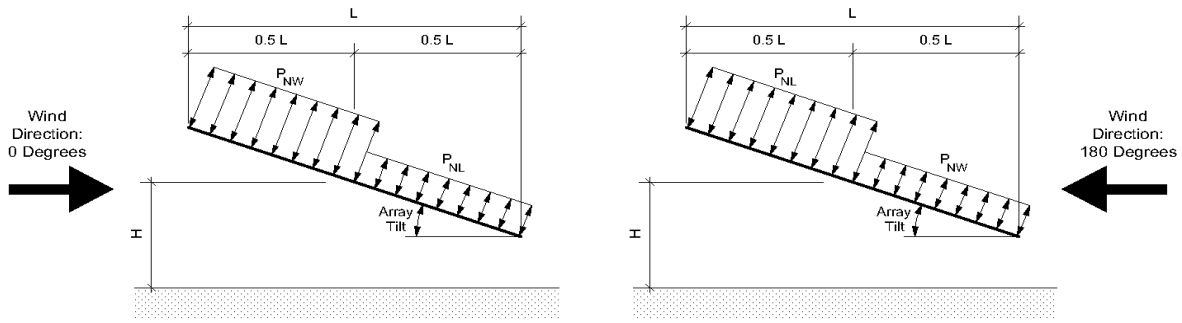
Wind Pressures and Loads for Ground Mounted PV Systems (ASCE 7-16)

Governing Building Code:	2022 CBC	
Wind Speed (3 Second Gust Speed) (V):	110	MPH
Exposure Category:	C	
Wind Directionality Factor (K_d):	0.85	
Velocity Pressure Exposure Coefficient (K_h):	0.85	
Topographic Factor (K_{zt}):	1.00	
Velocity Pressure (q):	**22.38**	**psf**
Gust Effect Factor (G):	0.85	
Module Width:	43.00	in.
Module Length:	83.00	in.
Module Area:	24.78	ft^2
Tributary Area of Point Loads:	7.17	ft^2

GC_N Factors & Design Wind Pressures Normal to Module Face

Array Tilt	Wind Direction	Module Zone	C_{NW}	C_{NL}	Wind Pressures (psf)		Point Loads on Rails (lbs.)	
					P_{NW}	P_{NL}	F1 & F2	F3 & F4
30°	0°	A	-1.8	-1.8	-34.2	-34.2	-245.4	-245.4
		B	-2.5	-0.5	-47.6	-9.5	-340.8	-68.2
	180°	A	2.1	2.1	39.9	39.9	286.3	286.3
		B	2.6	1.0	49.5	19.0	136.3	354.5



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4.2.4 – Seismic Loads

The maximum assumed spectral accelerations are shown below:

- Site Class = D (Assumed per IBC 1613.2.2)
- S_{DS} = 2.000 ($2/3^{*}S_{MS}$)

Based on these accelerations the worst-case Seismic Design Category is "D". Using a seismic importance factor of 1.00, and an R of 2.0 based on ASCE 7-16 Table 15.4-2 for Nonbuilding Structures Not Similar to Buildings, the base shear can be calculated:

- Base Shear (V) = $C_s{}^{*}W$ (per Equation 12.8-1)
  - W = weight (dead load)
  - Governing C_s = S_{DS} / (R/I) = 1.000

  V = $1.000^{*}W$ (Strength Level)

Using the weight of the modules and tributary area to each module to purlin connection point, a seismic force has been calculated for each direction:

- Solar module weight = 74.0 lbs.
- Tributary width to each connection point = 3.58 ft.
- Tributary length to each connection point = 2.0 ft.
- Dead load per connection point (line load) = 10.8 plf
- Seismic force in each direction at each point:
  - = 1.000^{*} 10.8 lbs. = **10.8 plf**

- Dead load per connection point (point load) = 21.5 lbs.
- Seismic force in each direction at each point:
  - = 1.000^{*} 21.5 lbs. = **21.5 lbs.**

These forces are listed in the following racking analysis.
(Note that the self-weight of the racking and posts has been taken into account in models)

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4.3 – Ground Mount Framing Analysis

The following pages includes an example of the structural design of the Tamarack Single Post Ground Mount under a set of example parameters to illustrate the analysis process used for each unit size and design scenario (tilt, wind speed, snow load, etc.).

The following example calculations and results are for a 3 module 1/40 unit ground mount with a 30˚ tilt, an 18" pier, Class 5 Soils, and 110 MPH wind speed (ASCE 7-16 wind speed) with 10 psf ground snow load. For all other wind speed and ground snow load combinations, the required unit type (#C/##) and required foundation size/depth has been summarized in the Summary Tables in Section 3.0 of this packet for the listed tilt options. The full analysis of every load combination and tilt is not shown in this packet in the interest of space but the overall results have been summarized in the Summary Tables in Section 3.0.

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Allowable Unit Type Based on Loading, 30 Degrees (3 Modules)

30 Degrees		Ground Snow Loads (P_g)										
		0 psf	10 psf	20 psf	30 psf	40 psf	50 psf	60 psf	70 psf	80 psf	90 psf	100 psf
ASCE 7-16 Wind Speeds (V)	90 MPH	1/40	1/40	1/40	1/40	1/40	1/80	1/80	2/40	2/40	2/40	2/40
	95 MPH	1/40	1/40	1/40	1/40	1/80	1/80	1/80	2/40	2/40	2/40	2/40
	100 MPH	1/40[B]	1/40[B]	1/40[B]	1/40[B]	1/80[B]	1/80[B]	2/40	2/40	2/40	2/40	2/40
	105 MPH	1/40[B]	1/40[B]	1/40[B]	1/40[B]	1/80[B]	1/80[B]	2/40	2/40	2/40	2/40	2/40
	110 MPH	1/40[B]	1/40[B]	1/40[B]	1/80[B]	1/80[B]	1/80[B]	2/40	2/40	2/40	2/40	2/40
	130 MPH	1C/80[A,B]	1C/80[A,B]	1C/80[A,B]	1C/80[A,B]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]	2/40[A]
	150 MPH	2/40[A,B]	2/40[A,B]	2/40[A,B]	2/40[A,B]	2/40[A,B]	2/40[A,B]	2/40[A,B]	2/40[A,B]	2/40[A,B]	2/40[A,B]	2/40[A,B]

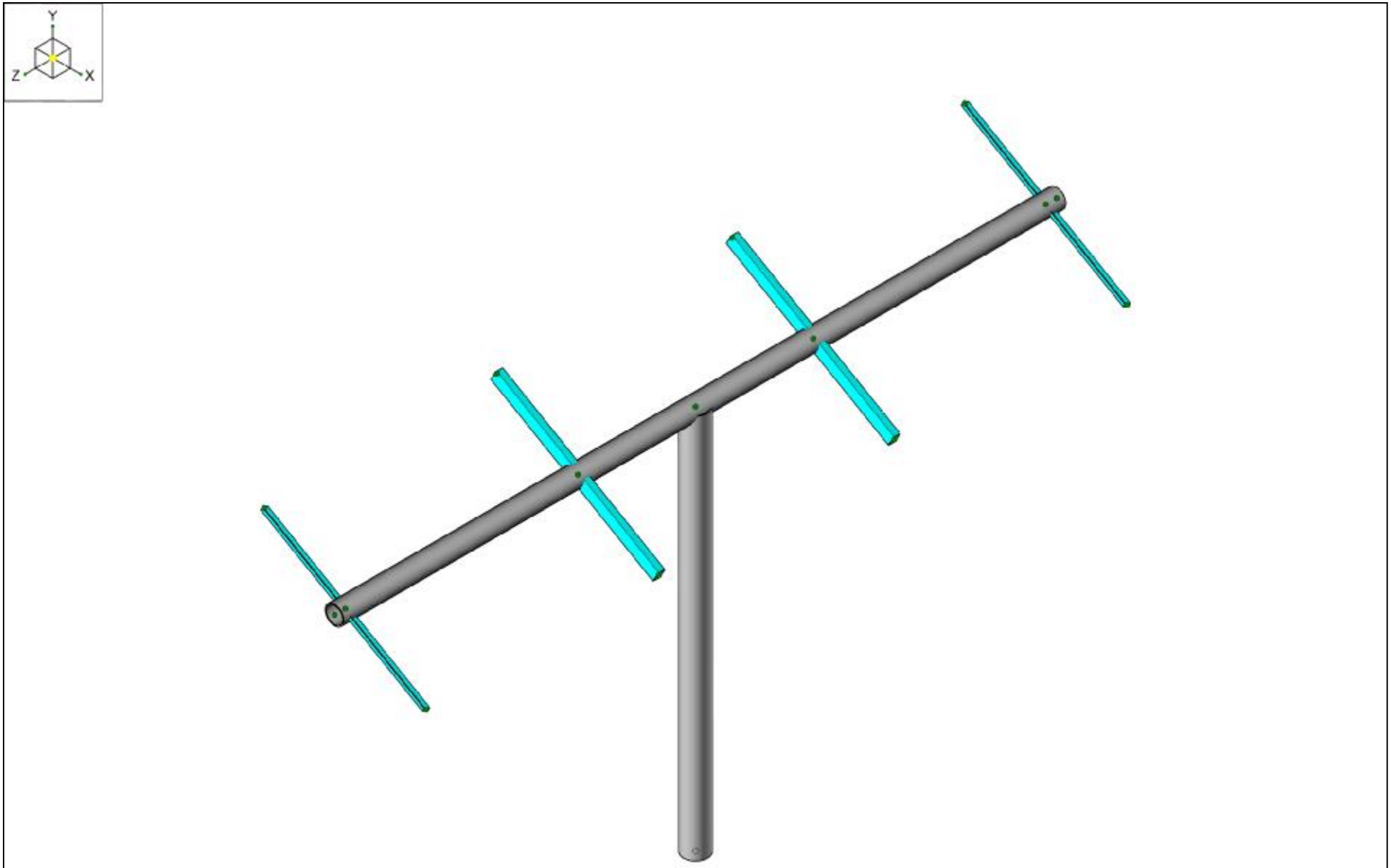
[A] For all units installed in wind speeds above 110 MPH, (1) 3/8" TEK screw shall be used in place of the (1) ¼" TEK screw to connect the module clamp to the beam.

[B] For single column units installed in wind speeds above 95 MPH, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap. For (2) column units installed in wind speeds above 130 MPH, (2) 3/8" TEK screws shall be used in place of the (2) ¼" TEK screws to connect the beam to the post cap.

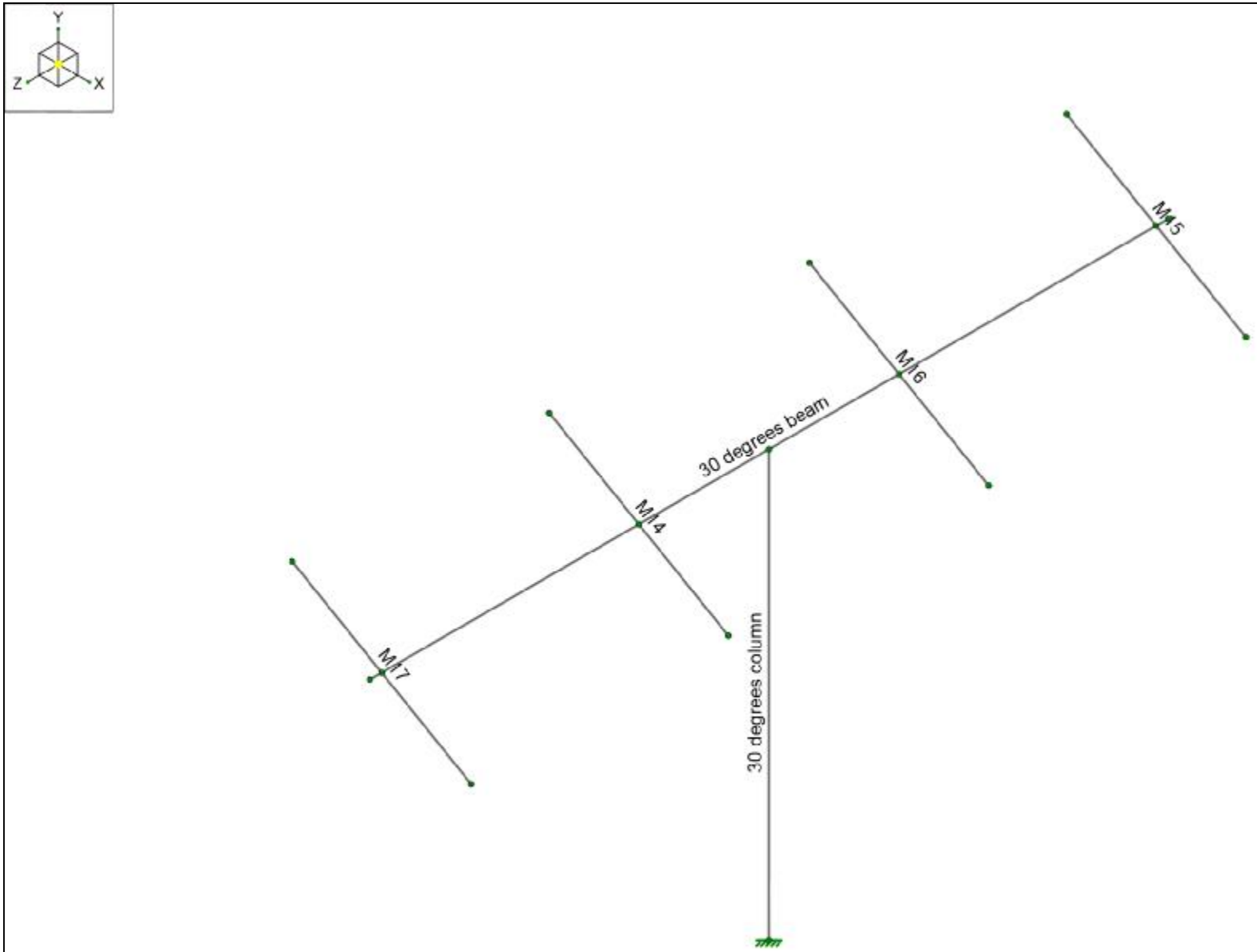
30 Degree Tilt, Concrete Pier Requirements (3 Modules)

Tilt	Unit Type	Pier Diameter	Soil Class	Depth
30°	1 Column	18"	Class 3	7 ft.
			Class 4	8 ft.
			Class 5	9 ft.
		24"	Class 3	7 ft.
			Class 4	7 ft.
			Class 5	8 ft.
	2 Columns	18"	Class 3	6 ft.
			Class 4	7 ft.
			Class 5	8 ft.
		24"	Class 3	6 ft.
			Class 4	6 ft.
			Class 5	7 ft.

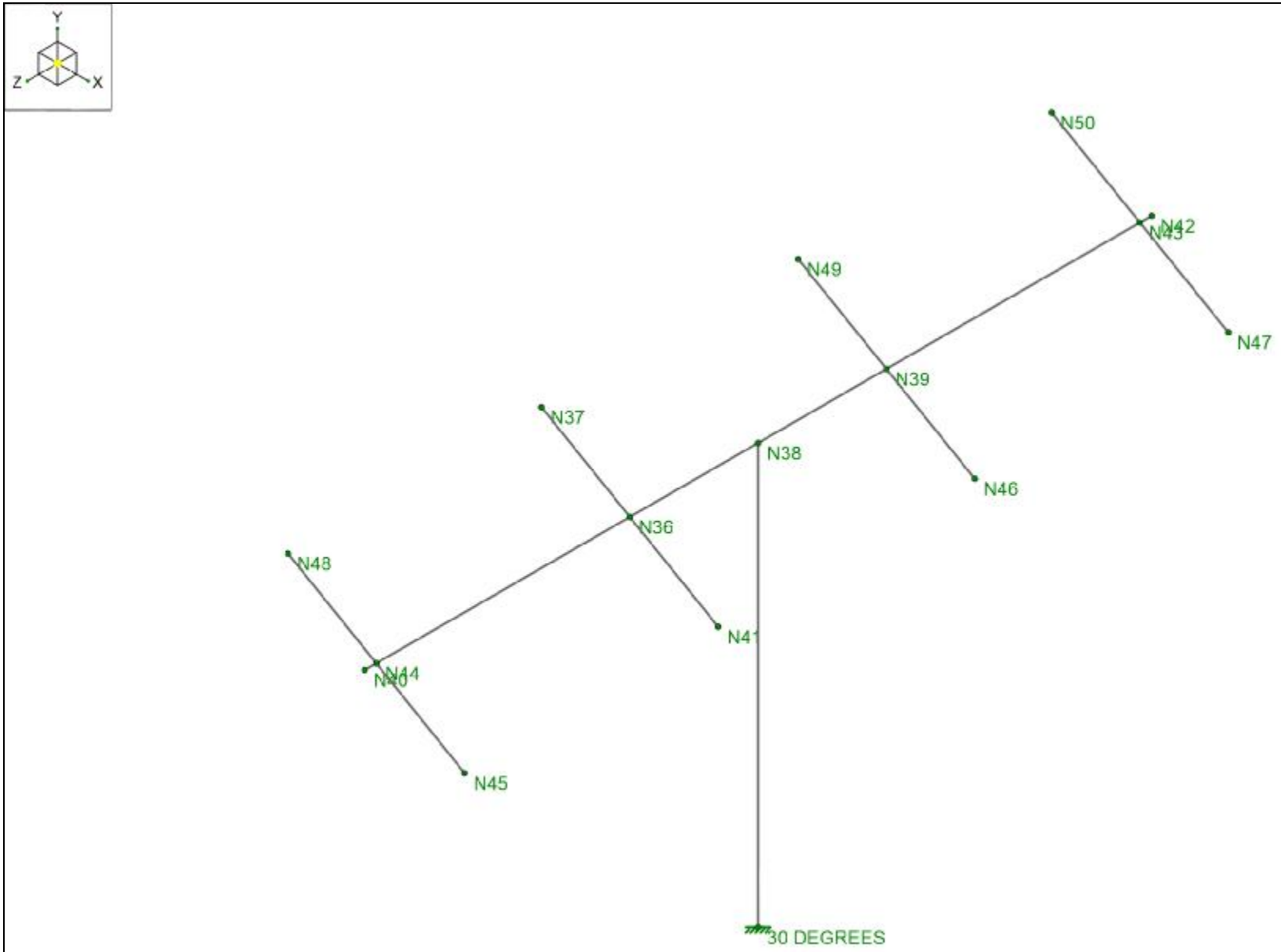
Excerpts from "Allowable Unit Type Based on Loading" and "Concrete Pier Requirements" Summary Tables for given example case



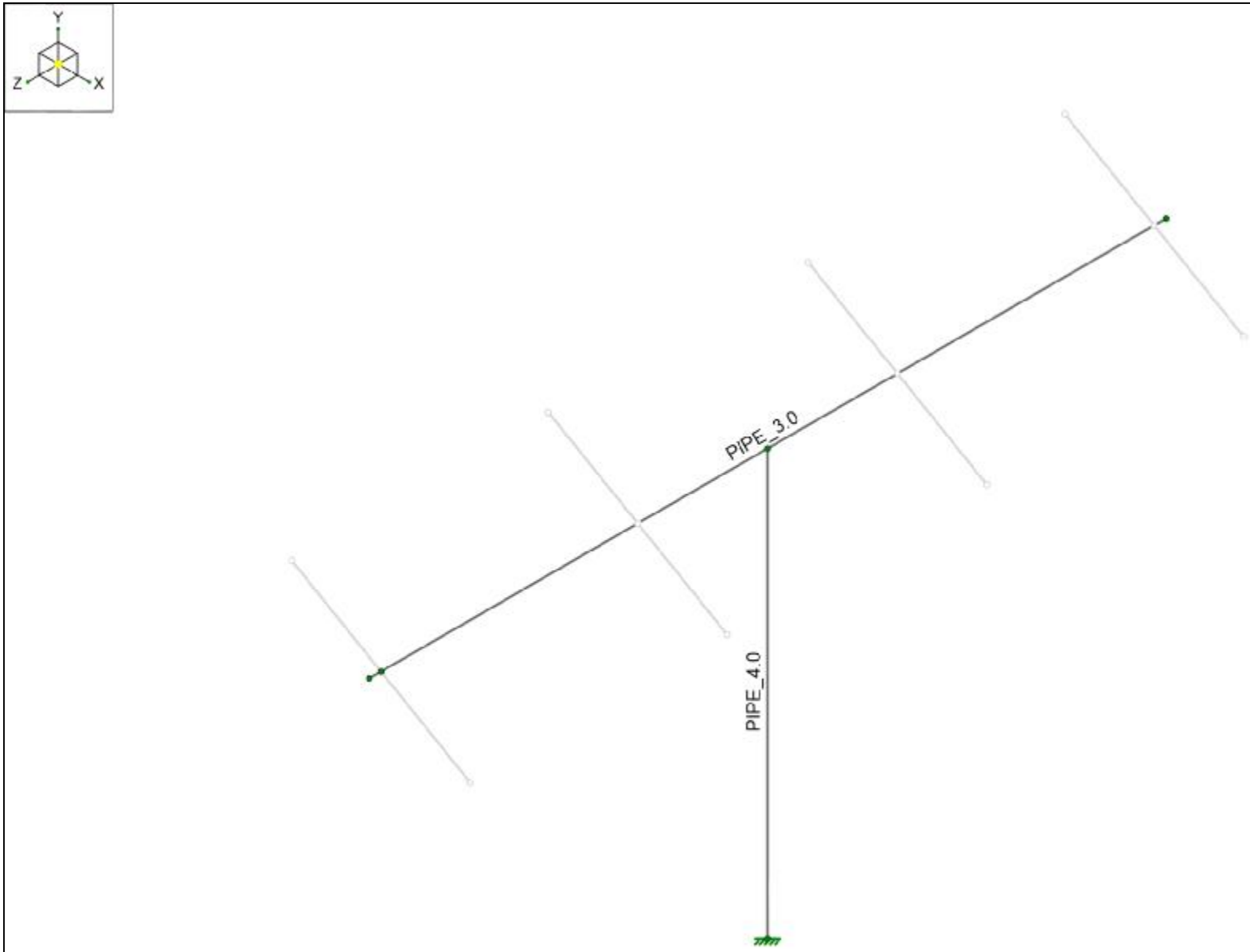
EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-1
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



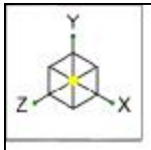
EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-2
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d

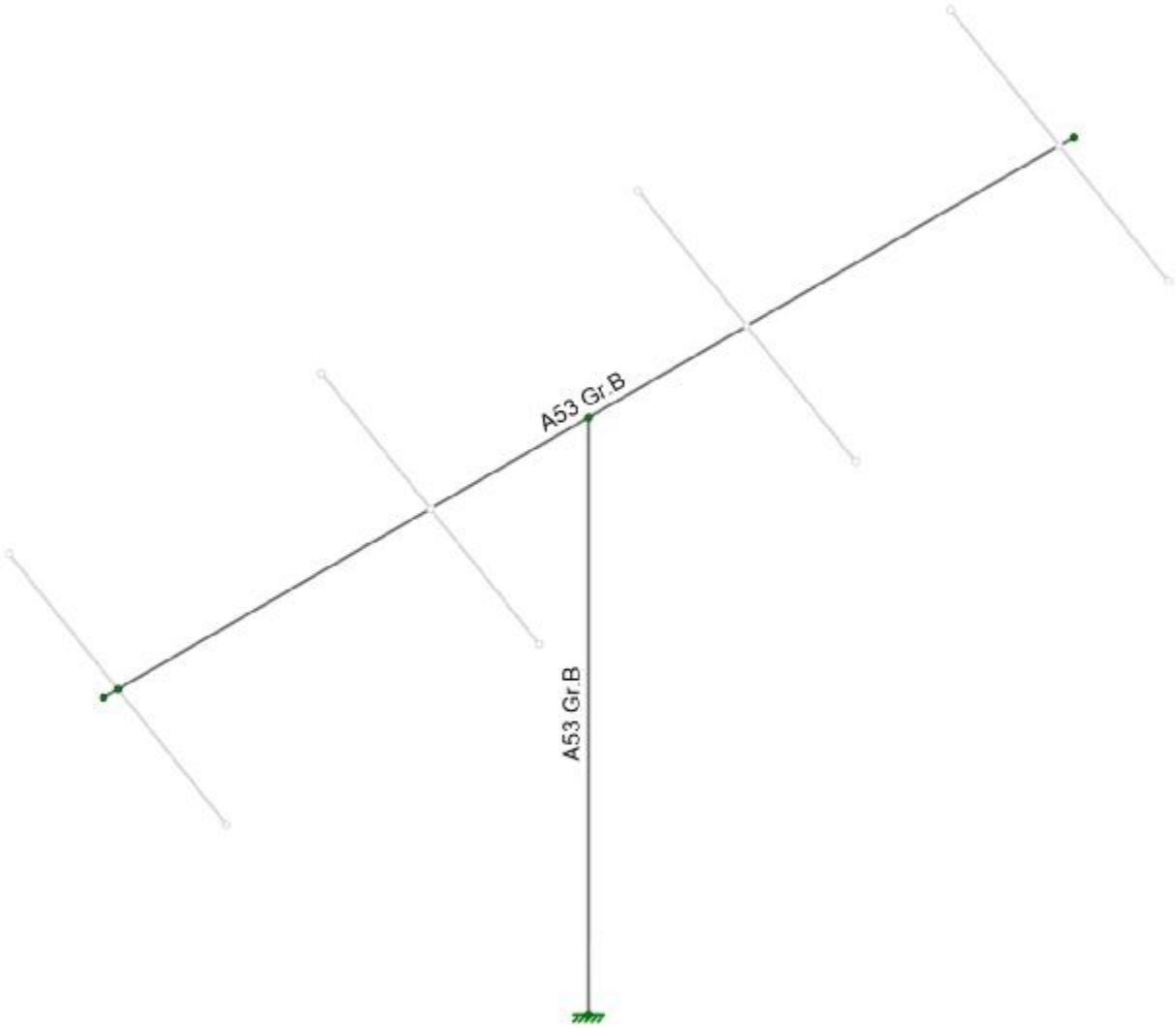


EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-3
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d

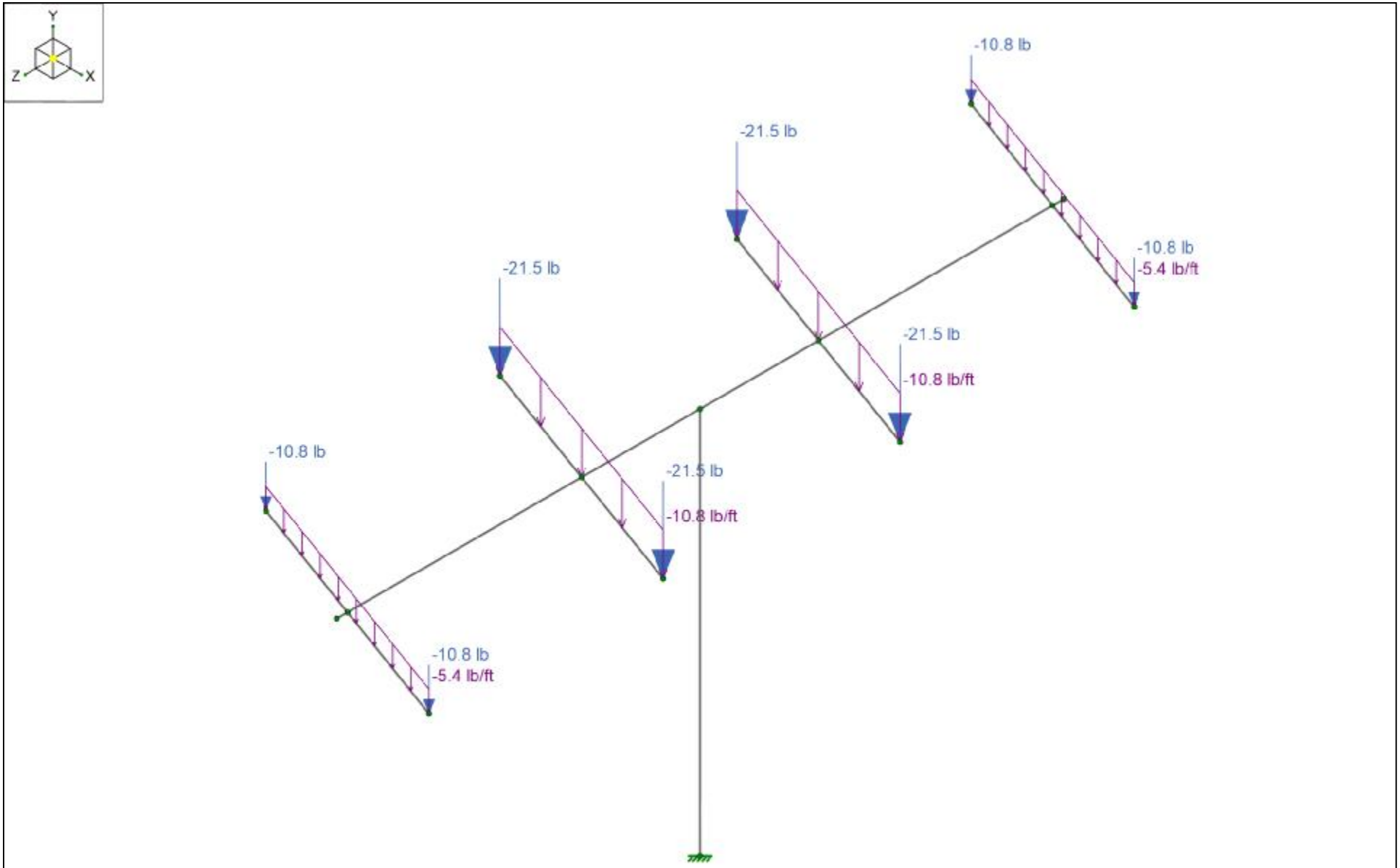


EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-4
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



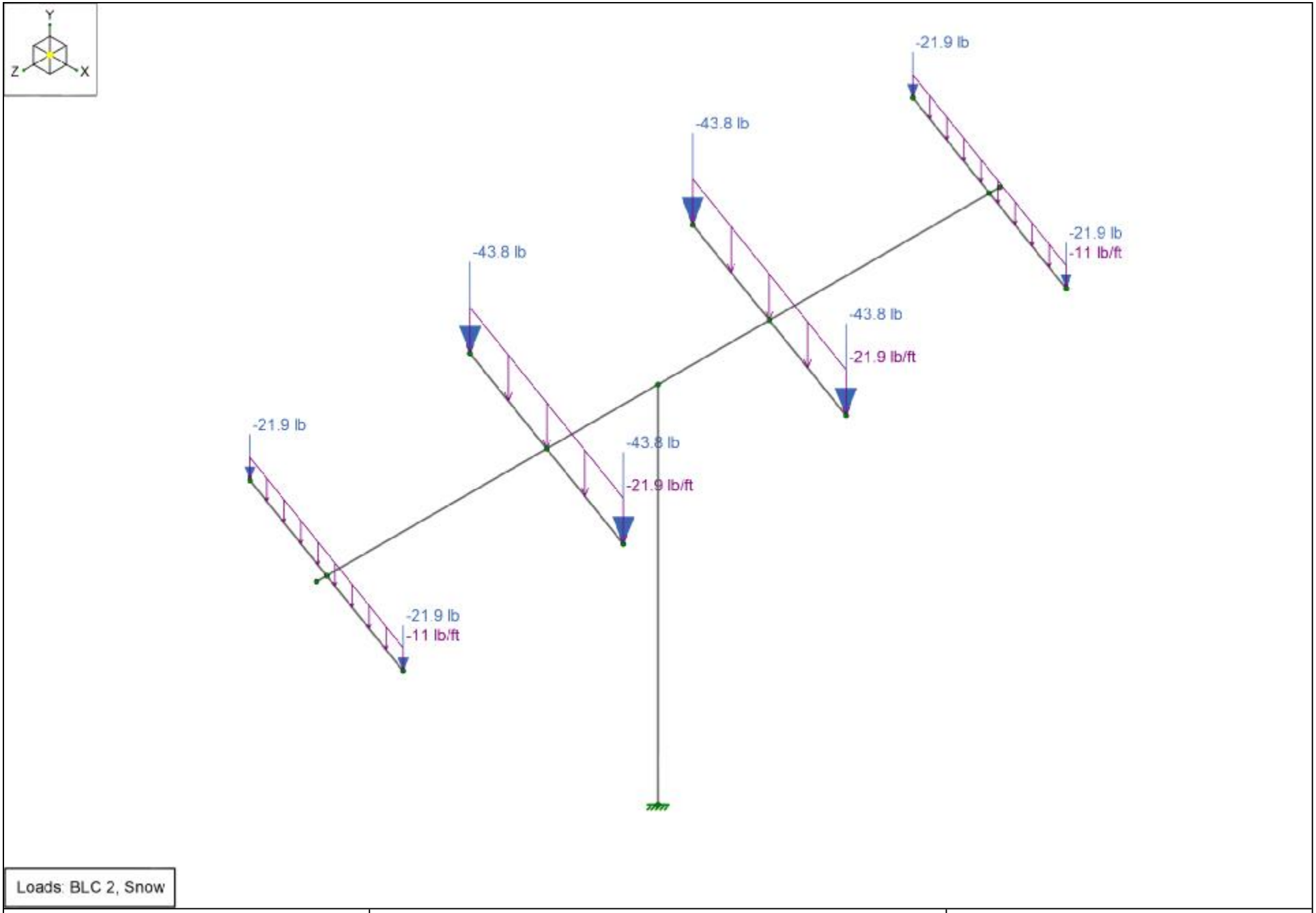


EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-5
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



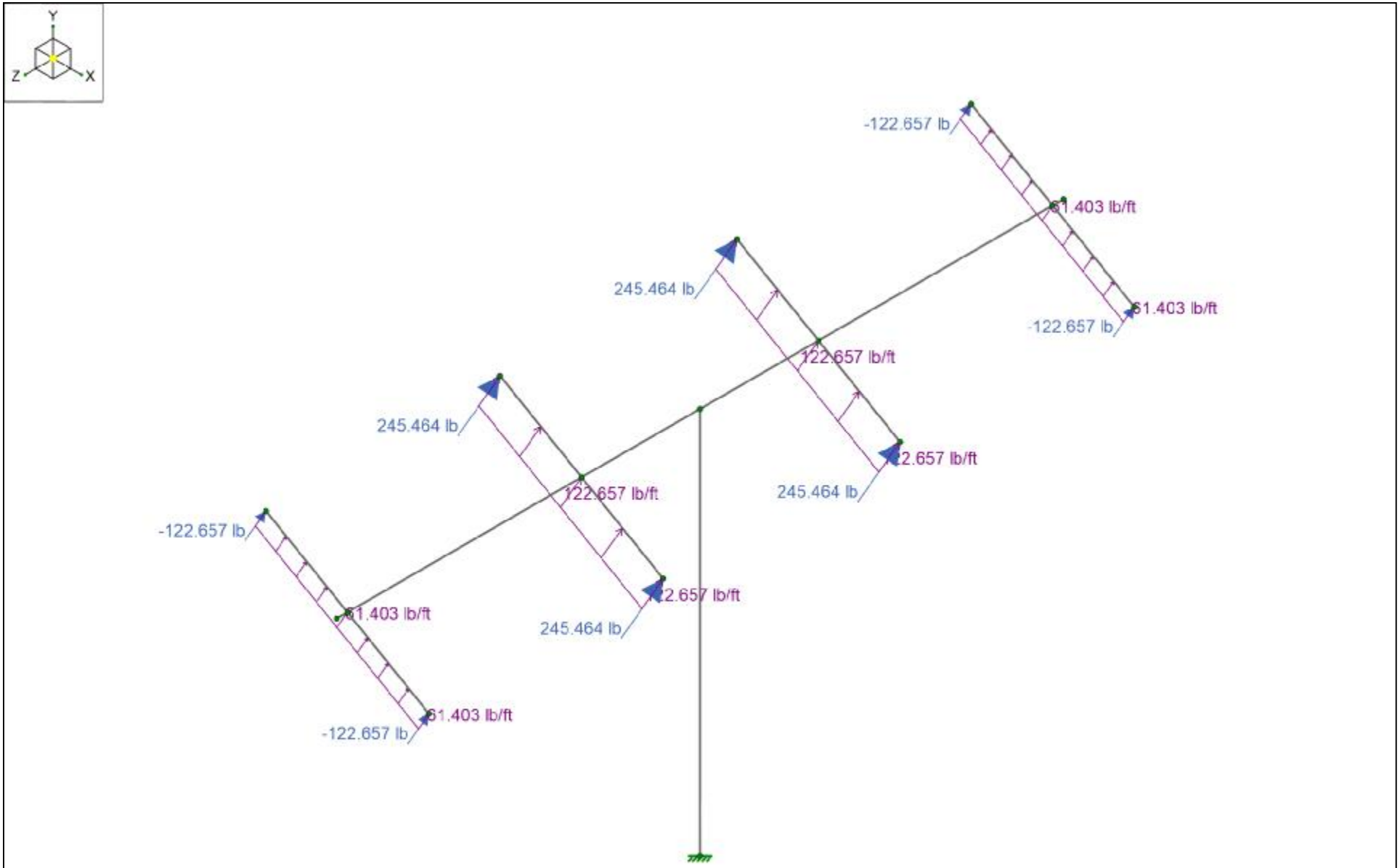
Loads: BLC 1, Dead

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-6
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



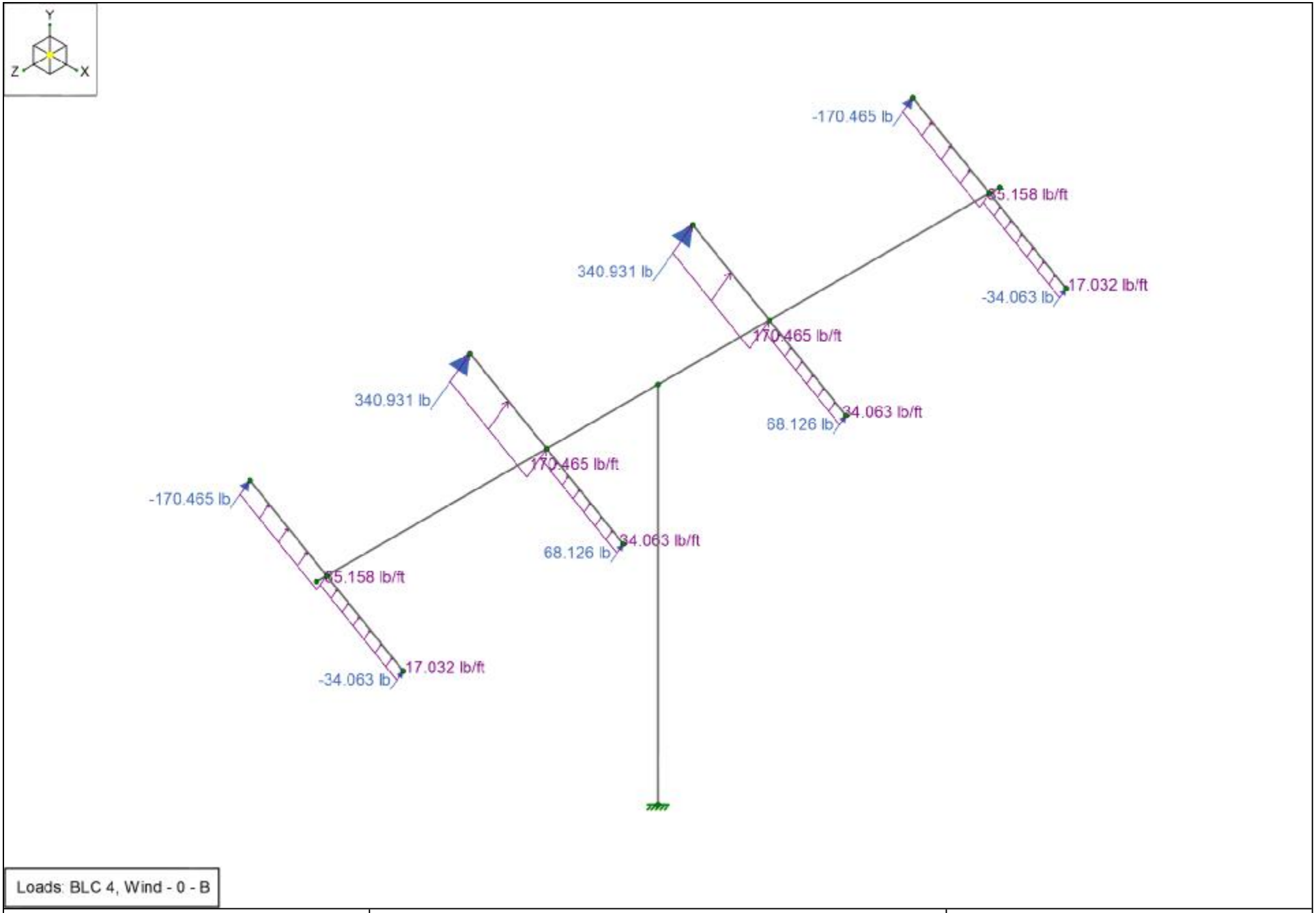
Loads: BLC 2, Snow

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-7
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



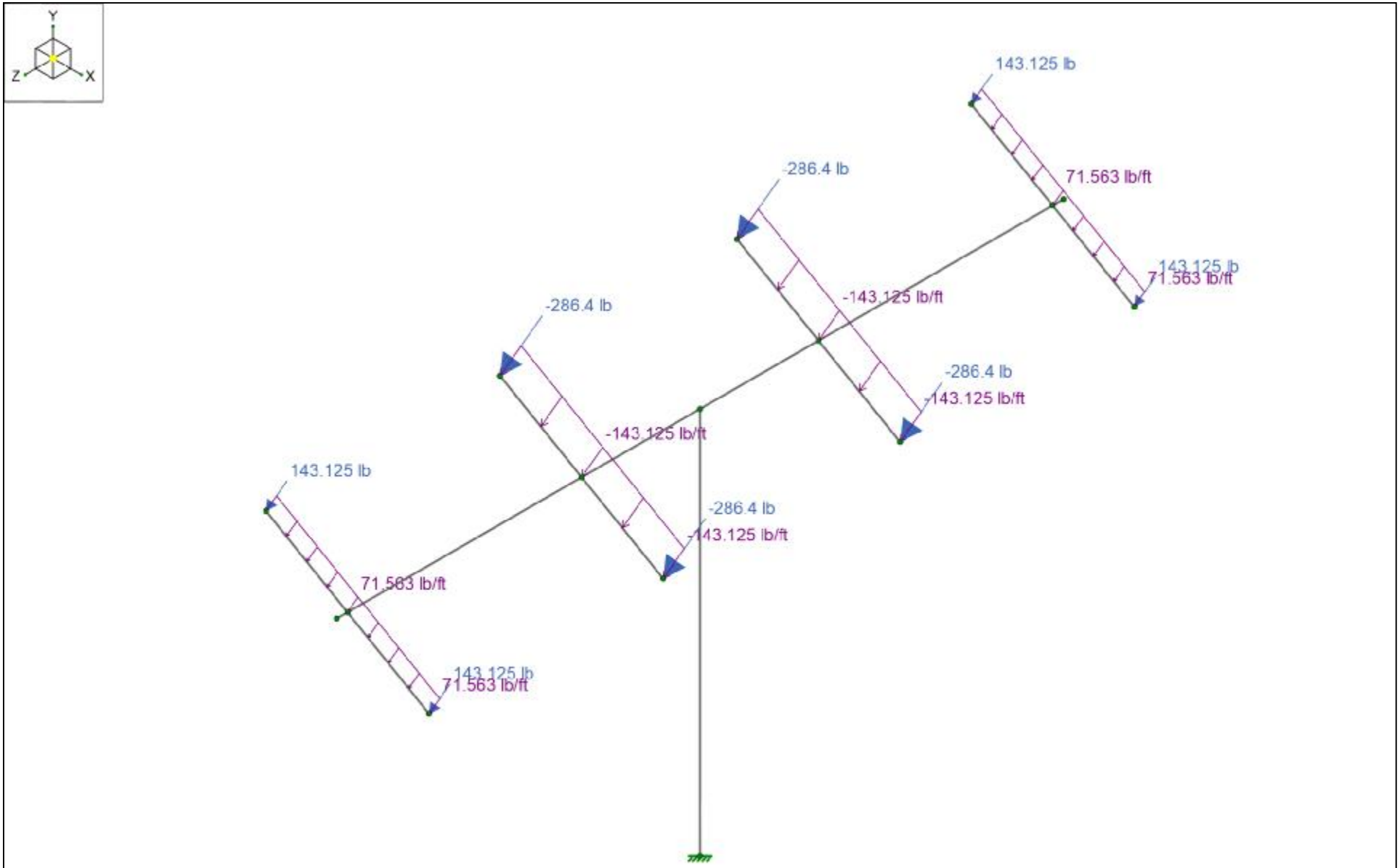
Loads: BLC 3, Wind - 0 - A

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-8
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



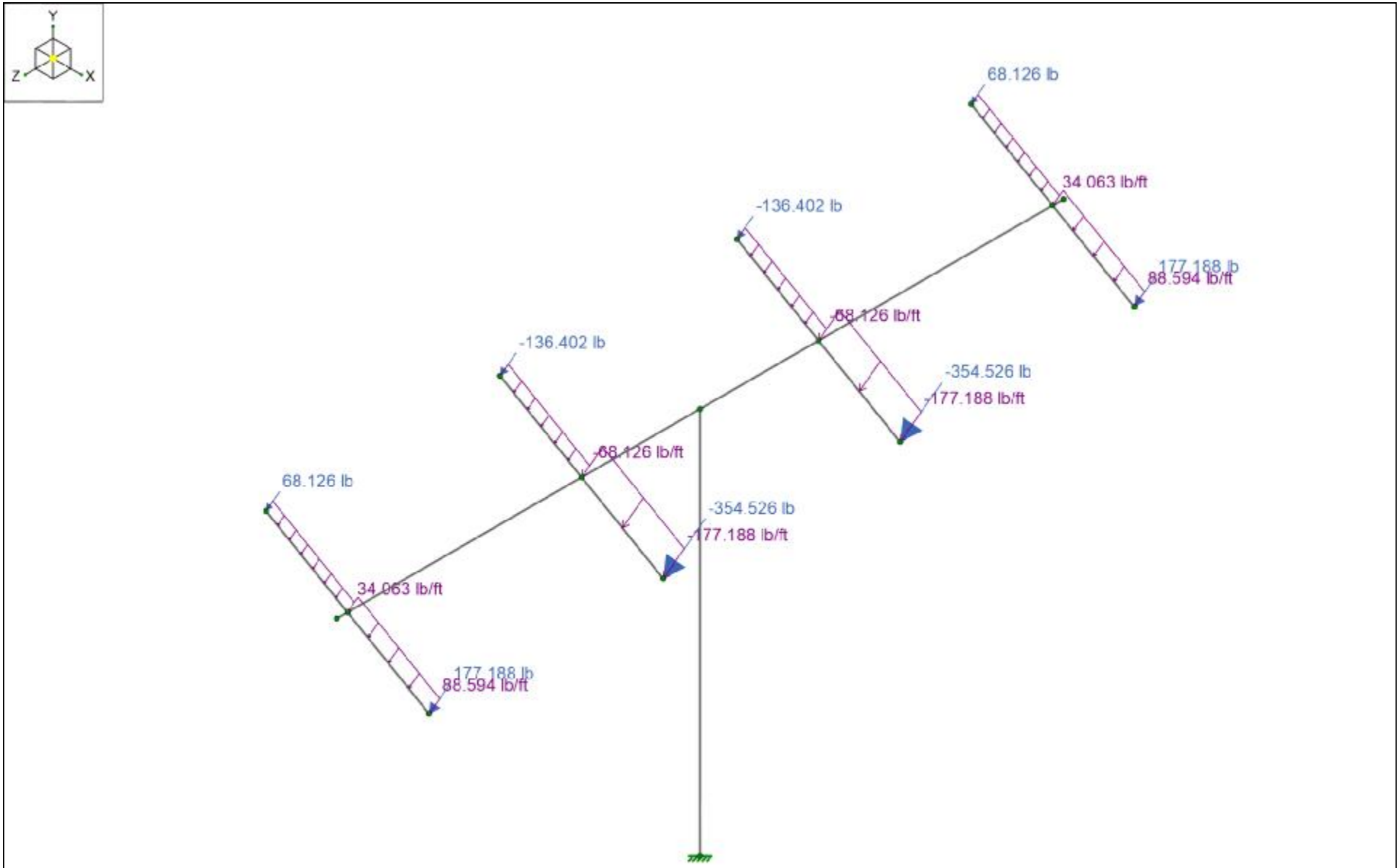
Loads: BLC 4, Wind - 0 - B

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-9
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



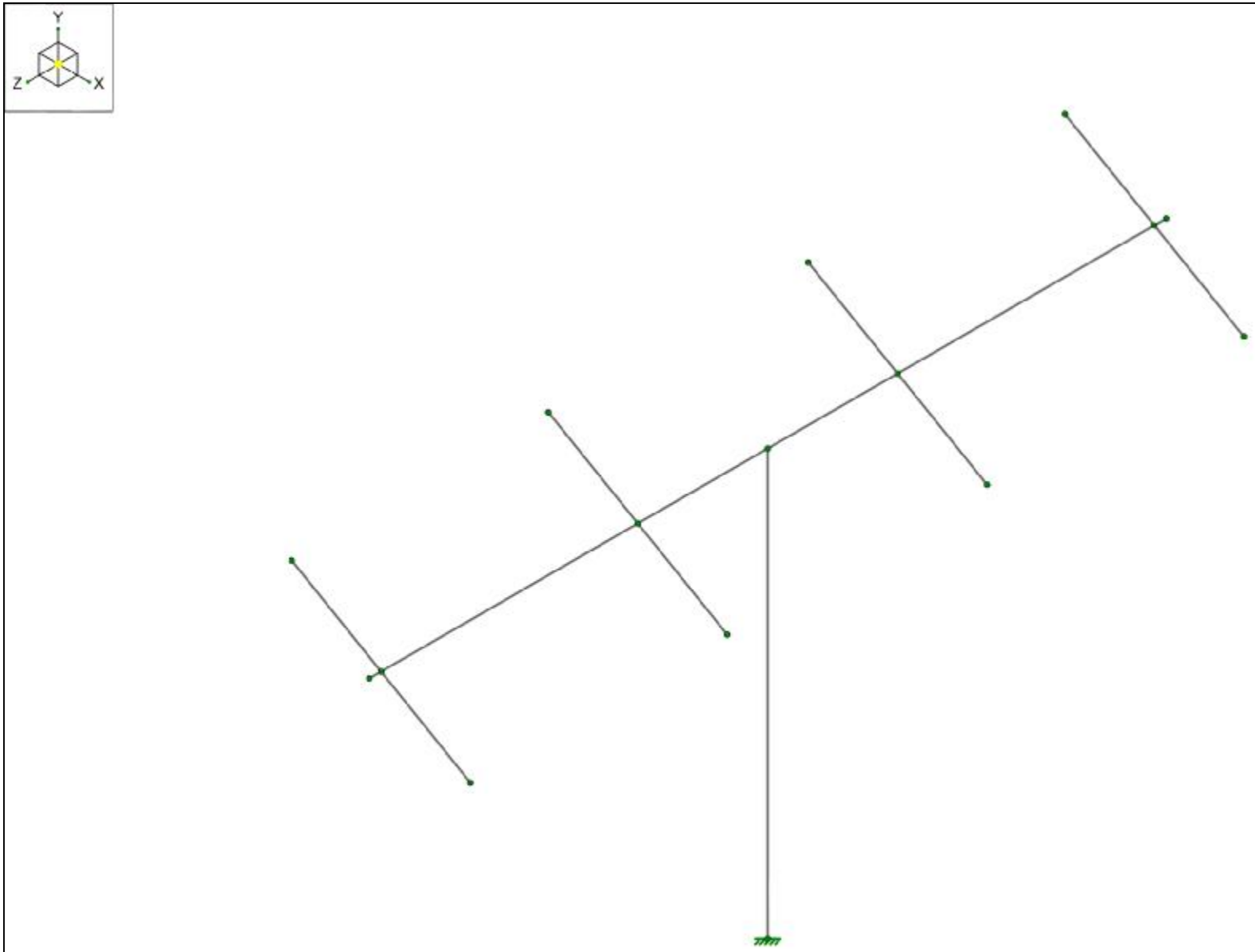
Loads: BLC 5, Wind - 180 - A

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-10
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



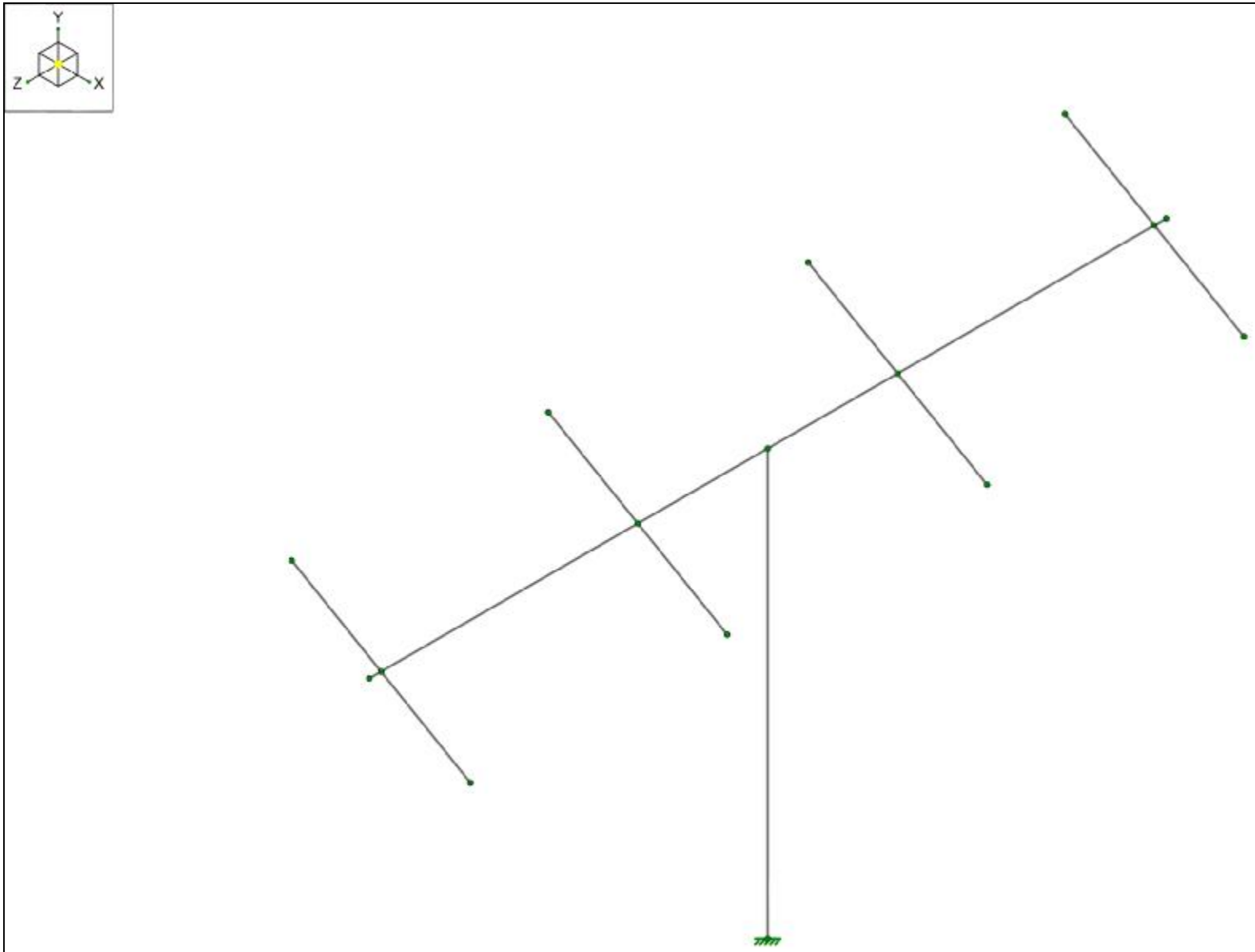
Loads: BLC 6, Wind - 180 - B

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-11
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



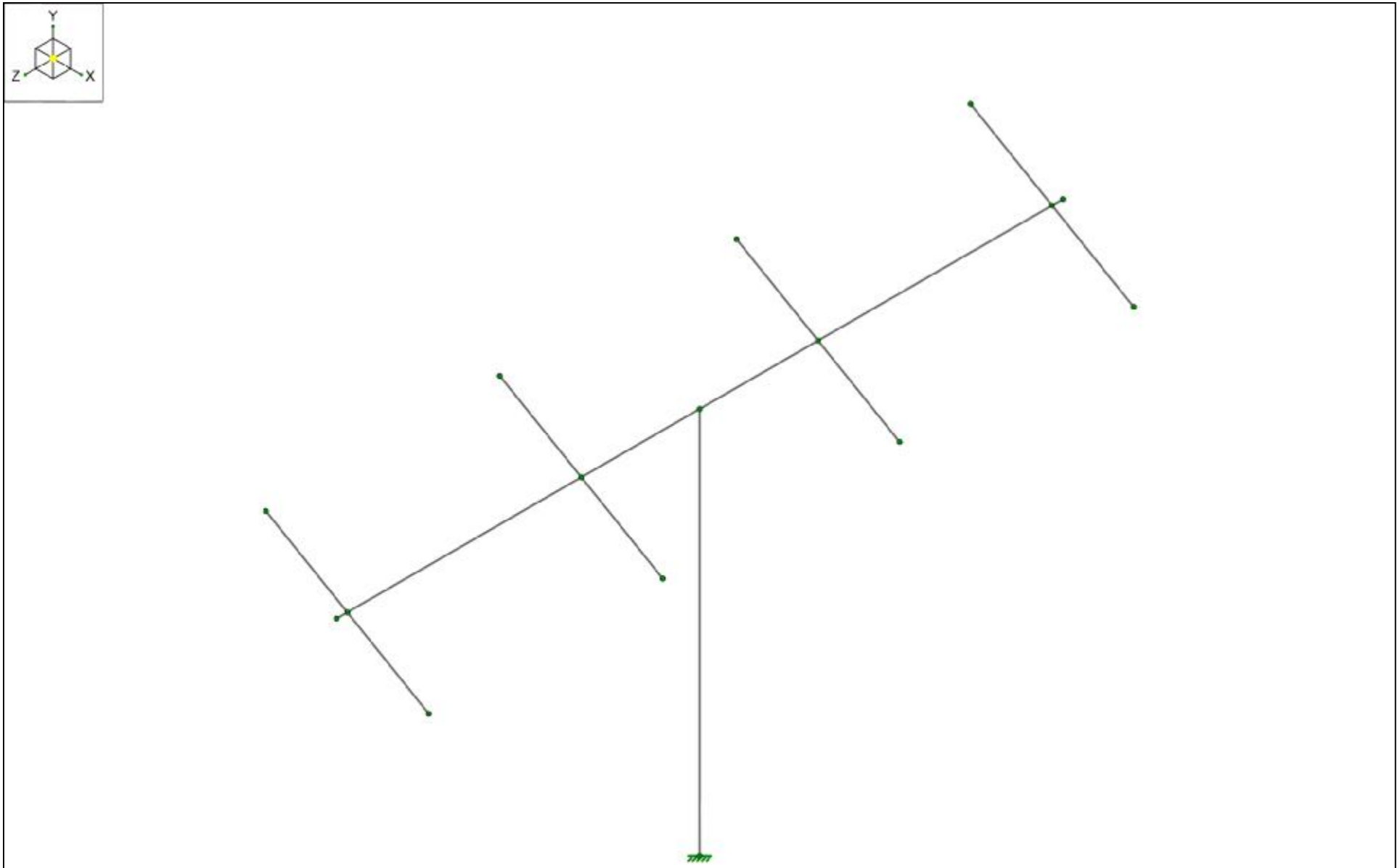
Loads: BLC 7, Wind (Billboard Case A)

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-12
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



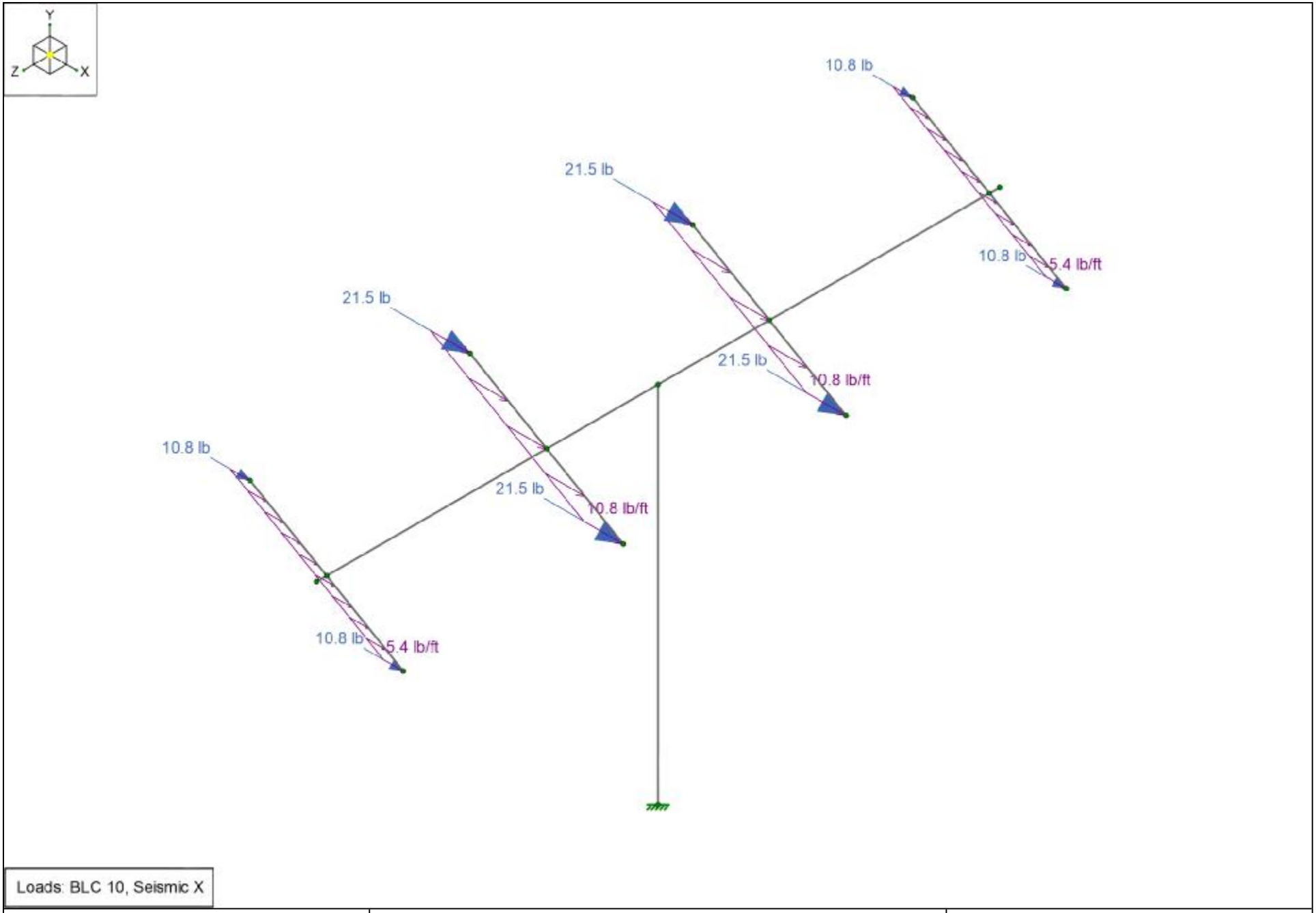
Loads: BLC 8, Wind (Billboard Case B)

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-13
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



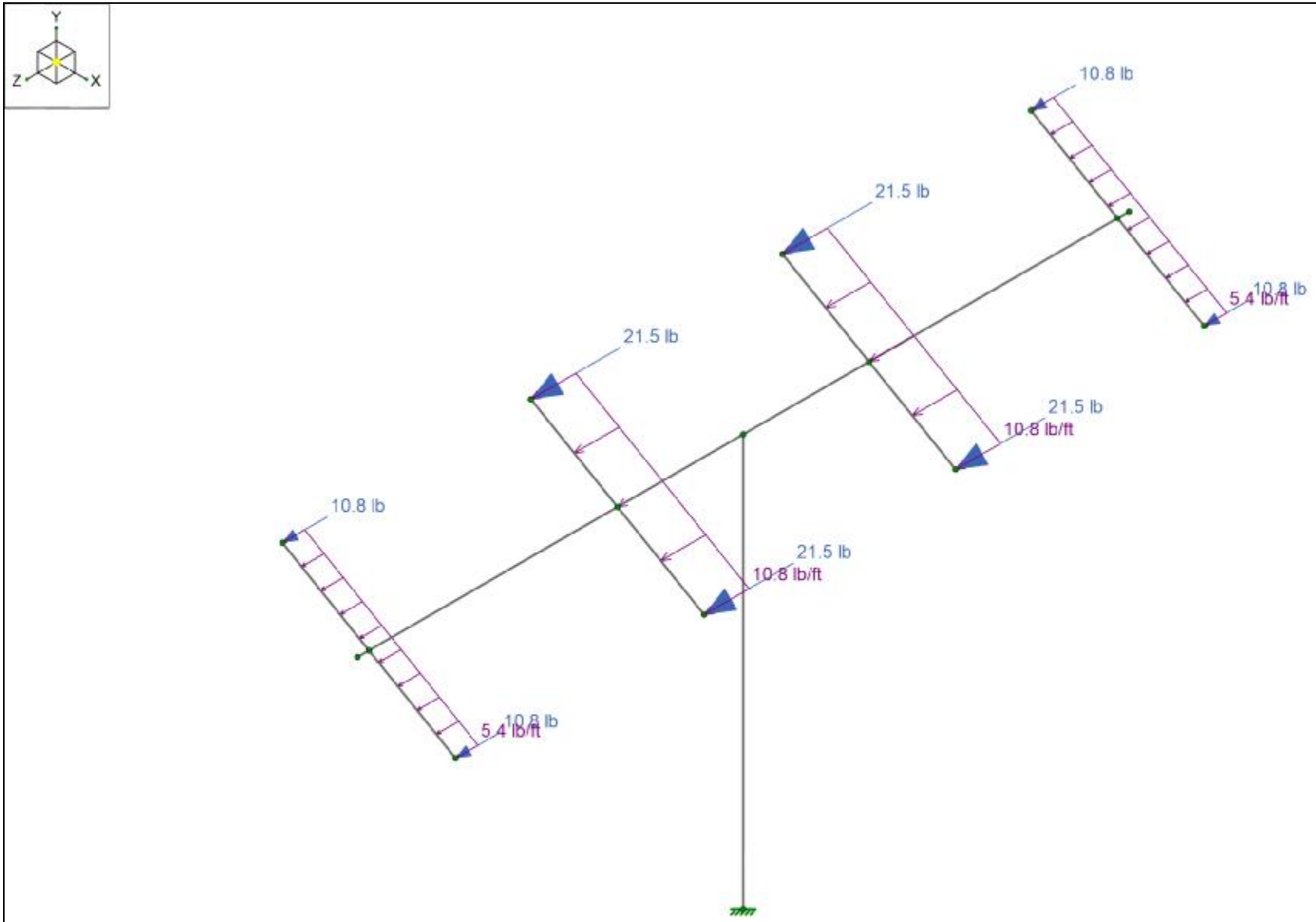
Loads: BLC 9, Wind (Billboard Case C)

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-14
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



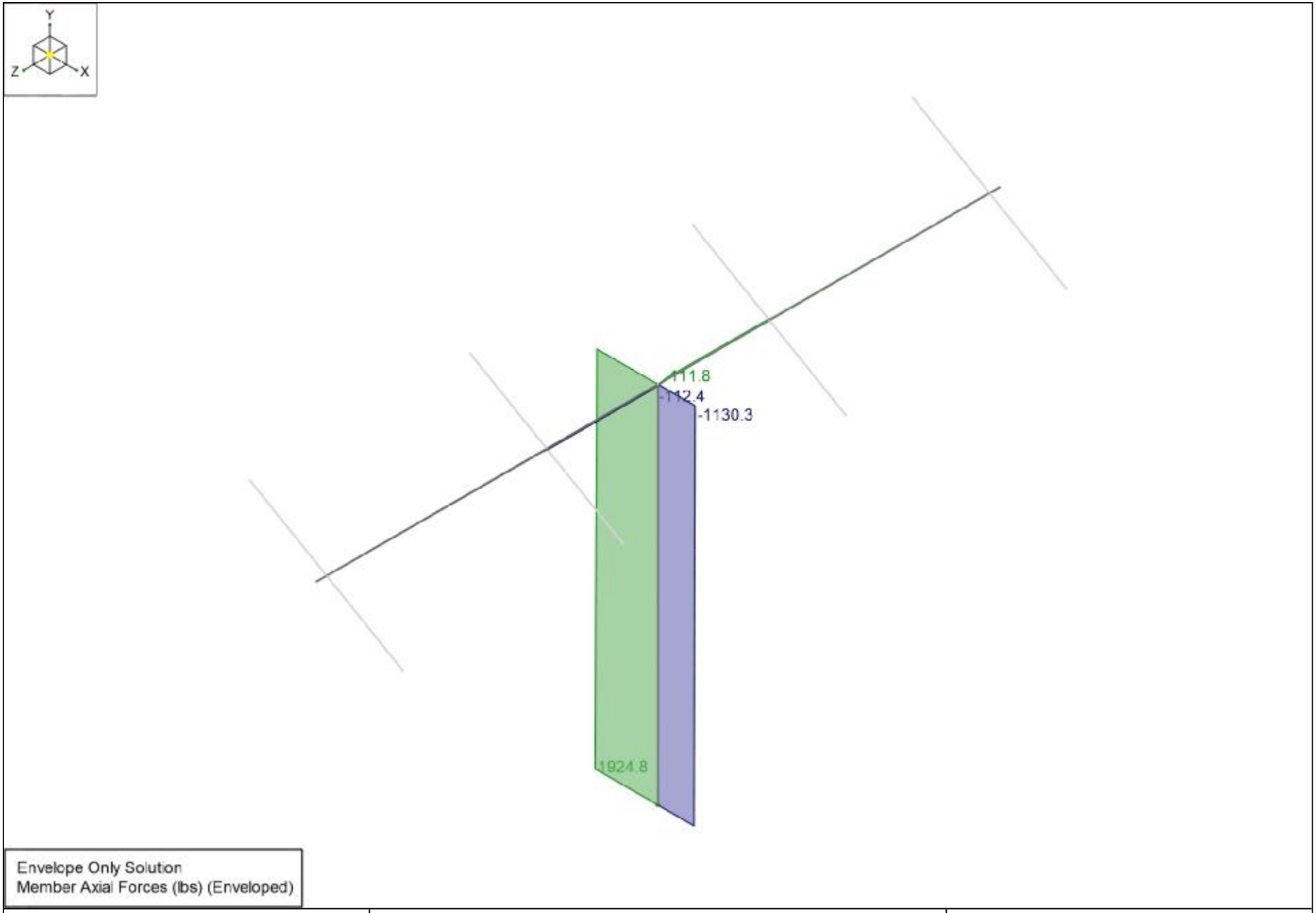
Loads: BLC 10, Seismic X

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-15
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



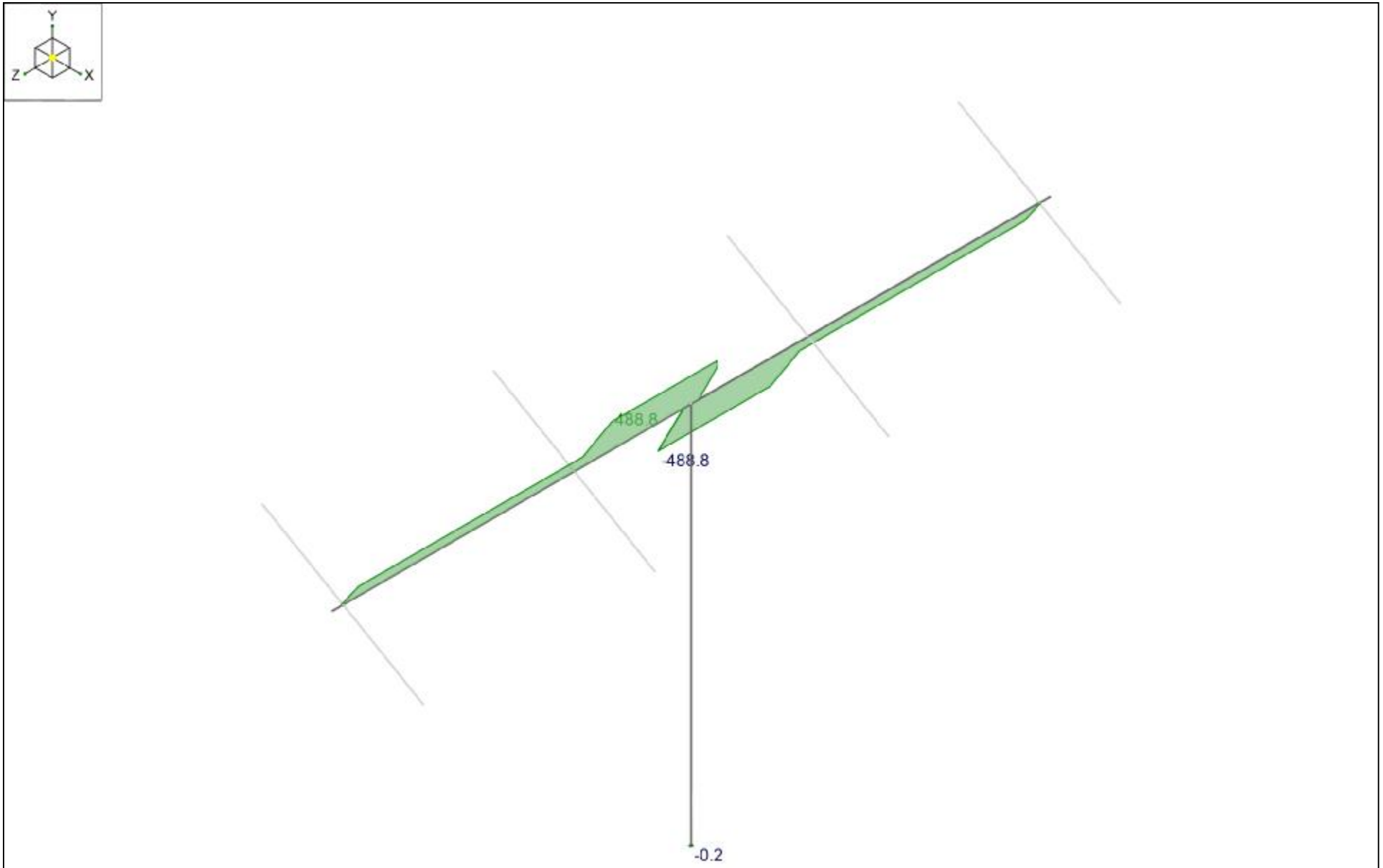
Loads: BLC 11, Seismic Z

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-16
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



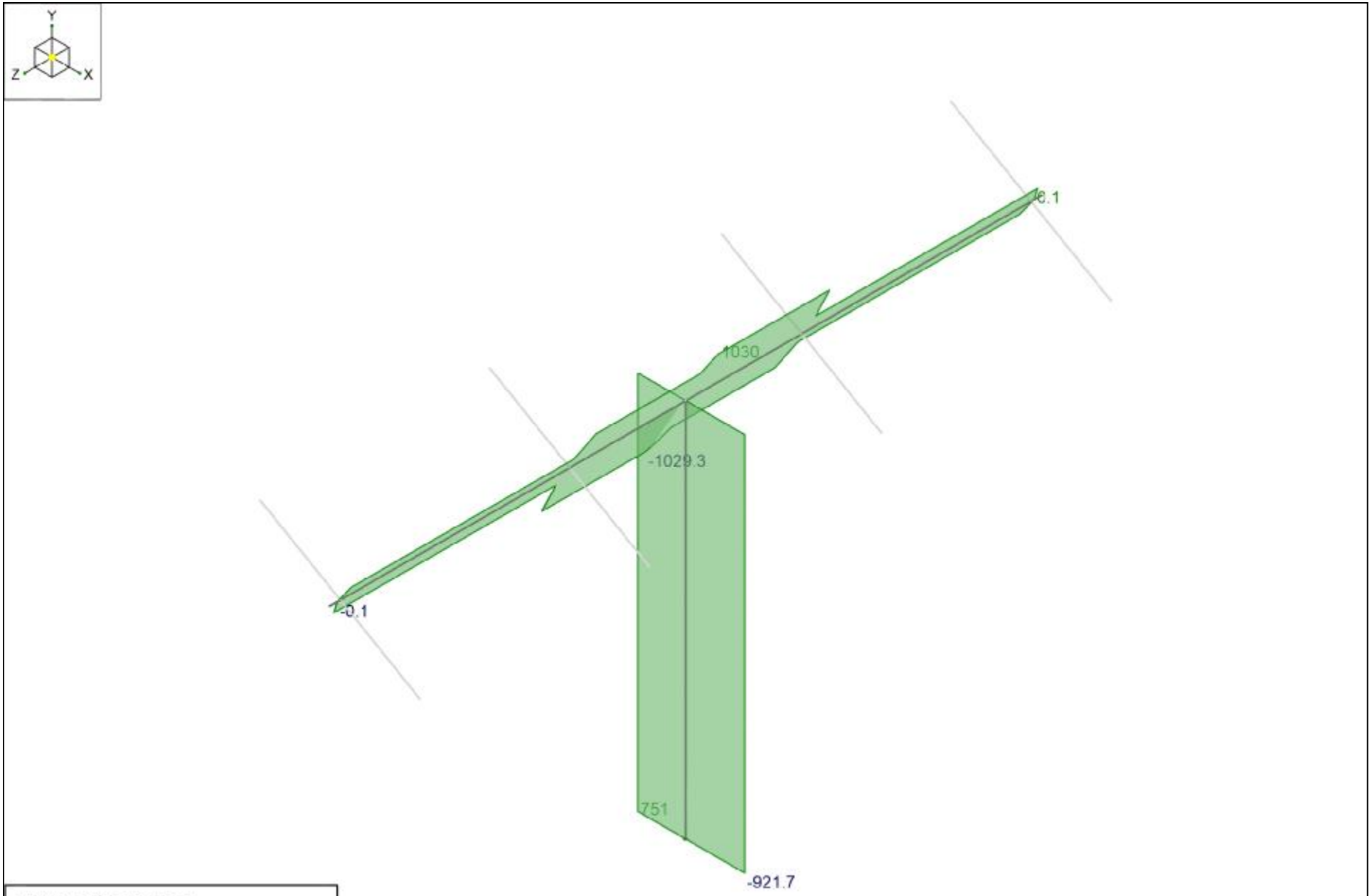
Envelope Only Solution
Member Axial Forces (lbs) (Enveloped)

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-17
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



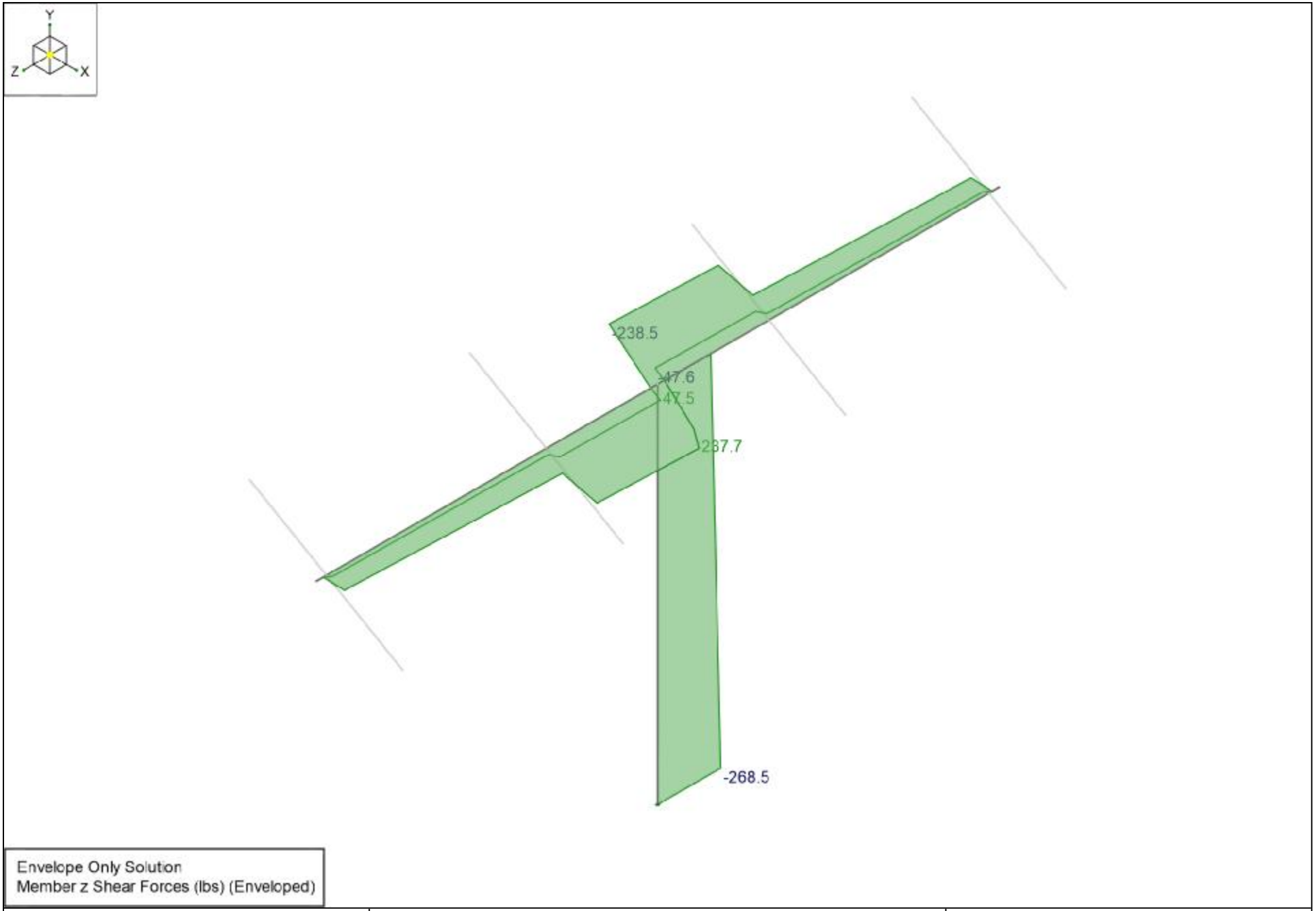
Envelope Only Solution
Member Torsion Moments (lb-ft) (Enveloped)

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-18
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



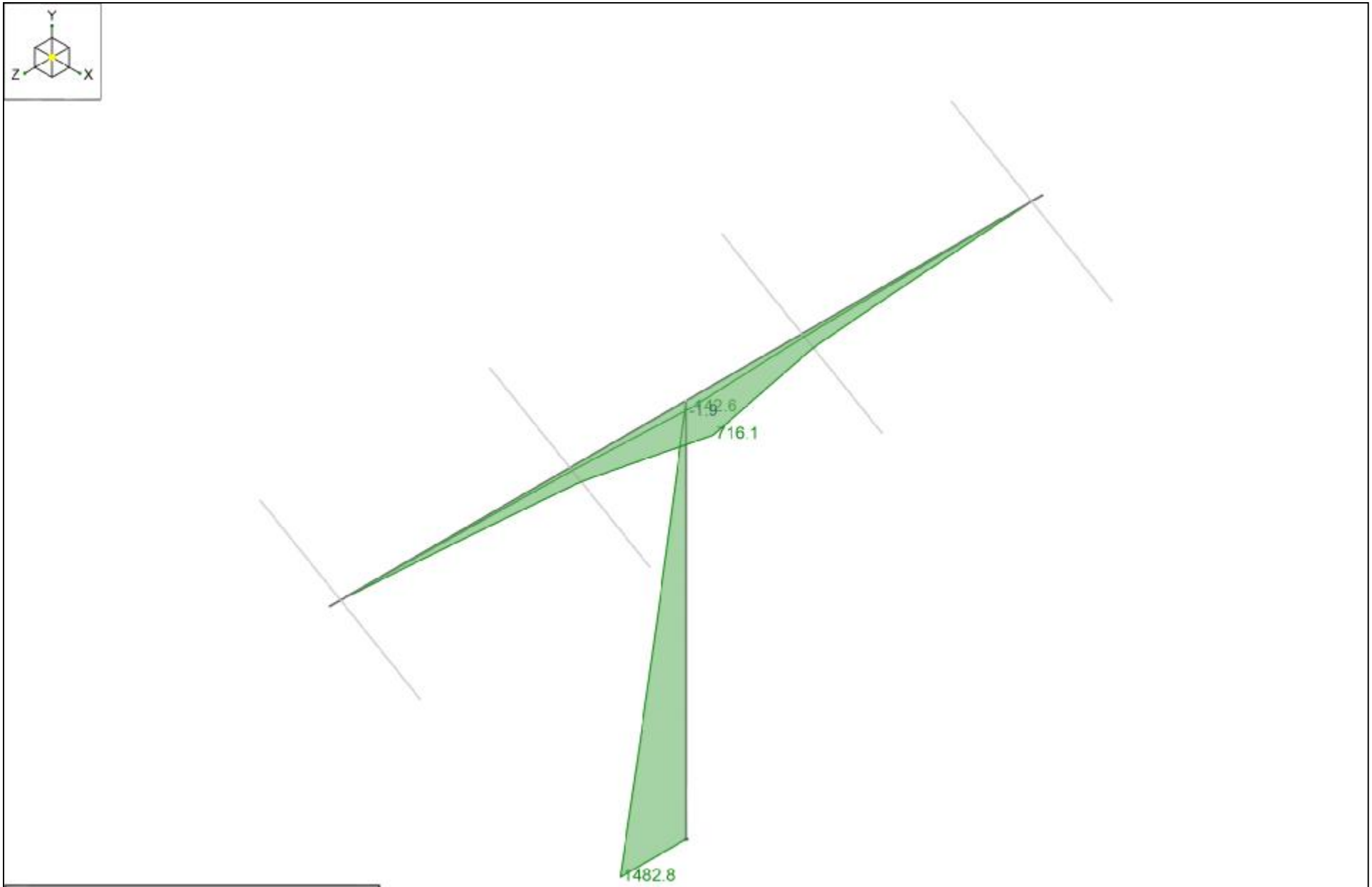
Envelope Only Solution
Member y Shear Forces (lbs) (Envelcped)

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-19
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



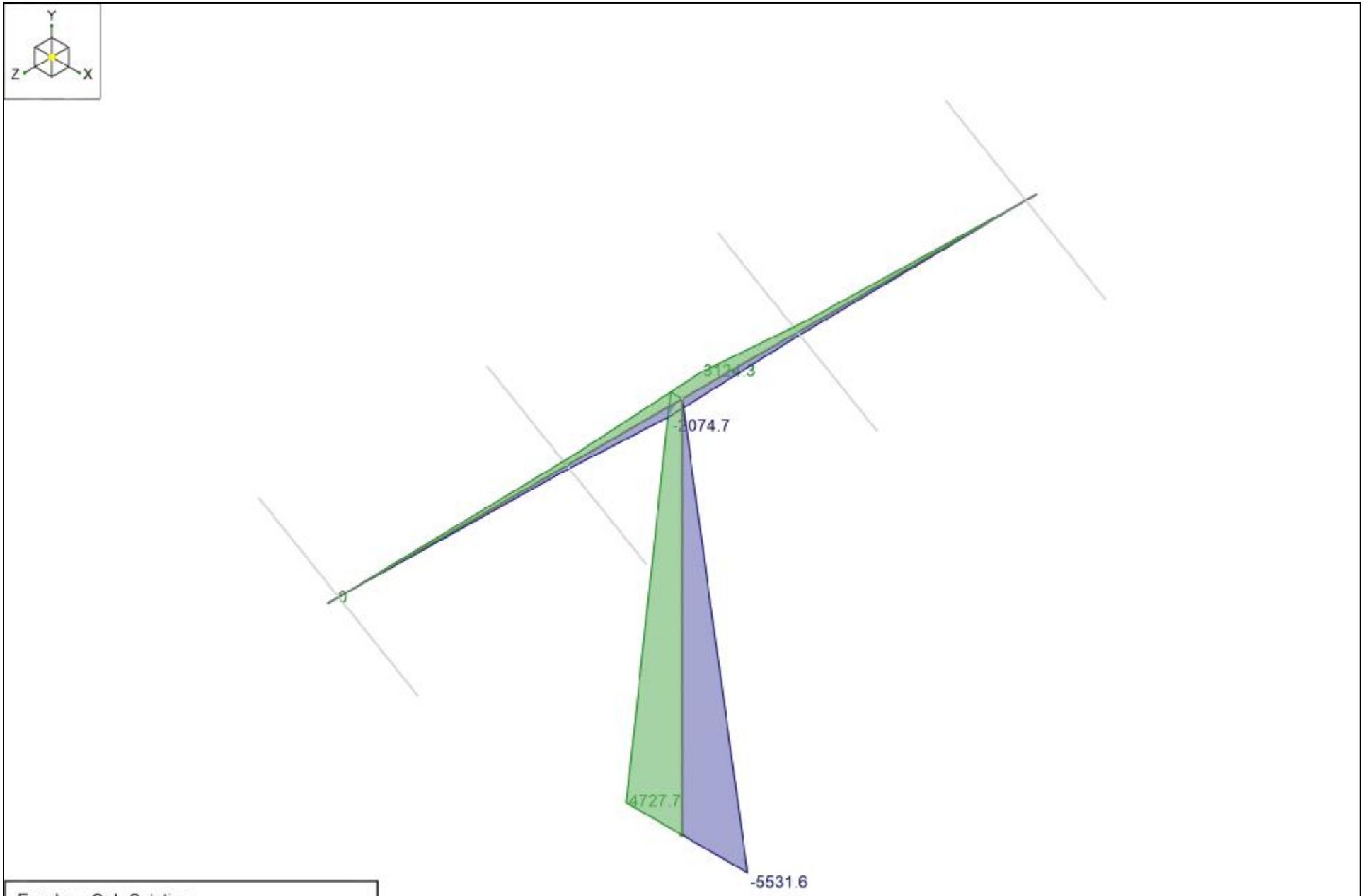
Envelope Only Solution
Member z Shear Forces (lbs) (Enveloped)

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-20
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



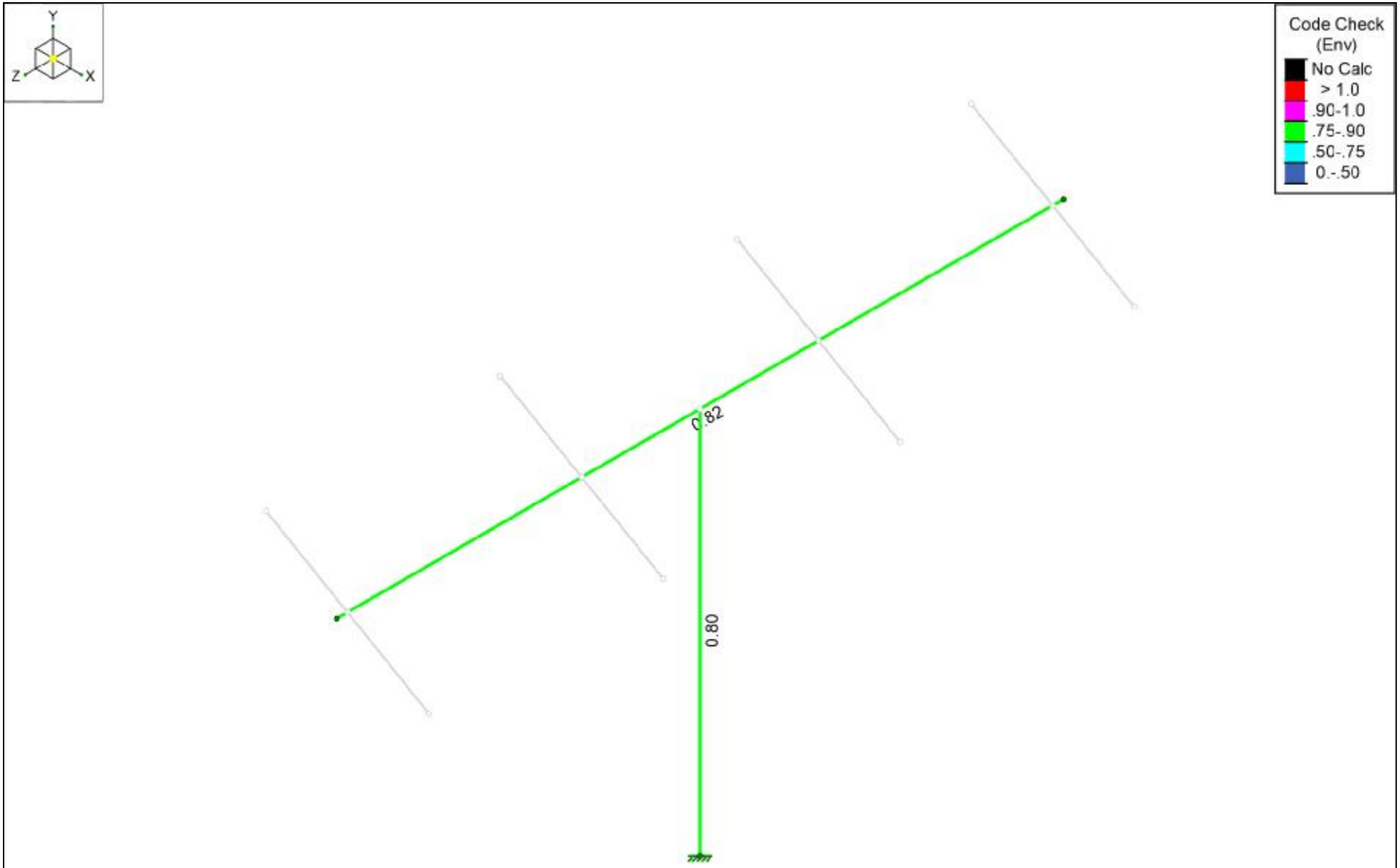
Envelope Only Solution
Member y Bending Moments (lb-ft) (Enveloped)

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-21
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d

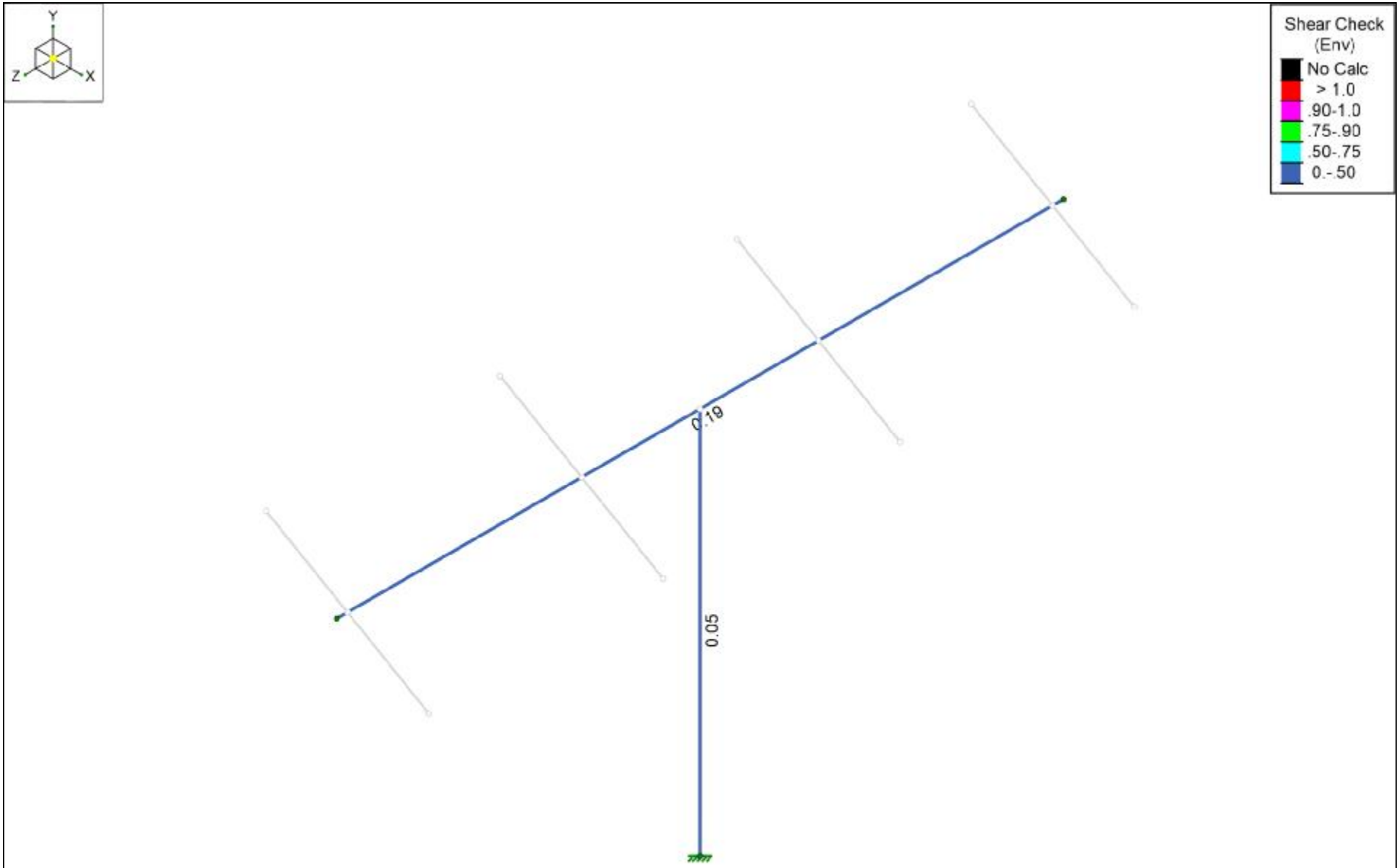


Envelope Only Solution
Member z Bending Moments (lb-ft) (Enveloped)

EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-22
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-23
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d



EPS	Tamarack Single Post Ground Mount - 3 Modules - 30 Degrees	SK-24
RK		Mar 17, 2023
23-TAM001		Single Post Ground Mount - 3 Module.r3d

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [1e⁵°F⁻¹]	Density [k/ft³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Design Parameters

	Label	Shape	Length [ft]	Lb y-y [ft]	Lb z-z [ft]	Lcomp top [ft]	Lcomp bot [ft]	Channel Conn.	a [ft]	Function
1	30 degrees beam	PIPE_3.0	11.25	5.625	5.625	3.667	5.625	N/A	N/A	Lateral
2	30 degrees column	PIPE_4.0	6			Lbyy		N/A	N/A	Lateral

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Nodal	Point	Distributed
1	Dead	DL		-1		1	8	4
2	Snow	SL				8	8	4
3	Wind - 0 - A	WL					8	8
4	Wind - 0 - B	WL					8	8
5	Wind - 180 - A	WL					8	8
6	Wind - 180 - B	WL					8	8
7	Wind (Billboard Case A)	WL						
8	Wind (Billboard Case B)	WL						
9	Wind (Billboard Case C)	WL						
10	Seismic X	ELX	1				8	4
11	Seismic Z	ELZ			1		8	4

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	ASCE ASD 1	Yes	Y	DL	1										
2	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1						
3	ASCE ASD 3 (b)	Yes	Y	DL	1	SL	1	SLN	1						
4	ASCE ASD 4 (b)	Yes	Y	DL	1	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75		
5	ASCE ASD 5 (a)	Yes	Y	DL	1	3	0.6								
6	ASCE ASD 5 (a)	Yes	Y	DL	1	4	0.6								
7	ASCE ASD 5 (a)	Yes	Y	DL	1	5	0.6								
8	ASCE ASD 5 (a)	Yes	Y	DL	1	6	0.6								
9	ASCE ASD 5 (a)	Yes	Y	DL	1	7	0.6								
10	ASCE ASD 5 (a)	Yes	Y	DL	1	8	0.6								
11	ASCE ASD 5 (a)	Yes	Y	DL	1	9	0.6								
12	ASCE ASD 6 (a)	Yes	Y	DL	1	3	0.45	LL	0.75	LLS	0.75				
13	ASCE ASD 6 (a)	Yes	Y	DL	1	4	0.45	LL	0.75	LLS	0.75				
14	ASCE ASD 6 (a)	Yes	Y	DL	1	5	0.45	LL	0.75	LLS	0.75				
15	ASCE ASD 6 (a)	Yes	Y	DL	1	6	0.45	LL	0.75	LLS	0.75				
16	ASCE ASD 6 (a)	Yes	Y	DL	1	7	0.45	LL	0.75	LLS	0.75				
17	ASCE ASD 6 (a)	Yes	Y	DL	1	8	0.45	LL	0.75	LLS	0.75				
18	ASCE ASD 6 (a)	Yes	Y	DL	1	9	0.45	LL	0.75	LLS	0.75				
19	ASCE ASD 6 (b)	Yes	Y	DL	1	3	0.45	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75

Load Combinations (Continued)

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
20	ASCE ASD 6 (b)	Yes	Y	DL	1	4	0.45	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75
21	ASCE ASD 6 (b)	Yes	Y	DL	1	5	0.45	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75
22	ASCE ASD 6 (b)	Yes	Y	DL	1	6	0.45	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75
23	ASCE ASD 6 (b)	Yes	Y	DL	1	7	0.45	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75
24	ASCE ASD 6 (b)	Yes	Y	DL	1	8	0.45	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75
25	ASCE ASD 6 (b)	Yes	Y	DL	1	9	0.45	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75
26	ASCE ASD 7	Yes	Y	DL	0.6	3	0.6								
27	ASCE ASD 7	Yes	Y	DL	0.6	4	0.6								
28	ASCE ASD 7	Yes	Y	DL	0.6	5	0.6								
29	ASCE ASD 7	Yes	Y	DL	0.6	6	0.6								
30	ASCE ASD 7	Yes	Y	DL	0.6	7	0.6								
31	ASCE ASD 7	Yes	Y	DL	0.6	8	0.6								
32	ASCE ASD 7	Yes	Y	DL	0.6	9	0.6								
33	ASCE ASD 8 (a)	Yes	Y	DL	1	ELX	0.7								
34	ASCE ASD 8 (b)	Yes	Y	DL	1	ELZ	0.7								
35	ASCE ASD 9 (a)	Yes	Y	DL	1	ELX	0.525	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75
36	ASCE ASD 9 (b)	Yes	Y	DL	1	ELZ	0.525	LL	0.75	LLS	0.75	SL	0.75	SLN	0.75
37	ASCE ASD 10 (a)	Yes	Y	DL	0.6	ELX	0.7								
38	ASCE ASD 10 (b)	Yes	Y	DL	0.6	ELZ	0.7								

Member Distributed Loads (BLC 1 : Dead)

	Member Label	Direction	Start Magnitude [lb/ft, F, psf, lb-ft/ft]	End Magnitude [lb/ft, F, psf, lb-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M14	Y	-10.8	-10.8	0	%100
2	M15	Y	-5.4	-5.4	0	%100
3	M16	Y	-10.8	-10.8	0	%100
4	M17	Y	-5.4	-5.4	0	%100

Member Distributed Loads (BLC 2 : Snow)

	Member Label	Direction	Start Magnitude [lb/ft, F, psf, lb-ft/ft]	End Magnitude [lb/ft, F, psf, lb-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M14	Y	-21.9	-21.9	0	%100
2	M15	Y	-11	-11	0	%100
3	M16	Y	-21.9	-21.9	0	%100
4	M17	Y	-11	-11	0	%100

Member Distributed Loads (BLC 3 : Wind - 0 - A)

	Member Label	Direction	Start Magnitude [lb/ft, F, psf, lb-ft/ft]	End Magnitude [lb/ft, F, psf, lb-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M14	y	122.657	122.657	0	%50
2	M14	y	122.657	122.657	%50	%100
3	M15	z	-61.403	-61.403	%50	%100
4	M15	z	-61.403	-61.403	0	%50
5	M16	y	122.657	122.657	%50	%100
6	M16	y	122.657	122.657	0	%50
7	M17	z	-61.403	-61.403	%50	%100
8	M17	z	-61.403	-61.403	0	%50

Member Distributed Loads (BLC 4 : Wind - 0 - B)

	Member Label	Direction	Start Magnitude [lb/ft, F, psf, lb-ft/ft]	End Magnitude [lb/ft, F, psf, lb-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M14	y	170.465	170.465	%50	%100
2	M14	y	34.063	34.063	0	%50
3	M15	z	-85.158	-85.158	%50	%100

Member Distributed Loads (BLC 4 : Wind - 0 - B) (Continued)

	Member Label	Direction	Start Magnitude [lb/ft, F, psf, lb-ft/ft]	End Magnitude [lb/ft, F, psf, lb-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
4	M15	z	-17.032	-17.032	0	%50
5	M16	y	34.063	34.063	0	%50
6	M16	y	170.465	170.465	%50	%100
7	M17	z	-85.158	-85.158	%50	%100
8	M17	z	-17.032	-17.032	0	%50

Member Distributed Loads (BLC 5 : Wind - 180 - A)

	Member Label	Direction	Start Magnitude [lb/ft, F, psf, lb-ft/ft]	End Magnitude [lb/ft, F, psf, lb-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M14	y	-143.125	-143.125	%50	%100
2	M14	y	-143.125	-143.125	0	%50
3	M15	z	71.563	71.563	0	%50
4	M15	z	71.563	71.563	%50	%100
5	M16	y	-143.125	-143.125	%50	%100
6	M16	y	-143.125	-143.125	0	%50
7	M17	z	71.563	71.563	0	%50
8	M17	z	71.563	71.563	%50	%100

Member Distributed Loads (BLC 6 : Wind - 180 - B)

	Member Label	Direction	Start Magnitude [lb/ft, F, psf, lb-ft/ft]	End Magnitude [lb/ft, F, psf, lb-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M14	y	-68.126	-68.126	%50	%100
2	M14	y	-177.188	-177.188	0	%50
3	M15	z	34.063	34.063	%50	%100
4	M15	z	88.594	88.594	0	%50
5	M16	y	-177.188	-177.188	0	%50
6	M16	y	-68.126	-68.126	%50	%100
7	M17	z	88.594	88.594	0	%50
8	M17	z	34.063	34.063	%50	%100

Member Distributed Loads (BLC 10 : Seismic X)

	Member Label	Direction	Start Magnitude [lb/ft, F, psf, lb-ft/ft]	End Magnitude [lb/ft, F, psf, lb-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M14	X	10.8	10.8	0	%100
2	M15	X	5.4	5.4	0	%100
3	M16	X	10.8	10.8	0	%100
4	M17	X	5.4	5.4	0	%100

Member Distributed Loads (BLC 11 : Seismic Z)

	Member Label	Direction	Start Magnitude [lb/ft, F, psf, lb-ft/ft]	End Magnitude [lb/ft, F, psf, lb-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M14	Z	10.8	10.8	0	%100
2	M15	Z	5.4	5.4	0	%100
3	M16	Z	10.8	10.8	0	%100
4	M17	Z	5.4	5.4	0	%100

Member Point Loads (BLC 1 : Dead)

	Member Label	Direction	Magnitude [lb, lb-ft]	Location [(ft, %)]
1	M14	Y	-21.5	0
2	M14	Y	-21.5	%100
3	M15	Y	-10.8	%100
4	M15	Y	-10.8	0
5	M16	Y	-21.5	%100

Member Point Loads (BLC 1 : Dead) (Continued)

	Member Label	Direction	Magnitude [lb, lb-ft]	Location [(ft, %)]
6	M16	Y	-21.5	0
7	M17	Y	-10.8	0
8	M17	Y	-10.8	%100

Member Point Loads (BLC 2 : Snow)

	Member Label	Direction	Magnitude [lb, lb-ft]	Location [(ft, %)]
1	M14	Y	-43.8	0
2	M14	Y	-43.8	%100
3	M15	Y	-21.9	0
4	M15	Y	-21.9	%100
5	M16	Y	-43.8	0
6	M16	Y	-43.8	%100
7	M17	Y	-21.9	0
8	M17	Y	-21.9	%100

Member Point Loads (BLC 3 : Wind - 0 - A)

	Member Label	Direction	Magnitude [lb, lb-ft]	Location [(ft, %)]
1	M14	y	245.464	%100
2	M14	y	245.464	0
3	M15	z	-122.657	0
4	M15	z	-122.657	%100
5	M16	y	245.464	%100
6	M16	y	245.464	0
7	M17	z	-122.657	0
8	M17	z	-122.657	%100

Member Point Loads (BLC 4 : Wind - 0 - B)

	Member Label	Direction	Magnitude [lb, lb-ft]	Location [(ft, %)]
1	M14	y	68.126	0
2	M14	y	340.931	%100
3	M15	z	-170.465	%100
4	M15	z	-34.063	0
5	M16	y	68.126	0
6	M16	y	340.931	%100
7	M17	z	-170.465	%100
8	M17	z	-34.063	0

Member Point Loads (BLC 5 : Wind - 180 - A)

	Member Label	Direction	Magnitude [lb, lb-ft]	Location [(ft, %)]
1	M14	y	-286.4	0
2	M14	y	-286.4	%100
3	M15	z	143.125	%100
4	M15	z	143.125	0
5	M16	y	-286.4	%100
6	M16	y	-286.4	0
7	M17	z	143.125	%100
8	M17	z	143.125	0

Member Point Loads (BLC 6 : Wind - 180 - B)

	Member Label	Direction	Magnitude [lb, lb-ft]	Location [(ft, %)]
1	M14	y	-136.402	%100
2	M14	y	-354.526	0
3	M15	z	177.188	0
4	M15	z	68.126	%100
5	M16	y	-136.402	%100
6	M16	y	-354.526	0
7	M17	z	68.126	%100
8	M17	z	177.188	0

Member Point Loads (BLC 10 : Seismic X)

	Member Label	Direction	Magnitude [lb, lb-ft]	Location [(ft, %)]
1	M14	X	21.5	0
2	M14	X	21.5	%100
3	M15	X	10.8	0
4	M15	X	10.8	%100
5	M16	X	21.5	0
6	M16	X	21.5	%100
7	M17	X	10.8	0
8	M17	X	10.8	%100

Member Point Loads (BLC 11 : Seismic Z)

	Member Label	Direction	Magnitude [lb, lb-ft]	Location [(ft, %)]
1	M14	Z	21.5	%100
2	M14	Z	21.5	0
3	M15	Z	10.8	%100
4	M15	Z	10.8	0
5	M16	Z	21.5	0
6	M16	Z	21.5	%100
7	M17	Z	10.8	0
8	M17	Z	10.8	%100

Envelope Maximum Member Section Forces

	Member		Axial[lb]	Loc[ft]	LC	y Shear[lb]	Loc[ft]	LC	z Shear[lb]	Loc[ft]	LC	Torque[lb-ft]	Loc[ft]	LC	y-y Moment[lb-ft]	Loc[ft]	LC	z-z Moment[lb-ft]	Loc[ft]	LC
1	M14	max	66.965	1.458	35	332.467	1.458	7	28.356	1.458	34	0	2.916	38	0	2.916	38	462.356	1.458	8
2		min	-66.34	1.428	35	-402.802	1.458	8	-28.056	1.428	34	0	0	1	-31.699	1.458	34	-383.945	1.458	27
3	M15	max	33.051	1.488	35	14.047	1.458	34	201.029	1.458	8	0	2.916	38	230.767	1.458	8	15.764	1.458	34
4		min	-33.36	1.458	35	-13.901	1.428	38	-166.198	1.458	7	0	0	1	-192.109	1.458	27	-0.187	1.458	35
5	M16	max	66.34	1.488	35	332.467	1.458	7	28.323	1.458	34	0	2.916	38	0.243	1.458	35	462.356	1.458	8
6		min	-66.965	1.458	35	-402.802	1.458	8	-28.023	1.428	34	0	0	1	-31.651	1.458	34	-383.945	1.458	27
7	M17	max	33.051	1.488	35	14.072	1.458	34	201.029	1.458	8	0	2.916	38	230.767	1.458	8	15.801	1.458	34
8		min	-33.36	1.458	35	-13.925	1.428	34	-166.198	1.458	7	0	0	1	-192.109	1.458	27	0	0	1
9	30 degrees beam	max	111.773	5.742	38	1030.045	5.625	7	237.687	5.508	35	488.785	5.508	6	716.101	5.625	35	3124.316	5.625	7
10		min	-112.35	5.625	38	-1029.33	5.508	7	-238.475	5.625	35	-488.785	5.625	6	0	0	1	-2074.702	5.625	26
11	30 degrees column	max	1924.774	0	7	750.961	6	5	0	6	37	0	6	37	1482.829	0	34	4727.665	0	6
12		min	-1130.303	6	26	-921.698	0	7	-268.495	0	34	-0.168	0	36	-1.926	6	36	-5531.58	0	7

Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

	Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	LC	Pnc/om [lb]	Pnt/om [lb]	Mnyy/om [lb-ft]	Mnzz/om [lb-ft]	Cb	Eqn
1	30 degrees beam	PIPE_3.0	0.819	5.625	7	0.187	7.383	27	36623.766	43383.234	3824.85	3824.85	1	H1-1b
2	30 degrees column	PIPE_4.0	0.799	0	7	0.05	6	7	55288.045	62035.928	7073.353	7073.353	1	H1-1b

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	30 DEGREES	max	891.048	28	1924.774	7	0	27	0	22	0	28	4727.665	6
2		min	-763.779	26	-1094.043	26	-267.004	34	-1482.829	34	-0.168	36	-5531.58	7
3	Totals:	max	891.048	28	1924.774	7	0	27						
4		min	-763.779	26	-1094.043	26	-267.004	34						

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4.4 – Connections

The previous portions of RISA printout provides an example of the loads (axial, shear, moment, etc.) to each member at the connection points. The following provides the capacity of each connection checked for the maximum envelope loads for the example stated previously. Note that the worst-case possible loads at all connections for all unit types and loading scenarios have been checked against the allowable capacities to ensure the connections do not govern the overall design. All bolt allowable capacities are per ICC Report ERS-1976 for 1/4" diameter ITW Buildex TEKS Screws unless noted otherwise.

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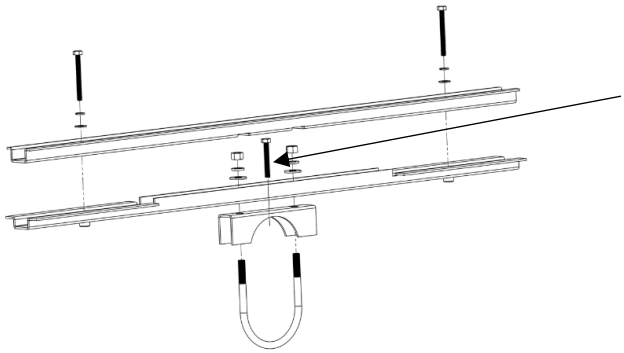
- Module Mid/End Clamp to Beam:



  - Tension Load per Example: 579 lbs.
  - Shear Load per Example: 1,118 lbs.
  - Connection Hardware: (1) 1/4" Dia. ITW Buildex TEKS Screw (Shear) & (1) ½" U-Bolt (Tension)
  - Minimum Pipe Thickness: 0.201"
  - Minimum U-Bolt Bracket Thickness: 0.105"
  - U-Bolt Tension Allowable Capacity*:
    4,413 lbs. per Side ≥ 579 lbs. → OK
  - Screw Shear Allowable Capacity**: 1,417 lbs. per Screw ≥ 1,118 lbs. → OK
  - Bearing Strength at Screw Holes (Eq. J3-6a) Based on Racking Framing
    - (2.4*0.25"*0.105"*55ksi) = 3465 lbs. / Ω = 1,732 lbs. ≥ 1,118 lbs. → OK
    - Where Ω = 2.00 (ASD level)

*One side of the U-Bolt conservatively used
**Capacity values interpolated for pipe thickness of 0.201" per Table 2 and Table 4 note 3. Capacity values are also multiplied by 1.33 for members with Fu = 60 ksi Table 2 and Table 4 note 5

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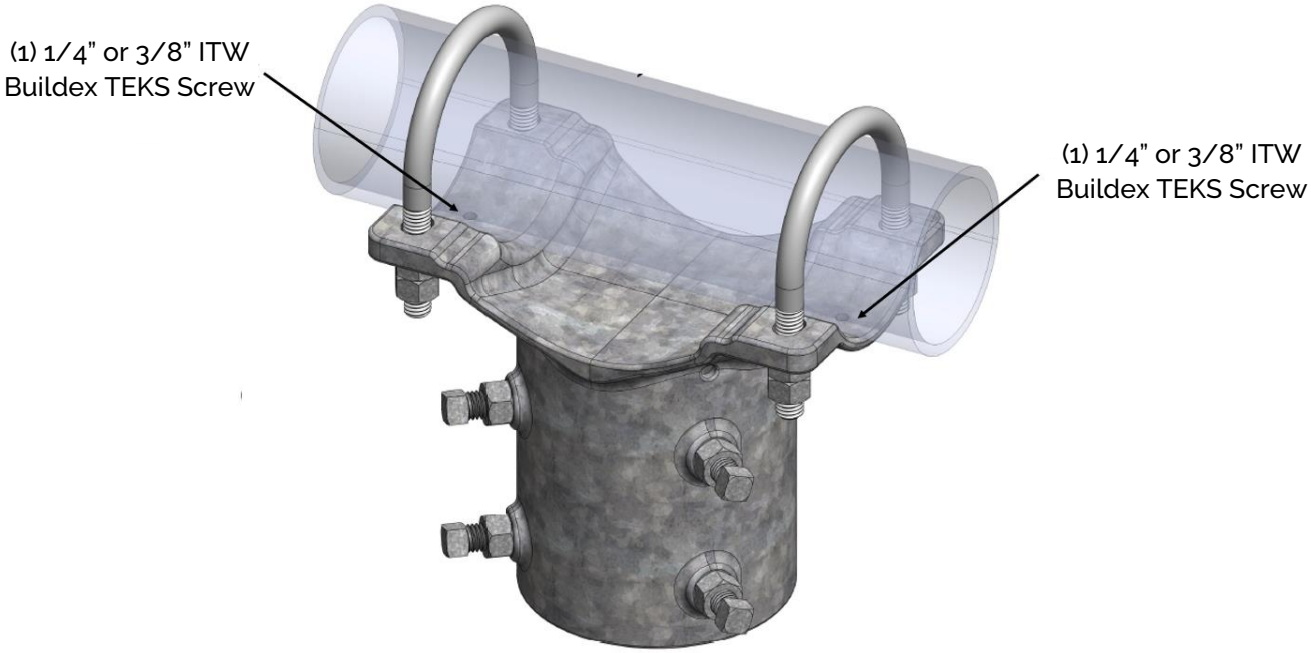
- Beam to Post Cap:



  - Max. Tension Load: 1,131 lbs.
  - Max. Shear Load: 3,354 lbs.
  - Connection Hardware: (2) 3/8" Dia. ITW Buildex TEKS Screws (Shear)
    (1) 1/2" Dia. U-Bolt (Tension)
  - Minimum Pipe Thickness: 0.201"
  - Minimum Cap Thickness where screw is inserted: 0.25"
  - U-Bolt Tension Allowable Capacity:
    4,413* lbs. per U-Bolt Side ≥ 566 lbs. → OK
  - Screw Shear Allowable Capacity**:
    2,361 lbs. per screw * 2 screws = 4,722 ≥ 3,354 lbs. → OK
  - Bearing Strength at Screw Holes (Eq. J3-6a) Based on Racking Framing
    - (2.4*0.25"*0.25"*65ksi) = 9750 lbs. / Ω = 4,875 lbs. ≥ 3,354 lbs. → OK
    - Where Ω = 2.00

*One side of U-Bolt conservatively used
**Capacity values interpolated for pipe thickness of 0.201" per Table 2 and Table 4 note 3. Capacity values are also multiplied by 1.33 for members with Fu = 60 ksi Table 2 and Table 4 note 5

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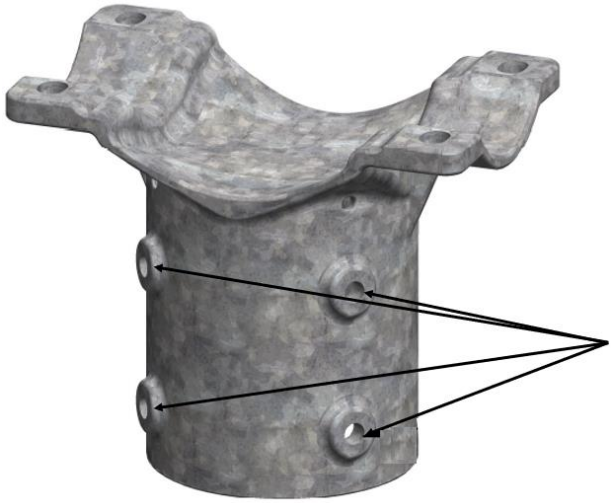
- Post Cap to Post:



  - Tension Load per Example: N/A
  - Shear Load per Example: 1,131 lbs.
  - Connection Hardware: (2) 1/4" Dia. ITW Buildex TEKS Screws & (2) ½" Set Screws (Conservatively Ignored)
  - Minimum Pipe Thickness: 0.221"
  - Minimum Cap Thickness where screw is inserted: 0.25"
  - Screw Shear Allowable Capacity*:
    1,417 lbs. per screw * 2 screws = 2,834 ≥ 1,131 lbs. → OK
  - Bearing Strength at Screw Holes (Eq. J3-6a) Based on Racking Framing
    - (2.4*0.25"*0.25"*65ksi) = 9750 lbs. / Ω = 4,875 lbs. ≥ 1,131 lbs. → OK
    - Where Ω = 2.00

*Capacity values interpolated for pipe thickness of 0.201" per Table 2 and Table 4 note 3. Capacity values are also multiplied by 1.33 for members with Fu = 60 ksi Table 2 and Table 4 note 5

Cap is to be installed such that the cap bears directly on the top of the column.

*NOTE: The Post Cap to Post connection may incorporate (4) ½" set screws in at the installers own risk in place of the (2) ½" set screws and (2) ¼" TEK screws listed here. EPS recommends the incorporation of the TEK screws to reduce the potential for twisting and shifting of the post cap over time due to loss of set screw friction, however, EPS recognizes that friction connections are an industry standard for this type of PV pole mount which may be utilized at the installers own risk.

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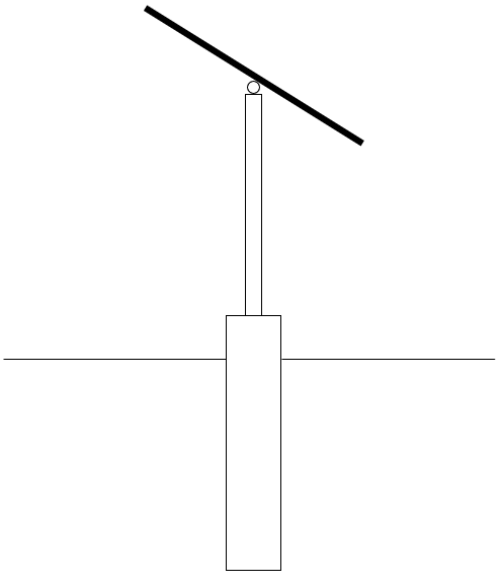
4.5 – Foundation Design and Analysis



Example Elevation

The foundation used on the Tamarack Single Post Ground Mount is a cylindrical concrete pier. EPS is assuming that the steel in the pier will be accounted for via embedding the pipe column above through the pier to a depth of 3"-12" from the bottom of the pier. The following is an example calculation (based upon the design of a 3 module 1/40 unit with 30˚ tilt, an 18" pier, Class 5 Soils, and 10 psf of snow with 110 MPH wind) illustrating the analysis used in determining the concrete pier depths prescribed in the Summary Tables in Section 3.0 of this packet. Pier Design Loads are taken at grade.

- Pier Design Loads (lbs.):
    - Down: 1925 lbs.
    - Up: -1095 lbs.
    - Lateral: 892 lbs.
    - Moment: 5532 lb-ft

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Depth Required Due to Vertical Loads:

As the location of installation for these Single Post Ground Mounts will be variable, EPS has used the code minimum soil values in the IBC for determining the soil capacity.

Presumptive Load-Bearing Values used for Class 5 Soils from IBC Table 1806.2:

- Bearing: 1500 psf
- Lateral Passive: 100 psf/ft (doubled to 200 psf/ft per code deflection allowance section 1806.3.4)
- Skin Friction: 250 psf

Soil conditions are to be field verified (by others). The top 1.0 ft. of soil has been conservatively ignored for skin friction for uplift.

- Compression Design:
  - Compression Resistance: 4.71 sf.*250 psf*8.0 ft. = 9420 lbs.
    → 9,420 lbs. ≥ 1,925 lbs. → OK

The top 1.0 ft. of soil has been ignored for skin friction for uplift.

- Uplift Design:
  - Uplift Resistance: 4.71 sf.* 250 psf *7.0 ft. = 8242 lbs.
    → 8,242 lbs. ≥ 1,095 lbs. → OK

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- Depth Required Due to Lateral Loads:

  Calculations Per IBC Section 1805.7.2.1, Eq. 18-1: Nonconstrained Pile/Pier

  $d = 0.5A[1+(1+(4.36h/A))^{1/2}$

  $A = 2.34\ P/S_1b$
  b = 1.5 ft.
  S1 = [200 psf * (8.0 ft. / 3)] = 533.333 psf
  P = 892 lbs.

  $A = 2.34 * (892\ lbs. / (533.33\ psf * 1.5\ ft.)) = 2.61\ ft.$

  h = 6.2 ft. (Corresponding height for the average moment)

  $d = 0.5 * 2.61\ ft. * [1+(1+((4.36 * 6.2\ ft.) / 2.61\ ft.))^{1/2}] = 5.7\ ft.$
  → 8.0 ft. ≥ 5.7 ft. → OK

Therefore, use an 18" diameter concrete pile with an embedment depth of 9.0 ft. min.

*EPS does not specialize in corrosion engineering and therefore the corrosion protection requirements of the steel posts, driven piles, and all racking elements/components are not included in EPS's analysis and is the responsibility of others.

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APPENDIX

(For Reference Only)

MATERIAL	FINISH	DIMENSIONS ARE IN INCHES TOLERANCES: .XX: +/- .030 XXX: +/- .010 ANGLES: +/- 0.5°	

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	A	relesed to production	11/8/2017	

ITEM NO.	PART NUMBER	DESCRIPTION	QTY
1	70-0300-PGM	3" Cross pipe to 4" pipe cap assy	1
2	UNI-PGRM-MID REV B	Mid Clamp Assy PGRM	3
3	UNI-PGRM-END REV B	PGRM END CLAMP ASSY	2

DRAWN	VZ	10/12/2018
CHECKED	VZ	10/12/2018
ENG APPR.	VZ	10/12/2018
MFG APPR.	VZ	10/12/2018
Q.A.	VZ	10/12/2018

COMMENTS:

DO NOT SCALE DRAWING

Tamarack Solar Products

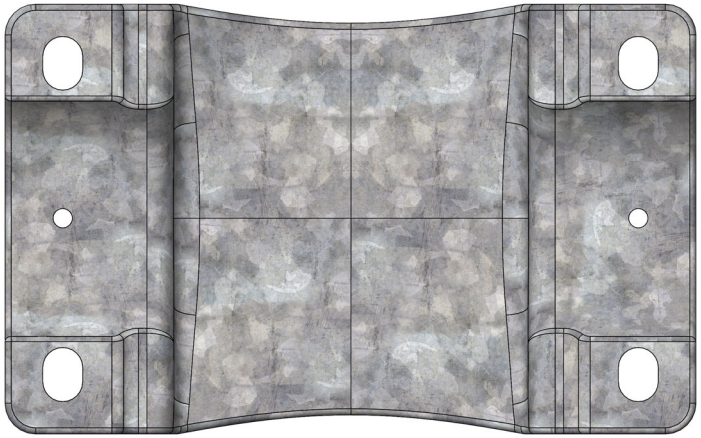
Single Pole Install

SIZE	DWG NO.	REV.
A	UNI-PGRM-41P	A

SCALE:1:32 | WT | SHEET 1 OF 1

MATERIAL	FINISH	DIMENSIONS ARE IN INCHES TOLERANCES: Per NADCA Product Specifications Standard, 2009 Version	PROPRIETARY AND CONFIDENTIAL
Cast Steel per Q355 GB/T 1591 -2018	HDG Per ASTM-123 GRD 100		

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	relesed to production	10/18/18	VZ
B	increased thickness of the gusset	10/19/2018	VZ
C	added powdercoat option	11/26/2018	vz
D	Changed cap from a weldment to a casting	10/13/2021	GMP



Tap 1/2-13 UNC 4 places
Threading to be
done **after plating**
NOTE: MUST USE A H11
(.005" oversized) tap
to allow for Galv plated
set screws to engage freely.

NOTES:

1. Finish HDG Per ASTM-123 Grade 100
2. All holes to be clear of excess plating
3. All dimensions not specified are basic per CAD file " 70-0400-000 rev D .igs"
4. All dimensions apply before hot dip galvanize.
5. Flagged dimensions apply after hot dip galvanizing, and should be checked with a go/no-go gauge
6. Corner Radii .008 to.020
7. Maximum burr height: .008
8. Maximum surface finish 12um, edge/cut finish 6.3 um
9. Finished part shall be clean, dry, and free of oil and dirt

DRAWN	VZ	10/26/2021
CHECKED	GMP	10/26/2021
ENG APPR.	GMP	10/26/2021
MFG APPR.	GMP	10/26/2021
Q.A.	GMP	10/26/2021

COMMENTS:

DO NOT SCALE DRAWING

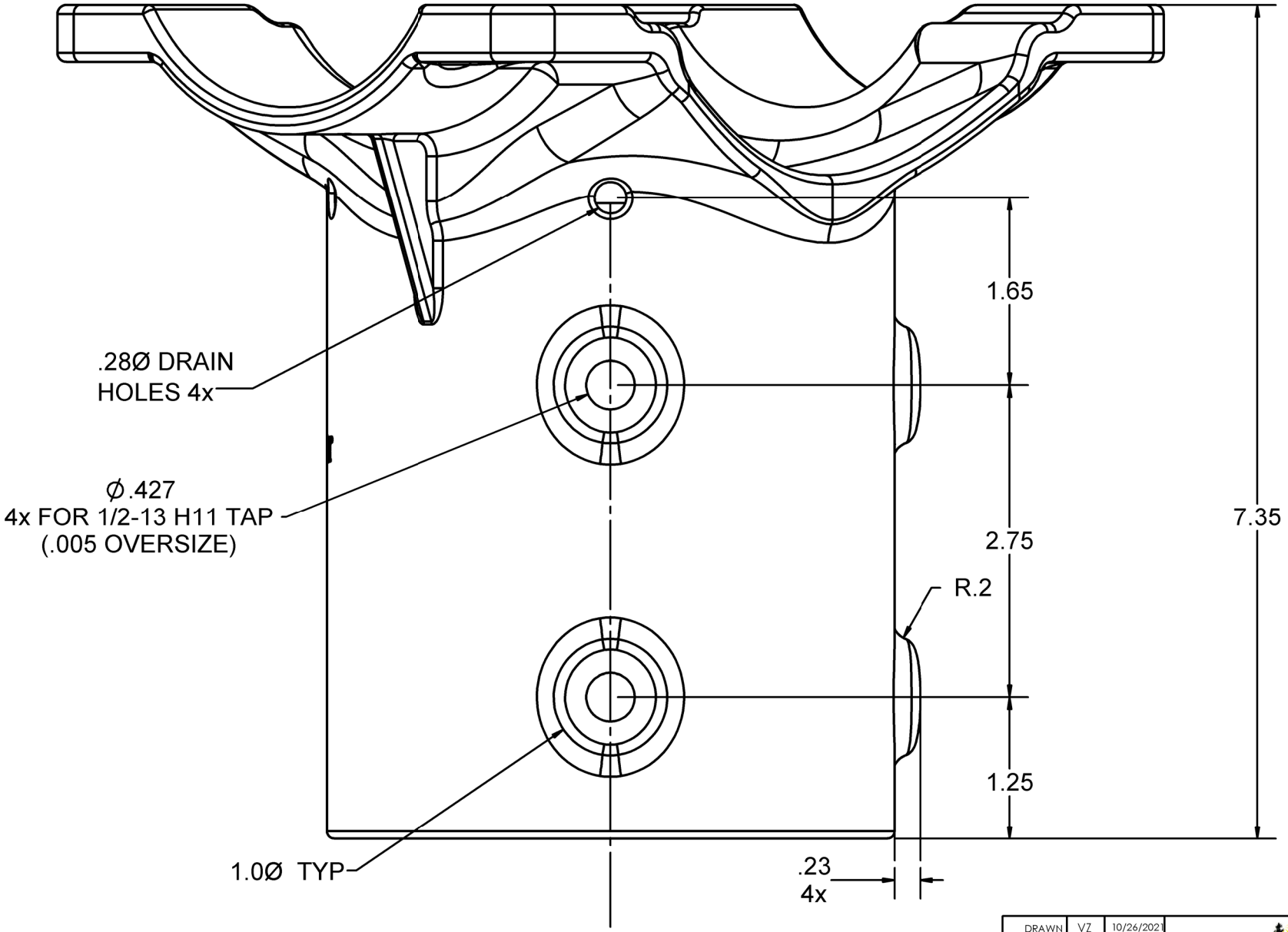
Tamarack Solar Products

Cap, 4" Pipe, 3" Cross Pipe

SIZE	DWG NO.	REV.
A	70-0400-000	D

SCALE:1:4 | WT | SHEET 1 OF 5

MATERIAL	FINISH		PROPRIETARY AND CONFIDENTIAL



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CHECKED	VZ	10/26/2021
ENG APPR.	VZ	10/26/2021
MFG APPR.	VZ	10/26/2021
Q.A.	VZ	10/26/2021

COMMENTS:

DO NOT SCALE DRAWING

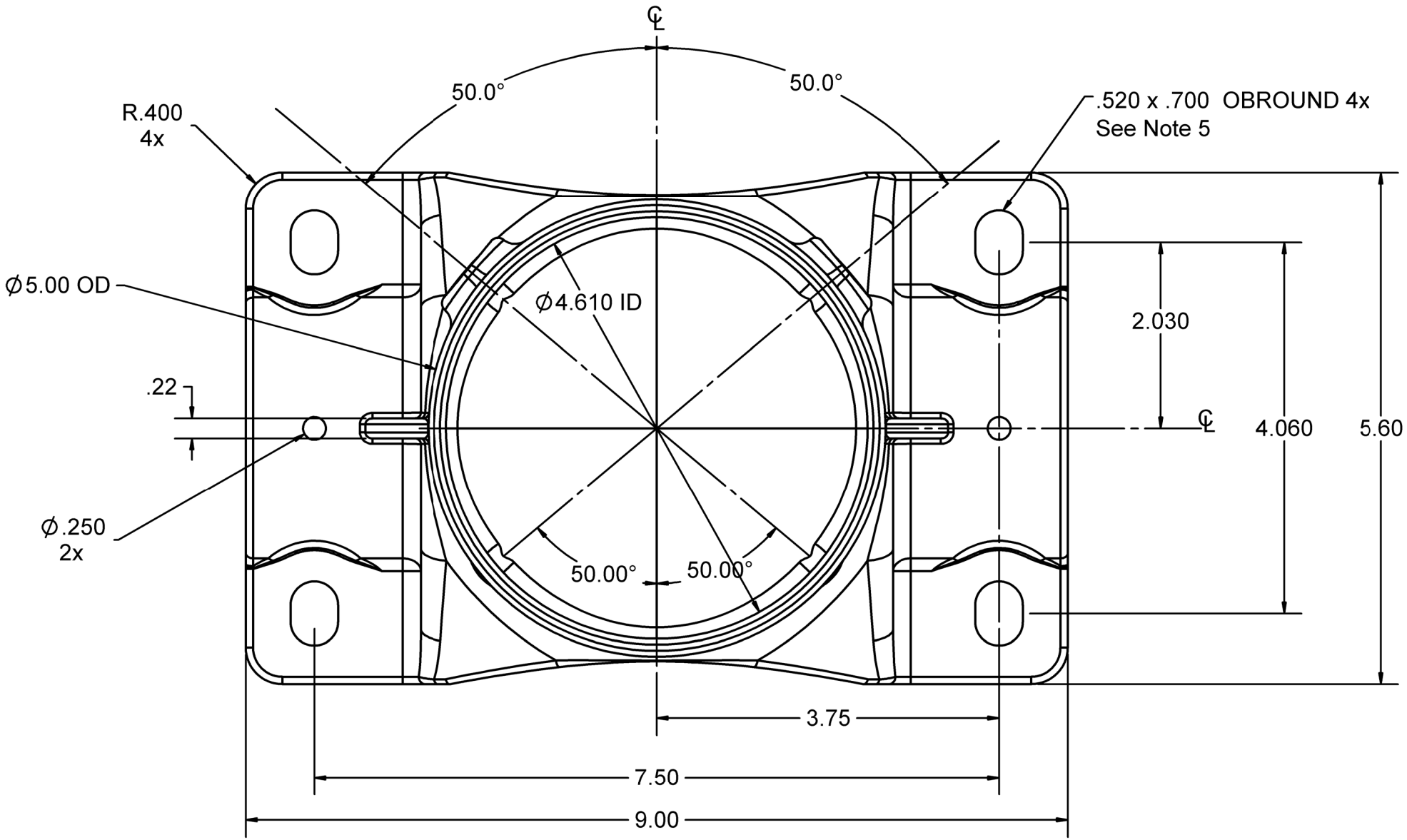
Tamarack Solar Products

Cap, 4" Pipe, 3" Cross Pipe

SIZE	DWG NO.	REV.
A	70-0400-000	D

SCALE:1:4	WT	SHEET 2 OF 5

MATERIAL	FINISH		PROPRIETARY AND CONFIDENTIAL THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF TAMARACK SOLAR. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF TAMARACK SOLAR. IS PROHIBITED.



DRAWN	VZ	10/26/2021
CHECKED	VZ	10/26/2021
ENG APPR.	VZ	10/26/2021
MFG APPR.	VZ	10/26/2021
Q.A.	VZ	10/26/2021

COMMENTS:

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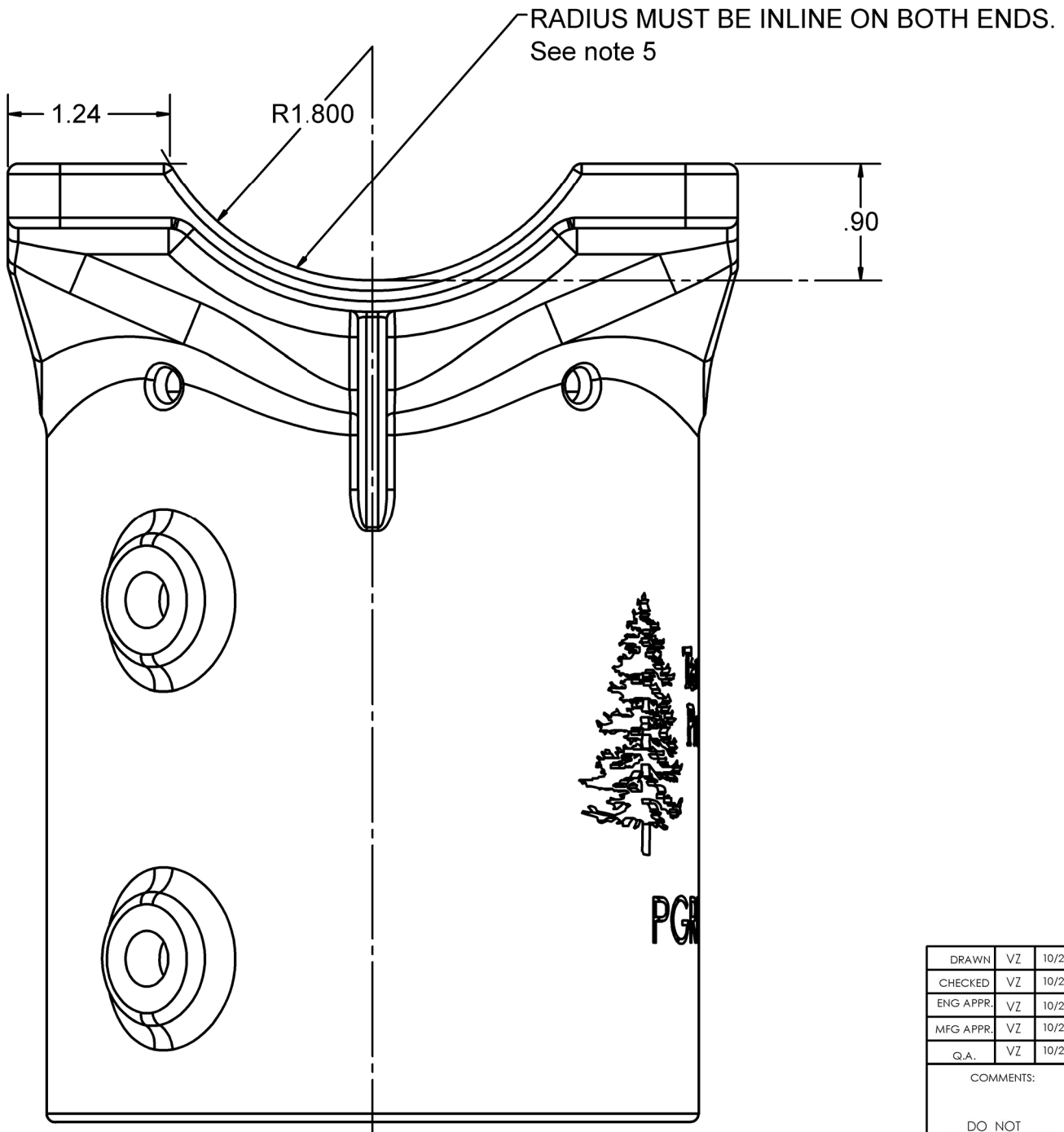
Cap, 4" Pipe, 3" Cross Pipe

SIZE	DWG NO.	REV.
A	70-0400-000	D

SCALE:1:4	WT	SHEET 3 OF 5

MATERIAL	FINISH		PROPRIETARY AND CONFIDENTIAL



DRAWN	VZ	10/26/2021
CHECKED	VZ	10/26/2021
ENG APPR.	VZ	10/26/2021
MFG APPR.	VZ	10/26/2021
Q.A.	VZ	10/26/2021

COMMENTS:

DO NOT SCALE DRAWING

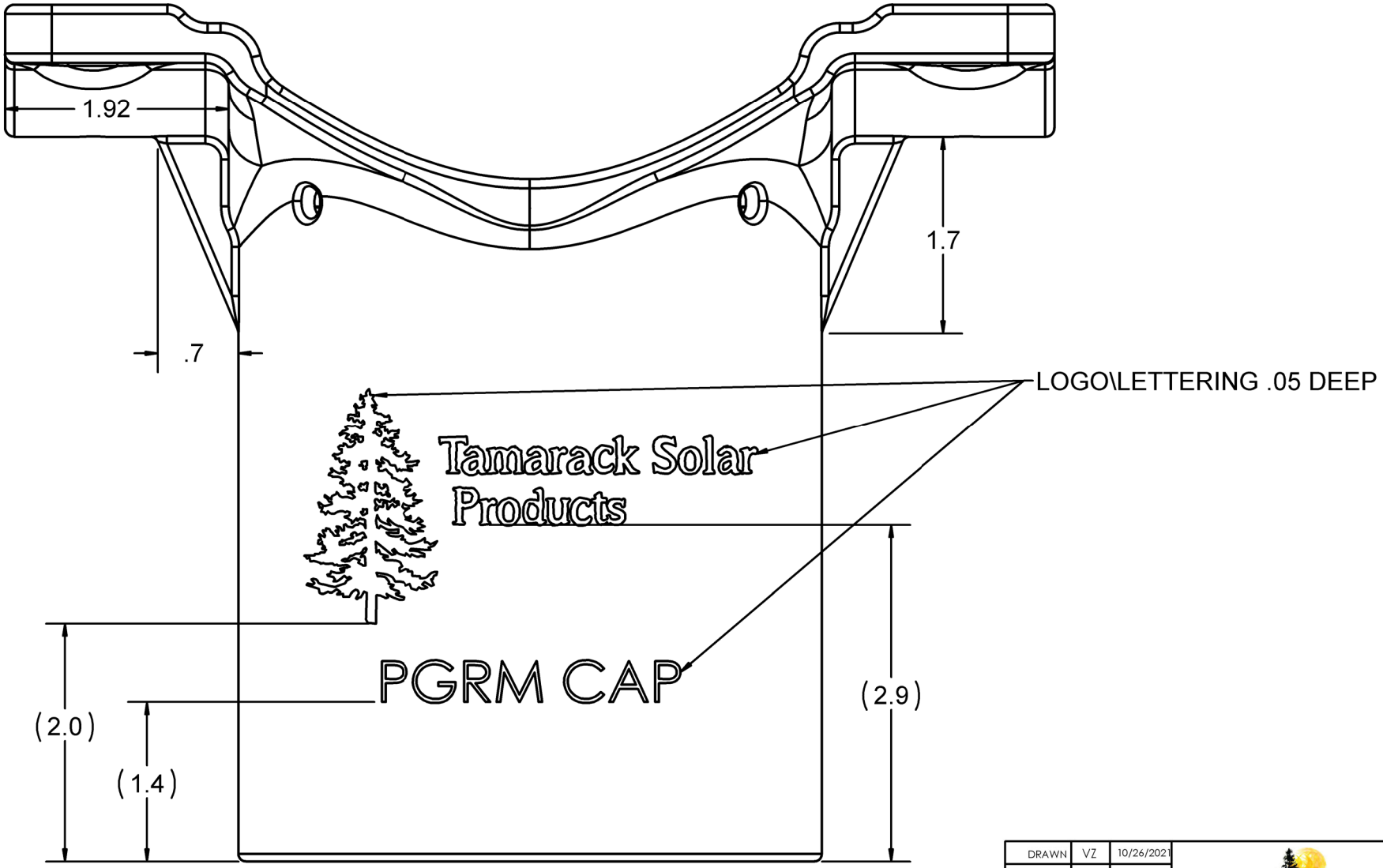
Tamarack Solar Products

Cap, 4" Pipe, 3" Cross Pipe

SIZE	DWG NO.	REV.
A	70-0400-000	D

SCALE:1:4	WT	SHEET 4 OF 5

MATERIAL	FINISH		PROPRIETARY AND CONFIDENTIAL
			THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF TAMARACK SOLAR. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF TAMARACK SOLAR. IS PROHIBITED.



DRAWN	VZ	10/26/2021
CHECKED	VZ	10/26/2021
ENG APPR.	VZ	10/26/2021
MFG APPR.	VZ	10/26/2021
Q.A.	VZ	10/26/2021

COMMENTS:

DO NOT SCALE DRAWING

Tamarack Solar Products

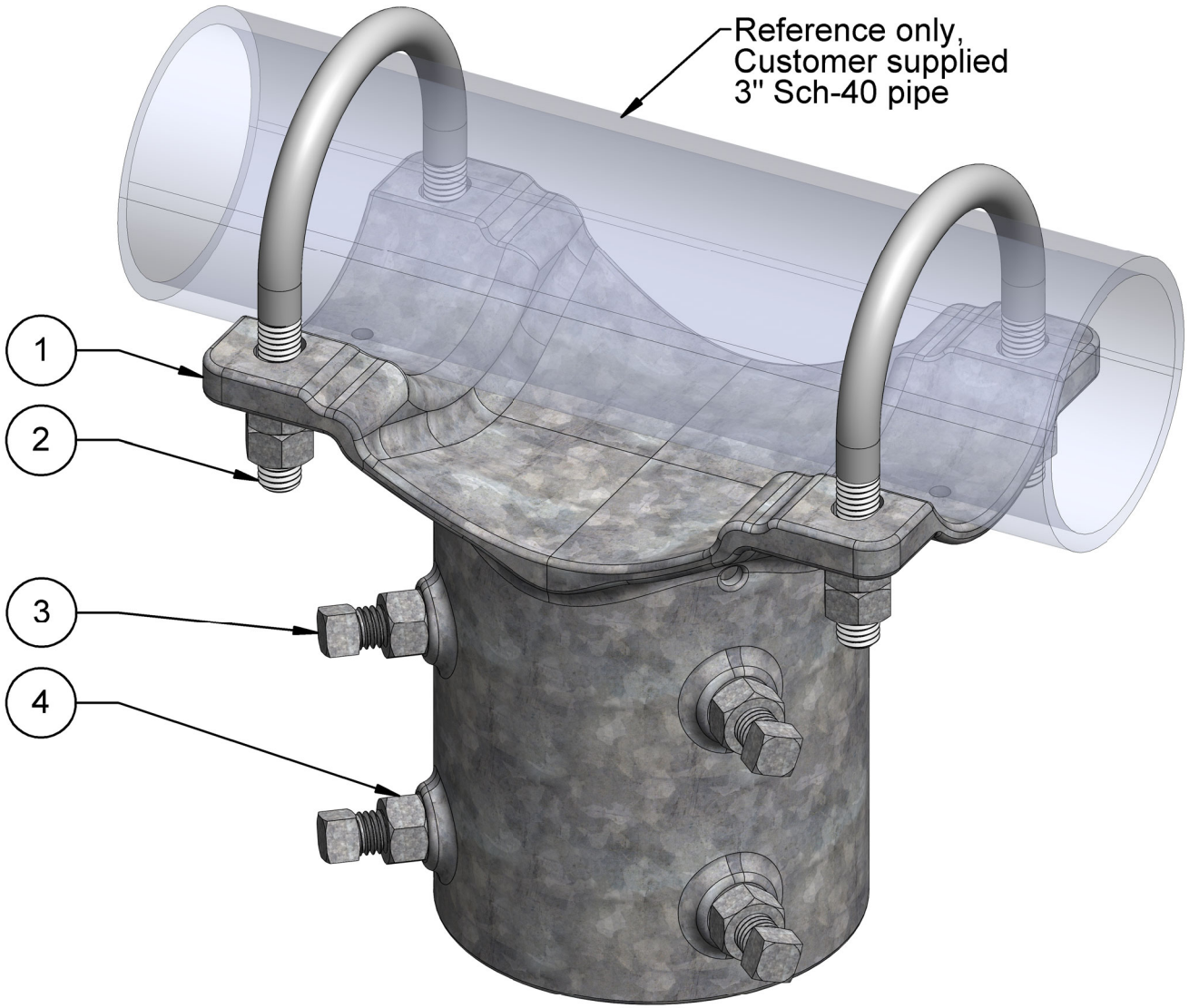
Cap, 4" Pipe, 3" Cross Pipe

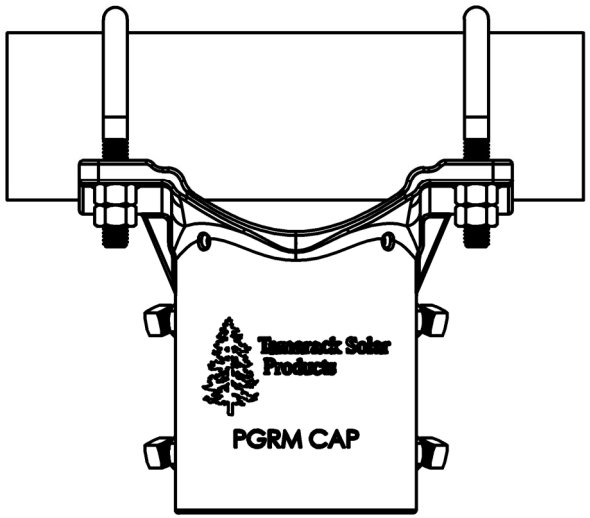
SIZE	DWG NO.	REV.
A	70-0400-000	D

SCALE:1:4	WT	SHEET 5 OF 5

MATERIAL	FINISH	DIMENSIONS ARE IN INCHES TOLERANCES: .XX: +/- .030 XXX: +/- .010 ANGLES: +/- 0.5°	

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	released to production	10/18/18	VZ
B	changed to a cast cap, removed u-bolt clamp, changed u-bolt to custom length, changed set screw length, jam nut to std nut. Removed flat and lock washers	10/18/2021	GMP





ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	70-0400-000 rev D	Cap, 4" Pipe, 3" Cross Pipe	1
2	23-3513-GLV rev A	Bolt-U, 3" Pipe (Custom) Galv	2
3	23-0513-125 rev A	Screw, Set SQ Head cup Point, 1/2-13 x 1.25"	4
4	24-5013-GLV rev A	Nut, 1/2-13 Galv	12

DRAWN	VZ	10/26/2021
CHECKED	GMP	10/26/2021
ENG APPR.	GMP	10/26/2021
MFG APPR.	GMP	10/26/2021
Q.A.	GMP	10/26/2021

COMMENTS:

DO NOT SCALE DRAWING

Tamarack Solar Products

Cap Assembly

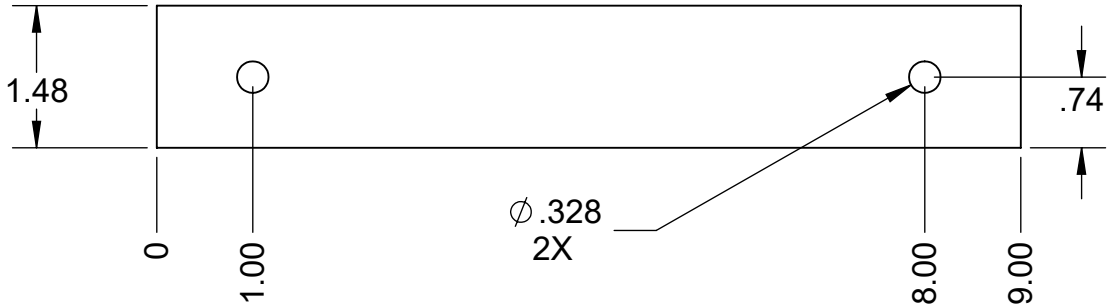
SIZE	DWG NO.	REV.
A	70-0300-PGM	B

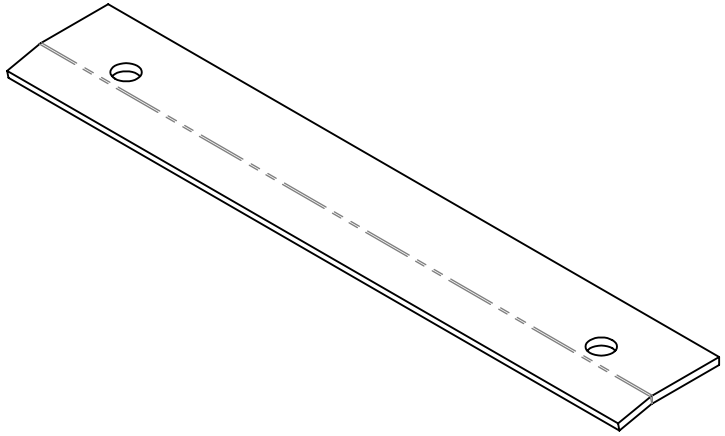
SCALE:1:4 | WT | SHEET 1 OF 1

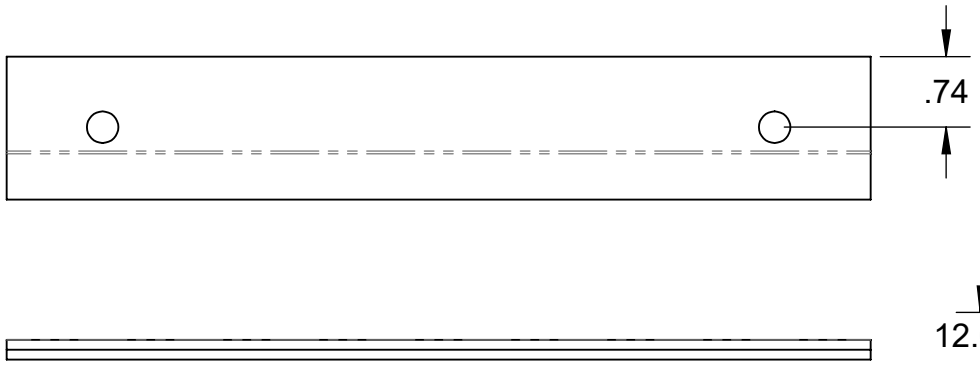
MATERIAL	FINISH		
12 GAGE G90 A653 CS Typ B	G90-PRE GALV	DIMENSIONS ARE IN INCHES TOLERANCES: .XX: +/- .030 XXX: +/- .010 ANGLES: +/- 0.5°	PROPRIETARY AND CONFIDENTIAL THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF TAMARACK SOLAR. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF TAMARACK SOLAR. IS PROHIBITED.

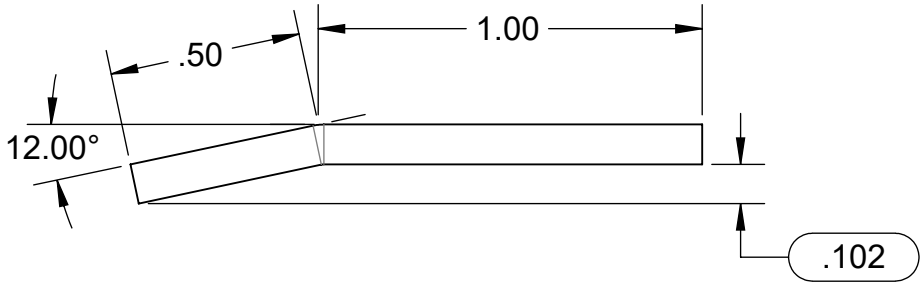
REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	A	relesed to production	06/25/18	VZ

K= .02









NOTES:
1. break sharp edges, do not sand off galv coating.

DRAWN	VZ	6/26/2018
CHECKED	VZ	6/26/2018
ENG APPR.	VZ	6/26/2018
MFG APPR.	VZ	6/26/2018
Q.A.	VZ	6/26/2018

COMMENTS:

DO NOT SCALE DRAWING

Tamarack Solar Products

UNDER PANEL FRAME CLAMP

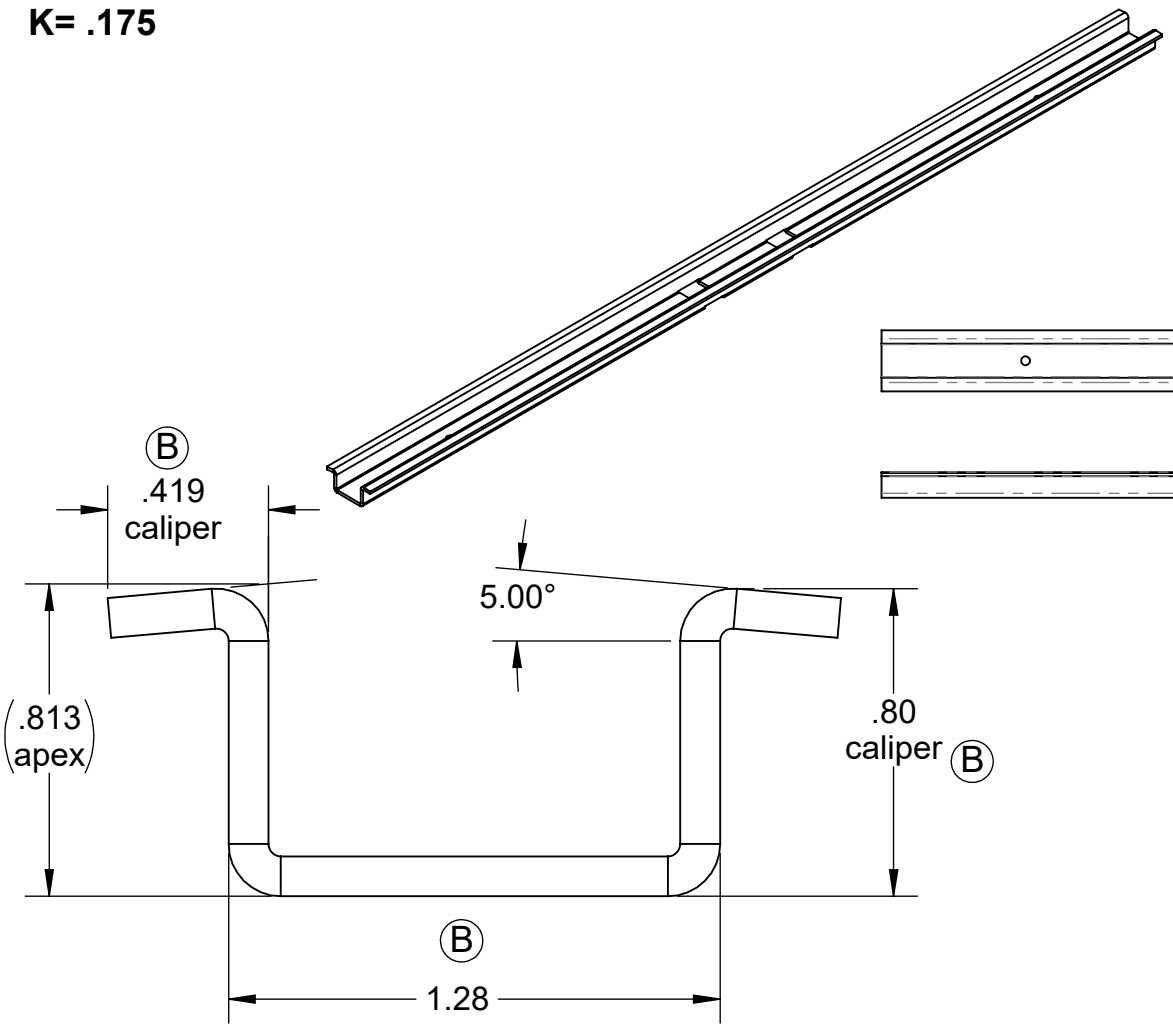
SIZE	DWG NO.	REV.
A	51-0835-UPC	A

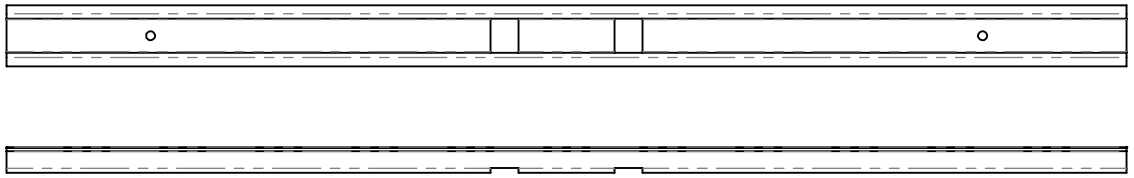
SCALE:1:4	WT .39Lbs	SHEET 1 OF 1

MATERIAL	FINISH	DIMENSIONS ARE IN INCHES TOLERANCES: .XX: +/- .030 XXX: +/- .010 ANGLES: +/- 0.5°	PROPRIETARY AND CONFIDENTIAL THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF TAMARACK SOLAR. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF TAMARACK SOLAR. IS PROHIBITED.
12 GAGE G90 A653 CS Typ B	G90-PRE GALV		

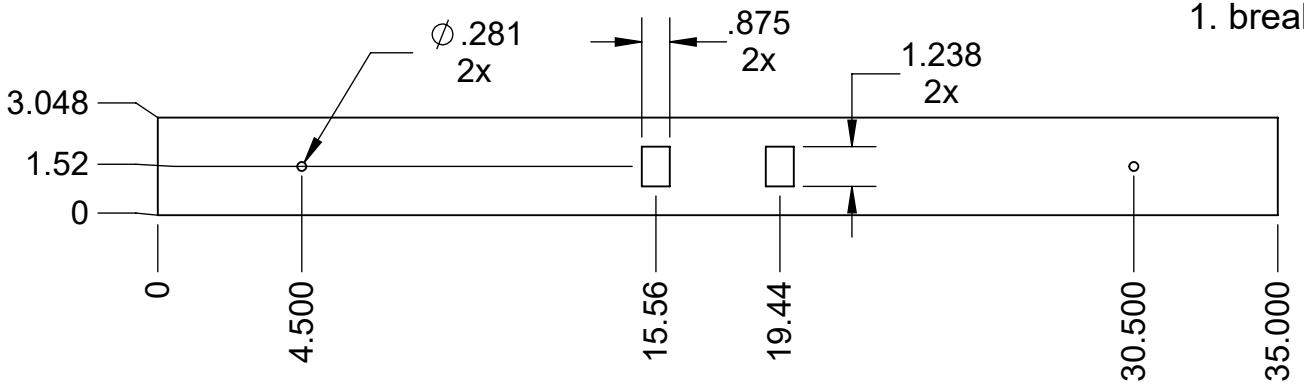
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	relesed to production	6/20/2017	
B	increased flange length, and width decreased hieght	7/6/2018	

K= .175





NOTES:
1. break sharp edges, do not sand off galv coating.



DRAWN	VZ	7/6/2018
CHECKED	VZ	7/6/2018
ENG APPR.	VZ	7/6/2018
MFG APPR.	VZ	7/6/2018
Q.A.	VZ	7/6/2018

COMMENTS:

DO NOT SCALE DRAWING

Tamarack Solar Products

MID CLAMP TOP

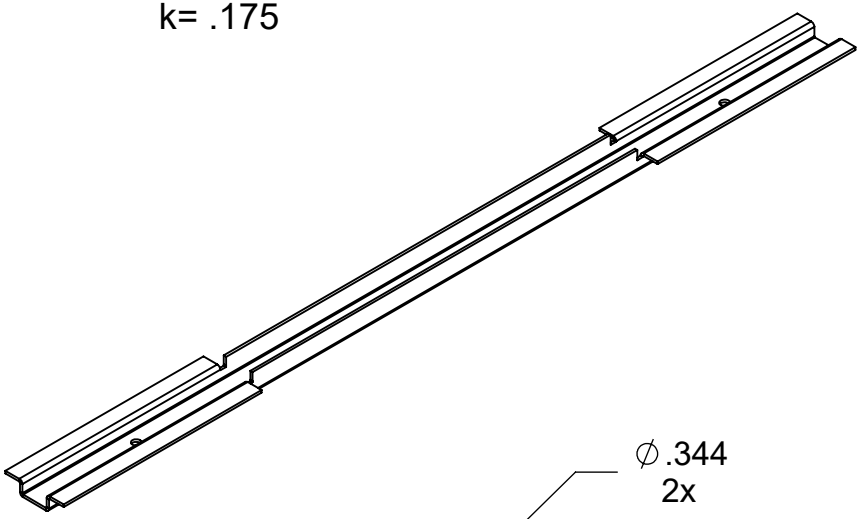
SIZE	DWG NO.	REV.
A	51-0835-MCT	B

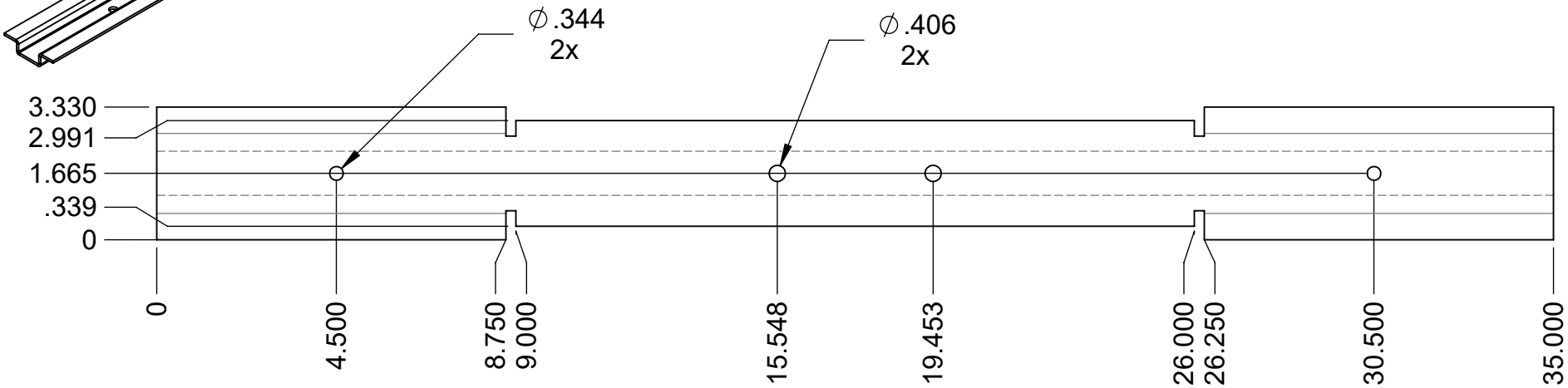
SCALE:1:16	WT 3.19Lbs	SHEET 1 OF 1

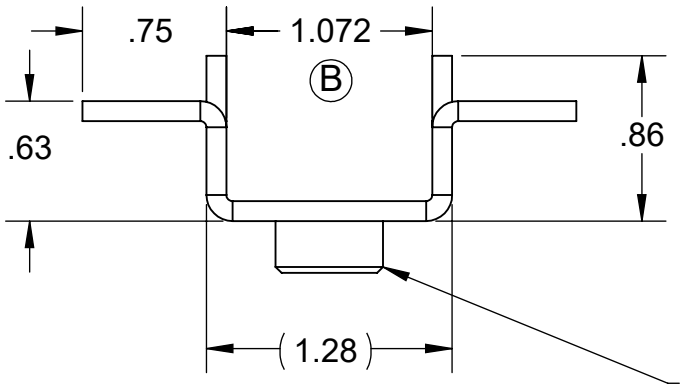
MATERIAL	FINISH	DIMENSIONS ARE IN INCHES TOLERANCES: .XX: +/- .030 XXX: +/- .010 ANGLES: +/- 0.5°	PROPRIETARY AND CONFIDENTIAL THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF TAMARACK SOLAR. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF TAMARACK SOLAR. IS PROHIBITED.
12 GAGE G90 A653 CS Typ B	G90 PRE-GALV		

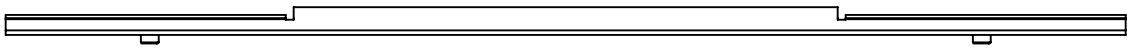
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	relesed to production	6/20/2018	VZ
B	ADDED .03 FOR WASHER CLEARANCE	7/6/2018	VZ

k= .175









CLS-0420-2
2x

NOTES:
1. break sharp edges, do not sand off galv coating.

DRAWN	VZ	7/6/2018
CHECKED	VZ	7/6/2018
ENG APPR.	VZ	7/6/2018
MFG APPR.	VZ	7/6/2018
Q.A.	VZ	7/6/2018

COMMENTS:

DO NOT SCALE DRAWING

Tamarack Solar Products

MID CLAMP BOTTOM

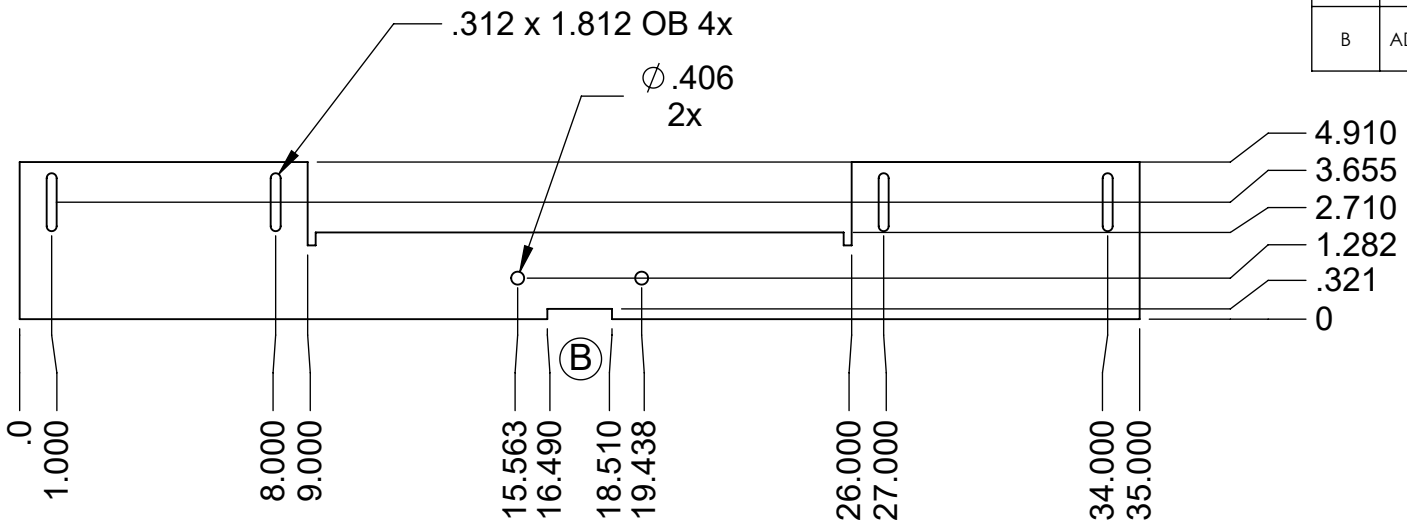
SIZE	DWG NO.	REV.
A	51-0835-MCB	B

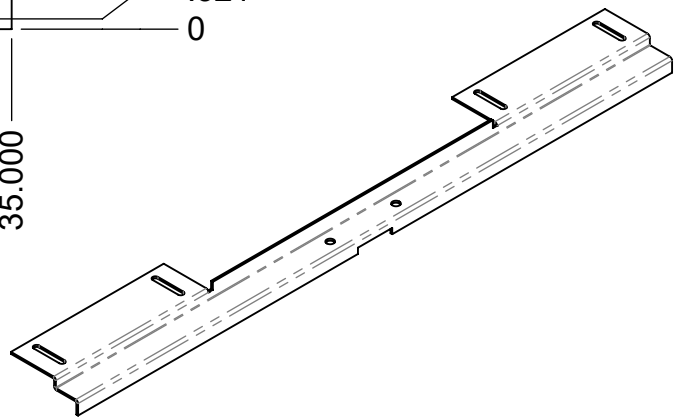
SCALE:1:8	WT 3.15Lbs	SHEET 1 OF 1

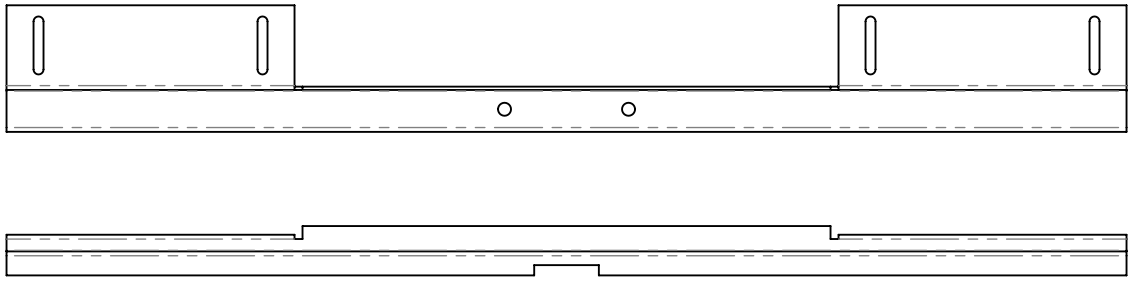
MATERIAL	FINISH		
12 GAGE G90 A653 CS Typ B	G90-PRE-GALV	DIMENSIONS ARE IN INCHES TOLERANCES: .XX: +/- .030 XXX: +/- .010 ANGLES: +/- 0.5°	

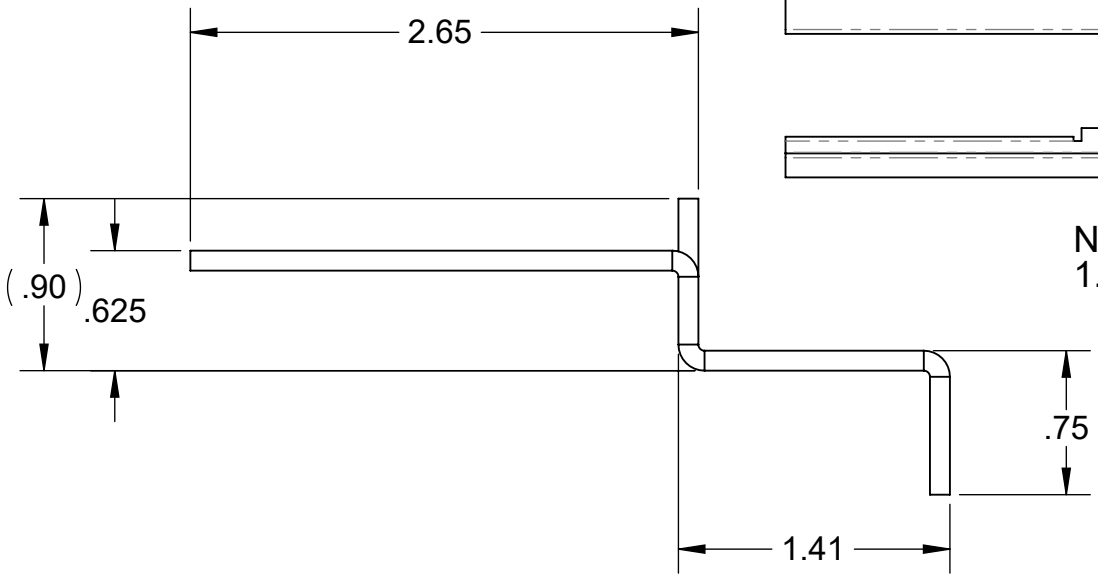
REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	relesed to production	06/20/18	VZ
B	ADDED PIPE CLEARANCE	7/6/2018	VZ

K= .175









NOTES:
1. break sharp edges, do not sand off galv coating.

DRAWN	VZ	10/12/2018
CHECKED	VZ	10/12/2018
ENG APPR.	VZ	10/12/2018
MFG APPR.	VZ	10/12/2018
Q.A.	VZ	10/12/2018

COMMENTS:

DO NOT SCALE DRAWING

Tamarack Solar Products

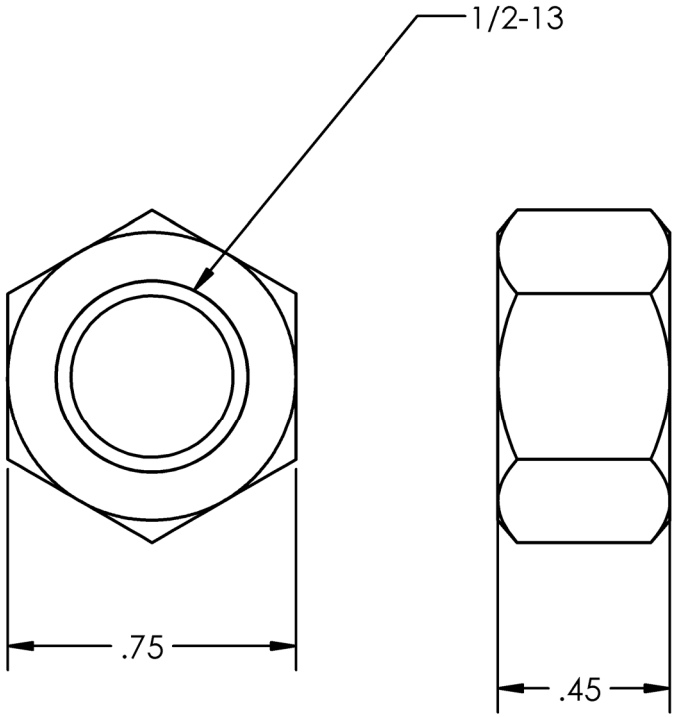
END CLAMP BASE

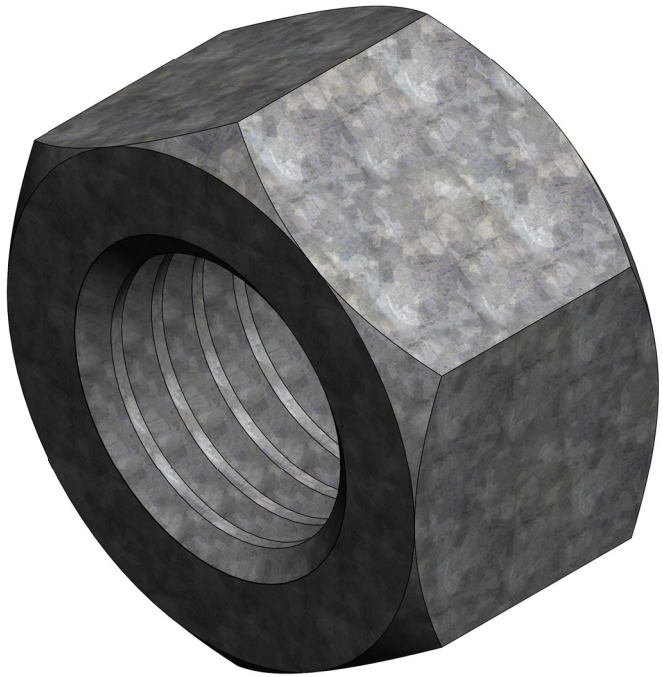
SIZE	DWG NO.	REV.
A	51-0835-ECB	B

SCALE:1:16	WT 3.99Lbs	SHEET 1 OF 1

MATERIAL	FINISH	DIMENSIONS ARE IN INCHES TOLERANCES: .XX: +/- .030 XXX: +/- .010 ANGLES: +/- 0.5°	PROPRIETARY AND CONFIDENTIAL THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF TAMARACK SOLAR. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF TAMARACK SOLAR. IS PROHIBITED.

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	released for production	10/26/2021	GMP





Notes:
1) Per ASME B.18.2.6-2010, Table 3
2) Materials: Steel, Carbon Alloy, Grade 2H, Per ASTM A194-2010A, 175 KSI Proof Stress
3) Finish: Hot Dip Galvanize per ASTM F239-05 OR ASTM A153 Class C

DRAWN	VZ	10/26/2021
CHECKED	GMP	10/26/2021
ENG APPR.	GMP	10/26/2021
MFG APPR.	GMP	10/26/2021
Q.A.	GMP	10/26/2021

COMMENTS:

DO NOT SCALE DRAWING

Tamarack Solar Products

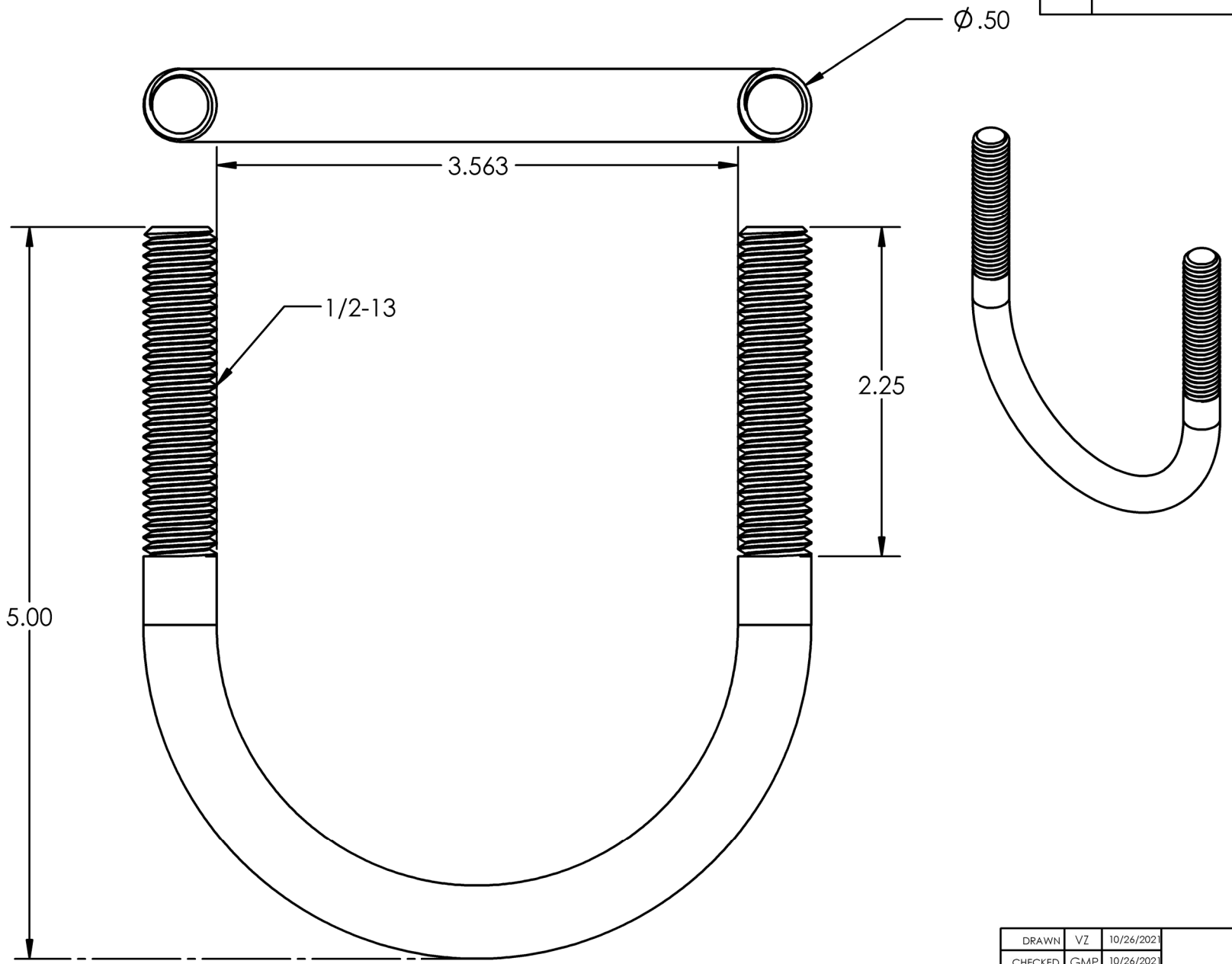
Nut, Hex 1/2-13

SIZE	DWG NO.	REV.
A	24-5013-GLV	A

SCALE:2:1 | WT | SHEET 1 OF 1

MATERIAL	FINISH	DIMENSIONS ARE IN INCHES TOLERANCES: .XX: +/- .030 XXX: +/- .010 ANGLES: +/- 0.5°
Steel Q235 GBT 1591-2008	HDG per ASTM A153 Class C	

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	Released for production	10/26/2021	GMP



DRAWN	VZ	10/26/2021
CHECKED	GMP	10/26/2021
ENG APPR.	GMP	10/26/2021
MFG APPR.	GMP	10/26/2021
Q.A.	GMP	10/26/2021

Tamarack Solar Products

COMMENTS:

DO NOT SCALE DRAWING

Bolt-U, 3" Pipe (Custom) Galv

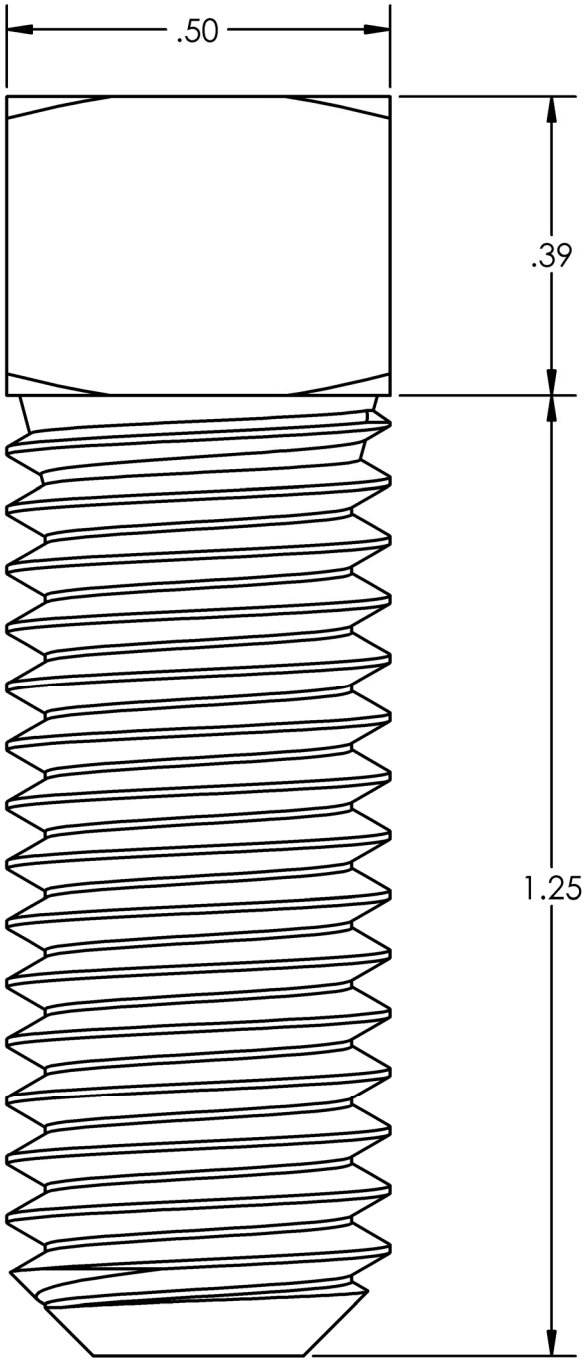
SIZE	DWG NO.	REV.
A	23-3513-GLV	A

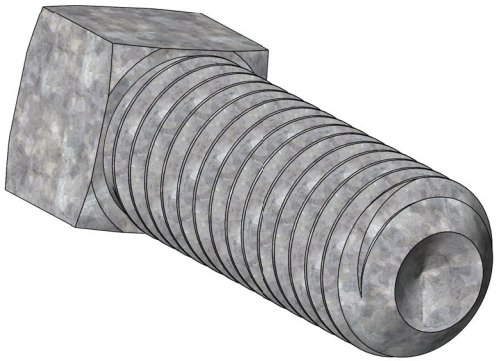
SCALE:1:2	WT	SHEET 1 OF 1

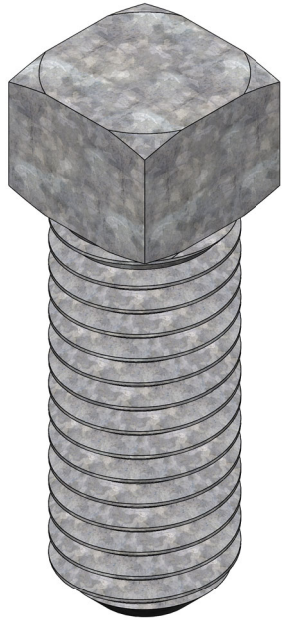
MATERIAL	FINISH	DIMENSIONS ARE IN INCHES TOLERANCES: .XX: +/- .030 XXX: +/- .010 ANGLES: +/- 0.5°	

REVISIONS

REV.	DESCRIPTION	DATE	APPROVED
A	Released for production	10/26/2021	GMP







Notes:

1) Per ASME B18.5-2008, Table 2
2) Material: Steel, Medium Carbon, Grade 5, per sae J429-2011, Table 2
3) Finish: Hot Dip Galvanize per ASTM F239-05 OR ASTM A153 Class C

DRAWN	VZ	10/26/2021
CHECKED	GMP	10/26/2021
ENG APPR.	GMP	10/26/2021
MFG APPR.	GMP	10/26/2021
Q.A.	GMP	10/26/2021

COMMENTS:

DO NOT SCALE DRAWING

Tamarack Solar Products

Screw, Set SQ Head cup Point, 1/2-13 x 1.25"

SIZE	DWG NO.	REV.
A	23-0513-125	A

SCALE:2:1 | WT | SHEET 1 OF 1

ICC EVALUATION SERVICE®

ICC-ES Evaluation Report

ESR-1976

Reissued July 2020
Revised April 2021
This report is subject to renewal July 2022.

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DIVISION: 05 00 00—METALS
Section: 05 05 23—Metal Fastenings

REPORT HOLDER:

ITW BUILDEX

EVALUATION SUBJECT:

ITW BUILDEX TEKS® SELF-DRILLING FASTENERS

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2021, 2018, 2015 and 2012 *International Building Code®* (IBC)
- 2021, 2018, 2015 and 2012 *International Residential Code®* (IRC)

For evaluation for compliance with codes adopted by Los Angeles Department of Building and Safety (LADBS), see ESR-1976 LABC and LARC Supplement.

Property evaluated:

Structural

2.0 USES

The ITW Buildex TEKS® Self-drilling Fasteners described in this report are used in engineered or code-prescribed connections of cold-formed steel framing and of sheet steel sheathing to cold-formed steel framing.

3.0 DESCRIPTION

3.1 General:

ITW Buildex TEKS® Self-drilling Fasteners are self-drilling tapping screws complying with the material, process, and performance requirements of ASTM C1513. The screws have either a hex washer head (HWH), an HWH with serrations, or a Phillips® (Type II) pan head. The screws are fully threaded with threads that comply with ASME B18.6.4, and the screws' drill points and flutes are proprietary and are designated as TEKS/1, TEKS/2, TEKS/3, TEKS/4, TEKS/4.5, TEKS/5.0 and TEKS/5. The screws have nominal sizes of No.10 (0.190 inch), No.12 (0.216 inch), and 1/4 inch (0.250 inch), and lengths from 1/2 inch to 4 inches (12.7 mm to 102 mm). See Figures 1 through 3 for depictions of the screws. Table 1 provides screw descriptions (size, tpi, length), nominal diameters, head style, head diameters, point styles, drilling capacity ranges, length of load-bearing area, minimum required protrusion lengths and coatings.

3.2 Material:

ITW Buildex TEKS® Self-drilling Fasteners are case-hardened from carbon steel conforming to ASTM A510, Grades 1018 to 1022, and are heat-treated and case-hardened to give them a hard outer surface necessary to cut internal threads in the joint material. Screws are coated with corrosion preventive coating identified as Climaseal®, or are plated with electrodeposited zinc (E-Zinc) complying with the minimum corrosion resistance requirements of ASTM F1941.

3.3 Cold-formed Steel:

Cold-formed steel material must comply with one of the ASTM specifications listed in Section A3.1 of AISI S100 (Section A2.1 of AISI S100 for the 2015 and 2012 IBC) and have the minimum specified tensile strengths shown in the tables in this report.

4.0 DESIGN AND INSTALLATION

4.1 Design:

4.1.1 General: Selection of screw length must be based on the thickness of the fastened steel members plus the minimum required protrusion past the back of the supporting steel. Point selection must be based on the drilling capacity of the screw. See Table 1 for minimum required protrusion lengths and drilling capacities.

When tested for corrosion resistance in accordance with ASTM B117, the screws meet the minimum requirement listed in ASTM F1941, as required by ASTM C1513, with no white corrosion after three hours and no red rust after 12 hours.

4.1.2 Prescriptive Design: ITW Buildex TEKS Self-drilling Fasteners described in Section 3.1 may be used where ASTM C1513 screws of the same size and head style/dimension are prescribed in the IRC and in the AISI standards referenced in IBC Section 2211 for steel-to-steel connections.

4.1.3 Engineered Design: ITW Buildex TEKS® Self-drilling Fasteners may be used in engineered connections of cold-formed steel construction. Design of the connection must comply with Section J4 of AISI S100 (Section E4 of AISI S100 for the 2015 and 2012 IBC), using the nominal and allowable fastener tension and shear strength for the screws, shown in Table 5. Allowable connection strength for use in Allowable Strength Design (ASD) for pull-out, pullover, and shear (bearing) capacity for common sheet steel thicknesses are provided in Tables 2, 3, and 4, respectively, based upon calculations in accordance with

AISI S100. Instructions on how to calculate connection design strengths for use in Load Resistance Factor Design (LRFD) are found in the footnotes of these tables. The connection strength values are applicable to connections where the connected steel elements are in direct contact with one another. For connections subject to tension, the least of the allowable pullout, pullover, and fastener tension strength found in Tables 2, 3 and 5, respectively, must be used for design. For connections subject to shear, the lesser of the fastener shear strength and allowable shear (bearing) found in Tables 5 and 4, respectively, must be used for design. Design provisions for tapping screw connections subjected to combined shear and tension loading are outside the scope of this report.

Under the 2021 IBC, for screws used in framing connections, in order for the screws to be considered fully effective, the minimum spacing between screws must be 3 times the nominal screw diameter and the minimum edge distance must be 1.5 times the nominal screw diameter. Under the 2018, 2015 and 2012 IBC, for screws used in framing connections, in order for the screws to be considered fully effective, the minimum spacing between the fasteners and the minimum edge distance must be three times the nominal diameter of the screws, except when the edge is parallel to the direction of the applied force, the minimum edge distance must be 1.5 times the nominal screw diameter. When the spacing between screws is less than 3 times the nominal screw diameter, but at least 2 times the nominal screw diameter, the connection shear strength values in Table 4 must be reduced by 20 percent [Refer to Section B1.5.1.3 of AISI S240 (Section D1.5 of AISI S200 for the 2015 and 2012 IBC)].

For screws used in applications other than framing connections, the minimum spacing between the fasteners must be three times the nominal screw diameter and the minimum edge and end distance must be 1.5 times the nominal screw diameter.

Connected members must be checked for rupture in accordance with Section J6 of AISI S100 (Section E6 of AISI S100 for the 2015 IBC, Section E5 of AISI S100-07/S2-10 for the 2012 IBC).

4.2 Installation:

Installation of ITW Buildex TEKS® Self-drilling Fasteners must be in accordance with the manufacturer's published installation instructions and this report. The manufacturer's published installation instructions must be available at the jobsite at all times during installation.

The screws must be installed perpendicular to the work surface, using a screw driving tool. The installation speed for 1/4-inch TEKS/3, 1/4-inch TEKS/5, #12 TEKS/5.0 and #12 TEKS/5 screws should not exceed 1,800 rpm; the installation speed for all other screws should not exceed 2,500 rpm. The screw must penetrate through the supporting steel with a minimum of three threads protruding past the back side of the supporting steel.

5.0 CONDITIONS OF USE

The ITW Buildex TEKS® Self-drilling Fasteners described in this report comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 Fasteners must be installed in accordance with the manufacturer's published installation instructions and this report. In the event of a conflict between this report and the manufacturer's published installation instructions, this report governs.

5.2 The use of the screws in engineered steel deck diaphragms has not been evaluated and is outside the scope of this evaluation report.

5.3 Evaluation of screws subjected to cyclic or fatigue loading is outside the scope of this report. Applicable Seismic Design Categories must be determined in accordance with the code for the entire assembly constructed with the screws.

5.4 The allowable load values (ASD) specified in Section 4.1 for screws or for screw connections are not permitted to be increased for short-duration loads, such as wind or earthquake loads.

5.5 Drawings and calculations verifying compliance with this report and the applicable code must be submitted to the code official for approval. The drawings and calculations are to be prepared by a registered design professional when required by the statutes of the jurisdiction in which the project is to be constructed.

5.6 The screws are manufactured under a quality control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Tapping Screw Fasteners Used in Steel-to-steel Connections (AC118), dated January 2018 (editorially revised December 2020).

7.0 IDENTIFICATION

7.1 ITW Buildex TEKS® Self-drilling Fastener heads are marked with "BX" as shown in Figures 1 through 3. Each box of fasteners has a label bearing the company name (ITW Buildex), fastener description (model, point type, diameter and length), lot number, and the evaluation report number (ESR-1976).

7.2 The report holder's contact information is the following:

ITW BUILDEX
155 HARLEM AVENUE
GLENVIEW, ILLINOIS 60025
(800) 848-5611
www.itwbuildex.com
techsupport@itwccna.com

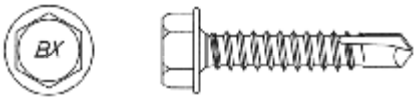

FIGURE 1—HEX WASHER HEAD (HWH)

FIGURE 2—HWH WITH SERRATIONS

FIGURE 3—PHILLIPS PAN HEAD

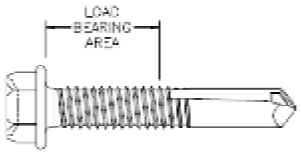

FIGURE 4—LENGTH OF LOAD-BEARING AREA

TABLE 1—TESK® SELF-DRILLING TAPPING SCREWS[1]

DESCRIPTION (nom. size-tpi x length)	NOMINAL DIAMETER (inch)	HEAD STYLE	HEAD DIAMETER (inch)	DRILL POINT	DRILLING CAPACITY[3] (in.)		LENGTH OF LOAD BEARING AREA[4] (inch)	MINIMUM REQUIRED PROTRUSION (inch)	COATING
					Min.	Max.			
10-16 x 3/4"	0.190	HWH	0.400	TEKS/1	0.018	0.095	0.220	0.530	Climaseal
12-14 x 3/4"	0.216	HWH	0.415	TEKS/1	0.018	0.095	0.205	0.545	Climaseal
1/4-14 x 7/8"	0.250	HWH	0.415	TEKS/1	0.018	0.095	0.380	0.495	Climaseal
10-16 x 1/2"	0.190	Pan	0.365	TEKS/3	0.036	0.175	0.075	0.425	Climaseal
10-16 x 5/8"	0.190	Pan	0.365	TEKS/3	0.036	0.175	0.200	0.425	Climaseal
10-16 x 3/4"	0.190	Pan	0.365	TEKS/3	0.036	0.175	0.325	0.425	Climaseal
10-16 x 1/2"	0.190	HWH	0.400	TEKS/3	0.036	0.175	0.075	0.425	Climaseal
10-16 x 5/8"	0.190	HWH	0.400	TEKS/3	0.036	0.175	0.200	0.425	Climaseal
10-16 x 3/4"	0.190	HWH	0.400	TEKS/3	0.036	0.175	0.325	0.425	Climaseal
10-16 x 1"	0.190	HWH	0.400	TEKS/3	0.036	0.175	0.575	0.425	Climaseal
10-16 x 1"	0.190	Pan	0.365	TEKS/3	0.036	0.175	0.575	0.425	Climaseal
10-16 x 1 1/4"	0.190	HWH	0.400	TEKS/3	0.036	0.175	0.825	0.425	Climaseal
10-16 x 1 1/2"	0.190	HWH	0.400	TEKS/3	0.036	0.175	1.075	0.425	Climaseal
10-16 x 3/4"	0.190	HWH[2]	0.435	TEKS/3	0.036	0.175	0.325	0.425	E-Zinc
12-14 x 3/4"	0.216	HWH	0.415	TEKS/3	0.036	0.210	0.200	0.550	Climaseal
12-14 x 1"	0.216	HWH	0.415	TEKS/3	0.036	0.210	0.450	0.550	Climaseal
12-14 x 1 1/4"	0.216	HWH	0.415	TEKS/2	0.036	0.210	0.550	0.700	Climaseal
12-14 x 1 1/2"	0.216	HWH	0.415	TEKS/2	0.036	0.210	0.800	0.700	Climaseal
12-14 x 2"	0.216	HWH	0.415	TEKS/3	0.036	0.210	1.450	0.550	Climaseal
12-14 x 2 1/2"	0.216	HWH	0.415	TEKS/3	0.036	0.210	1.950	0.550	Climaseal
12-14 x 3"	0.216	HWH	0.415	TEKS/3	0.036	0.210	2.450	0.550	Climaseal
12-14 x 4"	0.216	HWH	0.415	TEKS/3	0.036	0.210	3.450	0.550	Climaseal
1/4-14 x 3/4"	0.250	HWH	0.500	TEKS/3	0.036	0.210	0.150	0.600	Climaseal
1/4-14 x 1"	0.250	HWH	0.500	TEKS/3	0.036	0.210	0.400	0.600	Climaseal
1/4-14 x 1 1/4"	0.250	HWH	0.500	TEKS/3	0.036	0.210	0.650	0.600	Climaseal
1/4-14 x 1 1/2"	0.250	HWH	0.500	TEKS/3	0.036	0.210	0.900	0.600	Climaseal
1/4-14 x 2"	0.250	HWH	0.500	TEKS/3	0.036	0.210	1.400	0.600	Climaseal
1/4-14 x 2 1/2"	0.250	HWH	0.500	TEKS/3	0.036	0.210	1.900	0.600	Climaseal
1/4-14 x 3"	0.250	HWH	0.500	TEKS/3	0.036	0.210	2.400	0.600	Climaseal
1/4-14 x 4"	0.250	HWH	0.500	TEKS/3	0.036	0.210	3.400	0.600	Climaseal
1/4-14 x 3/4"	0.250	HWH[2]	0.610	TEKS/3	0.036	0.210	0.150	0.600	Climaseal
1/4-14 x 1"	0.250	HWH[2]	0.610	TEKS/3	0.036	0.210	0.400	0.600	Climaseal
12-24 x 7/8"	0.216	HWH	0.415	TEKS/4	0.125	0.250	0.325	0.550	Climaseal
12-24 x 1 1/4"	0.216	HWH	0.415	TEKS/4.5	0.125	0.375	0.575	0.675	Climaseal
12-24 x 1 1/4"	0.216	HWH	0.415	TEKS/5.0	0.125	0.500	0.450	0.800	Climaseal
12-24 x 1 1/4"	0.216	HWH	0.415	TEKS/5	0.125	0.500	0.375	0.875	Climaseal
12-24 x 1 1/2"	0.216	HWH	0.415	TEKS/5	0.125	0.500	0.625	0.875	Climaseal
12-24 x 2"	0.216	HWH	0.415	TEKS/5	0.125	0.500	1.125	0.875	Climaseal
1/4-28 x 3"	0.250	HWH	0.415	TEKS/5	0.125	0.500	2.150	0.850	Climaseal
1/4-28 x 4"	0.250	HWH	0.415	TEKS/5	0.125	0.500	3.150	0.850	Climaseal

For **SI:** 1 inch = 25.4 mm.

[1] Screw dimensions comply with ASME B18.6.4 (nom. size = nominal screw size, tip = threads per inch, length = inches).

[2] HWH with serrations.

[3] Drilling capacity refers to the minimum and maximum total allowable thicknesses of steel the fastener is designed to drill through.

[4] Length of load-bearing area is the total screw length minus the length from the screw point to the third full thread. See Figure 4.

TABLE 2—ALLOWABLE TENSILE PULL-OUT LOADS (P_{NOT}/Ω), pounds-force[1, 2, 3, 4, 5]

Steel F_u = 45 ksi, Applied Factor of Safety, Ω=3.0												
Screw Designation	**Nominal Diameter (in.)**	**Design Thickness of Member Not in Contact with the Screw Head (in)**										
		0.018	**0.024**	**0.030**	**0.036**	**0.048**	**0.060**	**0.075**	**0.105**	**0.125**	**0.187**	**0.250**
10-16	0.190	44	58	73	87	116	145	182	254	303	[6]	[6]
12-14, 12-24	0.216	50	66	83	99	132	165	207	289	344	515	689
$^1/_4$-14, $^1/_4$-28	0.250	57	77	96	115	153	191	239	335	398	596	797

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 ksi = 6.89 MPa.

[1]For tension connections, the least of the allowable pull-out, pullover, and fastener tension strength found in Tables 2, 3, and 5, respectively, must be used for design.
[2]ANSI/ASME standard screw diameters were used in the calculations and are listed in the tables.
[3]The allowable pull-out capacity for other member thickness can be determined by interpolating within the table.
[4]To calculate LRFD values, multiply values in table by the ASD safety factor of 3.0 and multiply again with the LRFD Φ factor of 0.5.
[5]For F_u = 58 ksi, multiply values by 1.29; for F_u = 65 ksi, multiply values by 1.44.
[6]Outside drilling capacity limits.

TABLE 3—ALLOWABLE TENSILE PULLOVER LOADS (P_{NOV}/Ω), pounds-force[1, 2, 3, 4, 5]

Steel Fu = 45 ksi, Applied Factor of Safety, Ω=3.0													
Screw Designation	**Nominal Diameter (in.)**	**Head or Integral Washer Diameter (in.)**	**Design Thickness of Member in Contact with the Screw Head (in)**										
			0.018	**0.024**	**0.030**	**0.036**	**0.048**	**0.060**	**0.075**	**0.105**	**0.125**	**0.187**	**0.250**
Hex Washer Head (HWH)													
10-16	0.190	0.400	162	216	270	324	432	540	675	945	1125	[6]	[6]
12-14, 12-24	0.216	0.415	168	224	280	336	448	560	700	980	1167	1746	2334
$^1/_4$-14	0.250	0.500	203	270	338	405	540	675	844	1181	1406	2104	2813
$^1/_4$-14, $^1/_4$-28	0.250	0.415	168	224	280	336	448	560	700	980	1167	1746	2334
HWH with Serrations													
10-16	0.190	0.435	176	235	294	352	470	587	734	1028	1223	[6]	[6]
$^1/_4$-14	0.250	0.610	203	270	338	405	540	675	844	1181	1406	2104	[6]
Phillips Pan Head													
10-16	0.190	0.365	148	197	246	296	394	493	616	862	1027	[6]	[6]

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 ksi = 6.89 MPa.

[1]For tension connections, the lower of the allowable pull-out, pullover, and fastener tension strength found in Tables 2, 3, and 5, respectively must be used for design.
[2]ANSI/ASME standard screw diameters were used in the calculations and are listed in the tables.
[3]The allowable pull-over capacity for other member thickness can be determined by interpolating within the table.
[4]To calculate LRFD values, multiply values in table by the ASD safety factor of 3.0 and multiply again with the LRFD Φ factor of 0.5.
[5]For Fu = 58 ksi, multiply values by 1.29; for Fu = 65 ksi, multiply values by 1.44.
[6]Outside drilling capacity limits.

TABLE 4—ALLOWABLE SHEAR (BEARING) CAPACITY (P_{NS}/Ω), pounds-force[1, 2, 3, 4, 5]

Steel Fu = 45 ksi, Applied Factor of Safety, Ω=3.0												
Screw Designation	Nominal Diameter (in.)	Design Thickness of Member Not in Contact with the Screw Head (in)	Design Thickness of Member in Contact with the Screw Head (in)									
			0.018	0.024	0.030	0.036	0.048	0.060	0.075	0.105	0.125	0.187	0.250
10-16	0.190	0.018	66	66	66	66	66	66	66	66	66	---	---
		0.024	102	102	102	102	102	102	102	102	102	---	---
		0.030	111	143	143	143	143	143	143	143	143	---	---
		0.036	120	152	185	188	188	188	188	188	188	---	---
		0.048	139	168	199	228	289	289	289	289	289	---	---
		0.060	139	185	213	239	327	404	404	404	404	---	---
		0.075	139	185	231	251	337	427	564	564	564	---	---
		0.105	139	185	231	277	356	436	570	808	808	---	---
		0.125	139	185	231	277	369	442	571	808	962	---	---
12-14 12-24	0.216	0.018	71	71	71	71	71	71	71	71	71	71	71
		0.024	109	109	109	109	109	109	109	109	109	109	109
		0.030	125	152	152	152	152	152	152	152	152	152	152
		0.036	136	170	205	200	200	200	200	200	200	200	200
		0.048	157	190	223	253	308	308	308	308	308	308	308
		0.060	157	210	240	266	362	430	430	430	430	430	430
		0.075	157	210	262	282	375	468	601	601	601	601	601
		0.105	157	210	262	315	402	483	624	919	919	919	919
		0.125	157	210	262	315	420	494	629	919	1094	1094	1094
		0.187	157	210	262	315	420	525	642	919	1094	1636	1636
		0.250	157	210	262	315	420	525	656	919	1094	1636	2187
1/4-14 1/4-28	0.250	0.018	76	76	76	76	76	76	76	76	76	76	76
		0.024	117	117	117	117	117	117	117	117	117	117	117
		0.030	142	164	164	164	164	164	164	164	164	164	164
		0.036	156	193	215	215	215	215	215	215	215	215	215
		0.048	182	218	253	283	331	331	331	331	331	331	331
		0.060	182	243	276	300	406	463	463	463	463	463	463
		0.075	182	243	304	322	424	521	647	647	647	647	647
		0.105	182	243	304	365	461	544	694	1063	1063	1063	1063
		0.125	182	243	304	365	486	560	703	1063	1266	1266	1266
		0.187	182	243	304	365	486	608	731	1063	1266	1893	1893
		0.250	182	243	304	365	486	608	759	1063	1266	1893	2531

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 ksi = 6.89 MPa.

[1]The lower of the allowable shear (bearing) and the allowable fastener shear strength found in Tables 4 and 5, respectively, must be used for design.
[2]ANSI/ASME standard screw diameters were used in the calculations and are listed in the tables.
[3]The allowable bearing capacity for other member thickness can be determined by interpolating within the table.
[4]To calculate LRFD values, multiply values in table by the ASD safety factor of 3.0 and multiply again with the LRFD Φ factor of 0.5.
[5]For F_u = 58 ksi, multiply values by 1.29; for F_u = 65 ksi, multiply values by 1.44.

TABLE 5—FASTENER STRENGTH OF SCREWS[1, 2, 3, 4, 5]

SCREW DESIGNATION	DIAMETER (in.)	ALLOWABLE FASTENER STRENGTH		NOMINAL FASTENER STRENGTH	
		Tensile, P_{ts}/Ω (lbf)	Shear, P_{ss}/Ω (lbf)	Tensile, P_{ts} (lbf)	Shear, P_{ss} (lbf)
10-16	0.190	885	573	2654	1718
12-14	0.216	1184	724	3551	2171
12-24	0.216	1583	885	4750	2654
1/4-14	0.250	1605	990	4816	2970
1/4-28	0.250	1922	1308	5767	3925

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.45 N.

[1]For tension connections, the least of the allowable pull-out, pullover, and fastener tension strength found in Tables 2, 3, and 5, respectively, must be used for design.
[2]For shear connection, the lower of the allowable shear (bearing) and the allowable fastener shear strength found in Table 4 and 5, respectively, must be used for design.
[3]See Section 4.1 for fastener spacing and end distance requirements.
[4]Nominal strengths are based on laboratory tests
[5]To calculate LRFD values, multiply nominal strength values by the LRFD Φ factor of 0.5.

DIVISION: 05 00 00—METALS
Section: 05 05 23—Metal Fastenings

REPORT HOLDER:

ITW BUILDEX

EVALUATION SUBJECT:

ITW BUILDEX TEKS® SELF-DRILLING FASTENERS

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the ITW Buildex TEKS® Self-Drilling Fasteners, described in ICC-ES evaluation report ESR-1976, have also been evaluated for compliance with the codes noted below as adopted by the Los Angeles Department of Building and Safety (LADBS).

Applicable code editions:

- 2020 *City of Los Angeles Building Code* (LABC)
- 2020 *City of Los Angeles Residential Code* (LARC)

2.0 CONCLUSIONS

The ITW Buildex TEKS® Self-Drilling Fasteners, described in Sections 2.0 through 7.0 of evaluation report ESR-1976, comply with the LABC Chapter 22, and the LARC, and are subject to the conditions of use described in this supplement.

3.0 CONDITIONS OF USE

The ITW Buildex TEKS® Self-Drilling Fasteners described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the evaluation report ESR-1976.
- The design, installation, conditions of use and identification of the ITW Buildex TEKS® Self-drilling Fasteners are in accordance with the 2018 *International Building Code®* (IBC) provisions noted in the evaluation report ESR-1976.
- The design, installation and inspection are in accordance with additional requirements of LABC Chapters 16 and 17, as applicable.
- Under the LARC, an engineered design in accordance with LARC Section R301.1.3 must be submitted.

This supplement expires concurrently with the evaluation report, reissued July 2020 and revised April 2021.

DIVISION: 05 00 00—METALS
Section: 05 05 23—Metal Fastenings

REPORT HOLDER:

ITW BUILDEX

EVALUATION SUBJECT:

ITW BUILDEX TEKS® SELF-DRILLING FASTENERS

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the ITW Buildex TEKS® Self-Drilling Fasteners, addressed in ICC-ES evaluation report ESR-1976, have also been evaluated for compliance with the codes noted below.

Applicable code editions:

- 2020 *Florida Building Code—Building*
- 2020 *Florida Building Code—Residential*

2.0 CONCLUSIONS

The ITW Buildex TEKS® Self-Drilling Fasteners, described in Sections 2.0 through 7.0 of ICC-ES evaluation report ESR-1976, comply with the *Florida Building Code—Building* and *Florida Building Code—Residential.* The design requirements must be determined in accordance with the *Florida Building Code—Building* or the *Florida Building Code—Residential,* as applicable. The installation requirements noted in ICC-ES evaluation report ESR-1976 for the 2018 *International Building Code®* meet the requirements of the *Florida Building Code—Building* or *Florida Building Code—Residential,* as applicable.

Use of the ITW Buildex TEKS® Self-Drilling Fasteners in accordance with the High-Velocity Hurricane Zone provisions of the *Florida Building Code—Building* and the *Florida Building Code—Residential* has not been evaluated and is outside the scope of this supplement report.

For products falling under Florida Rule 61G20-3, verification that the report holder's quality assurance program is audited by a quality assurance entity approved by the Florida Building Commission for the type of inspections being conducted is the responsibility of an approved validation entity (or the code official when the report holder does not possess an approval by the Commission).

This supplement expires concurrently with the evaluation report, reissued July 2020 and revised April 2021.