valmont® UTILITY

Frame Structures - PyraMAX & SAPS

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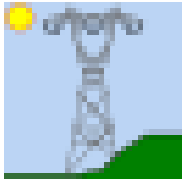
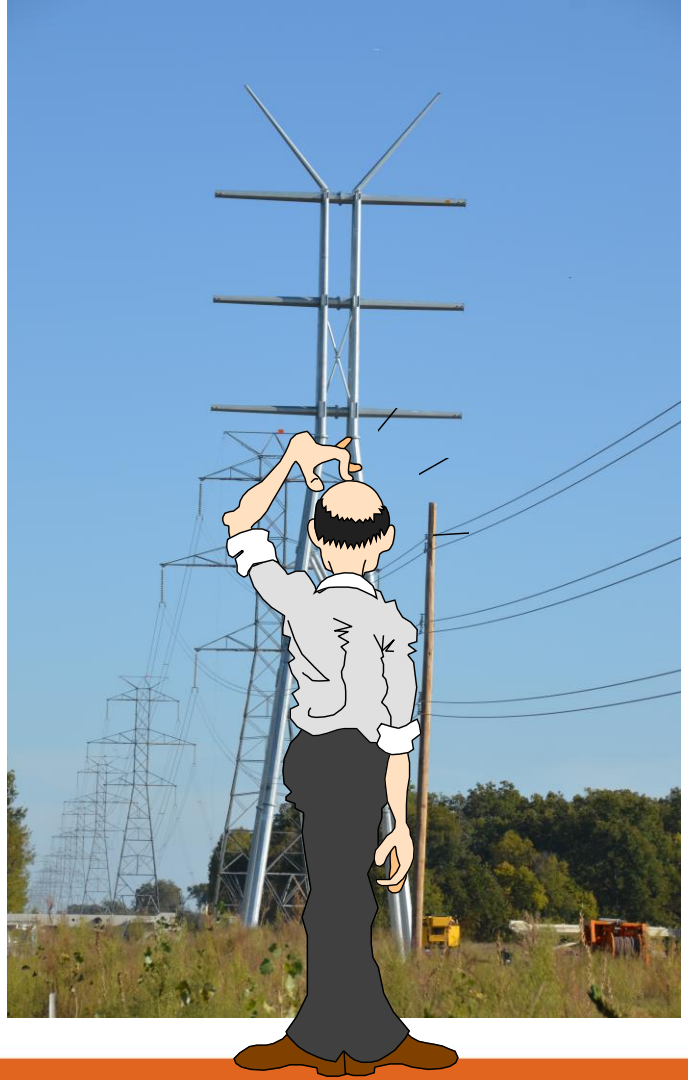
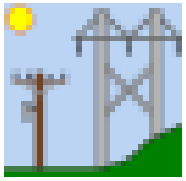
June 15, 2022

PYRAMAX



TOWER





PLS-POLE

PyraMAX Design Overview

- Design based on ASCE Standard 48
- Designed with Valmont IMPAX
- Valmont standard connection types
- Form of a tower; Components of a Pole
  - “Battering” the legs allows efficient conversion of transverse to axial load

EXCELL MARINE

PyraMax Crossing Structure

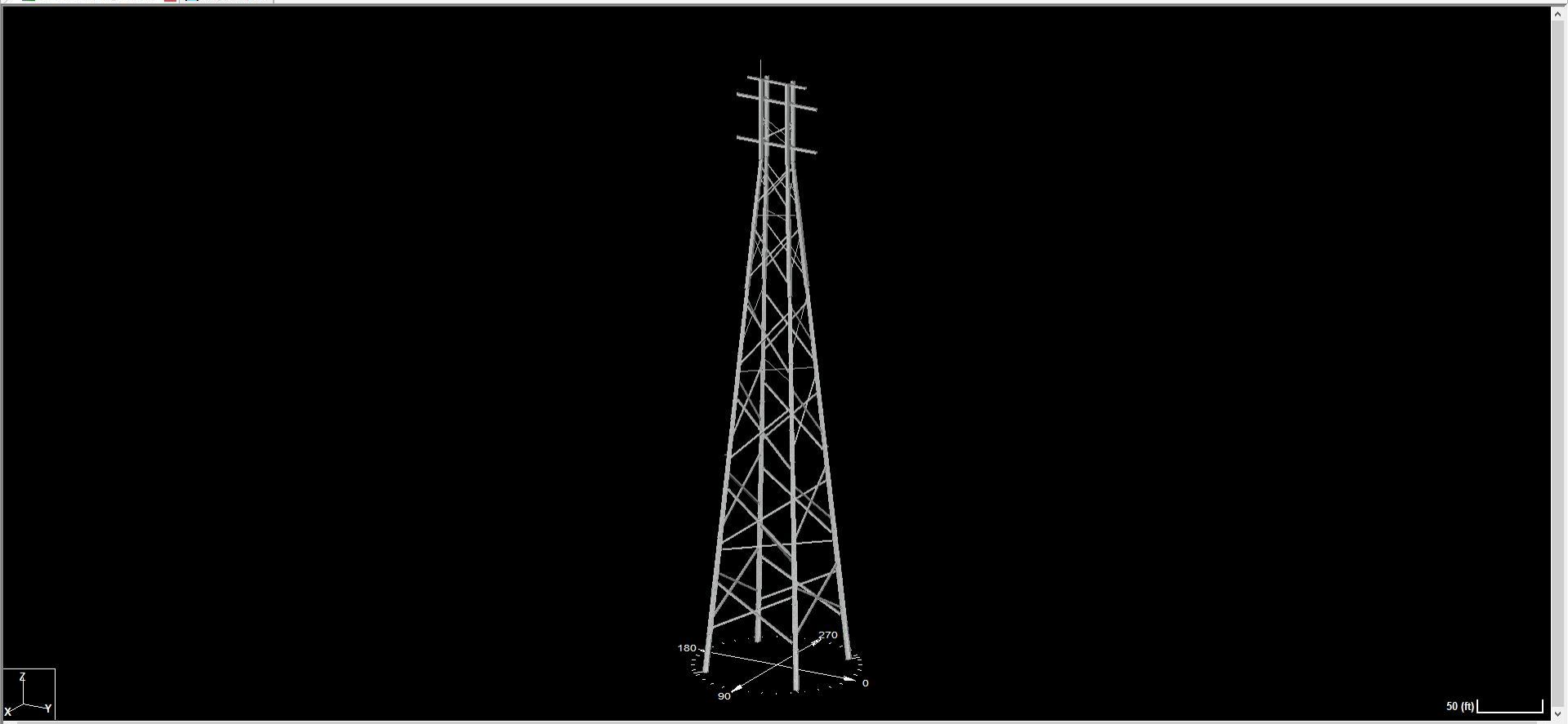
- 230 kV, Double Circuit
- 475 ft. (+15 ft. Lightning Mast)
- 410 ft. to Bend Line (Transition from battered legs to vertical)
- Base Spread – 80 ft. x 80 ft.
- “Legs” at the base – 55 inch diamater

PLS-POLE - [R1-175-MAX475_Mod.POL]

File Edit View General Components Geometry Loads Model Drafting Window Help

Search Menus, Help and TechNotes

R1-175-MAX475_Mod.POL | Project Report



Entity Info (Left click for Entity menu, Right click for view menu): Joint Info (Left Click): Joint 'LdPt9', Load case 'Undeformed Geometry', X=14.043 Y=-19.568 Z=323.891

US NUM

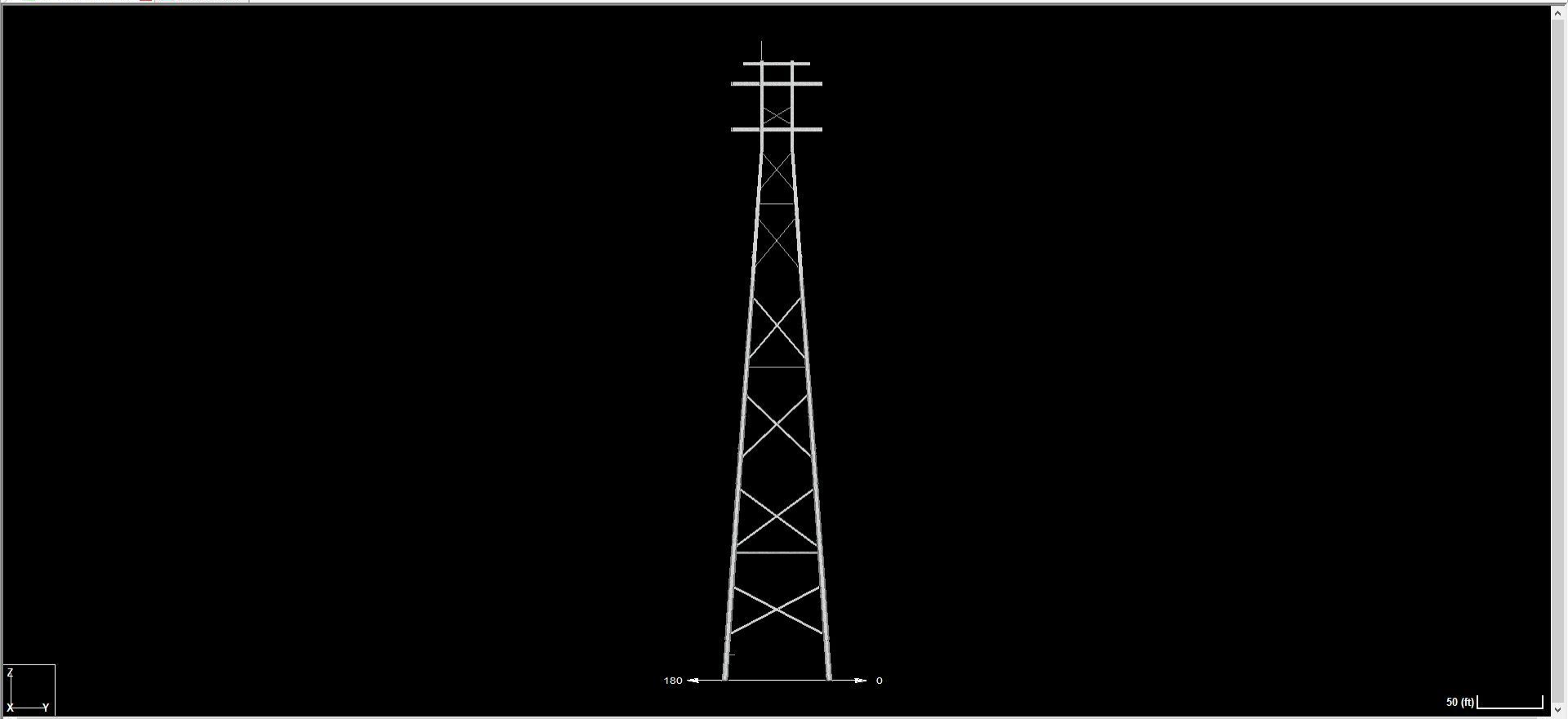
PLS-POLE - [R1-175-MAX475.POL]

File Edit View General Components Geometry Loads Model Drafting Window Help

Init Close All

Search Menus, Help and TechNotes

R1-175-MAX475.POL | Project Report



Entity Info (Left click for Entity menu, Right click for view menu): Joint Info (Left Click): Joint 'Tdv2:PT1', Load case 'Undeformed Geometry', X=0.000 Y=35.000 Z=457.500

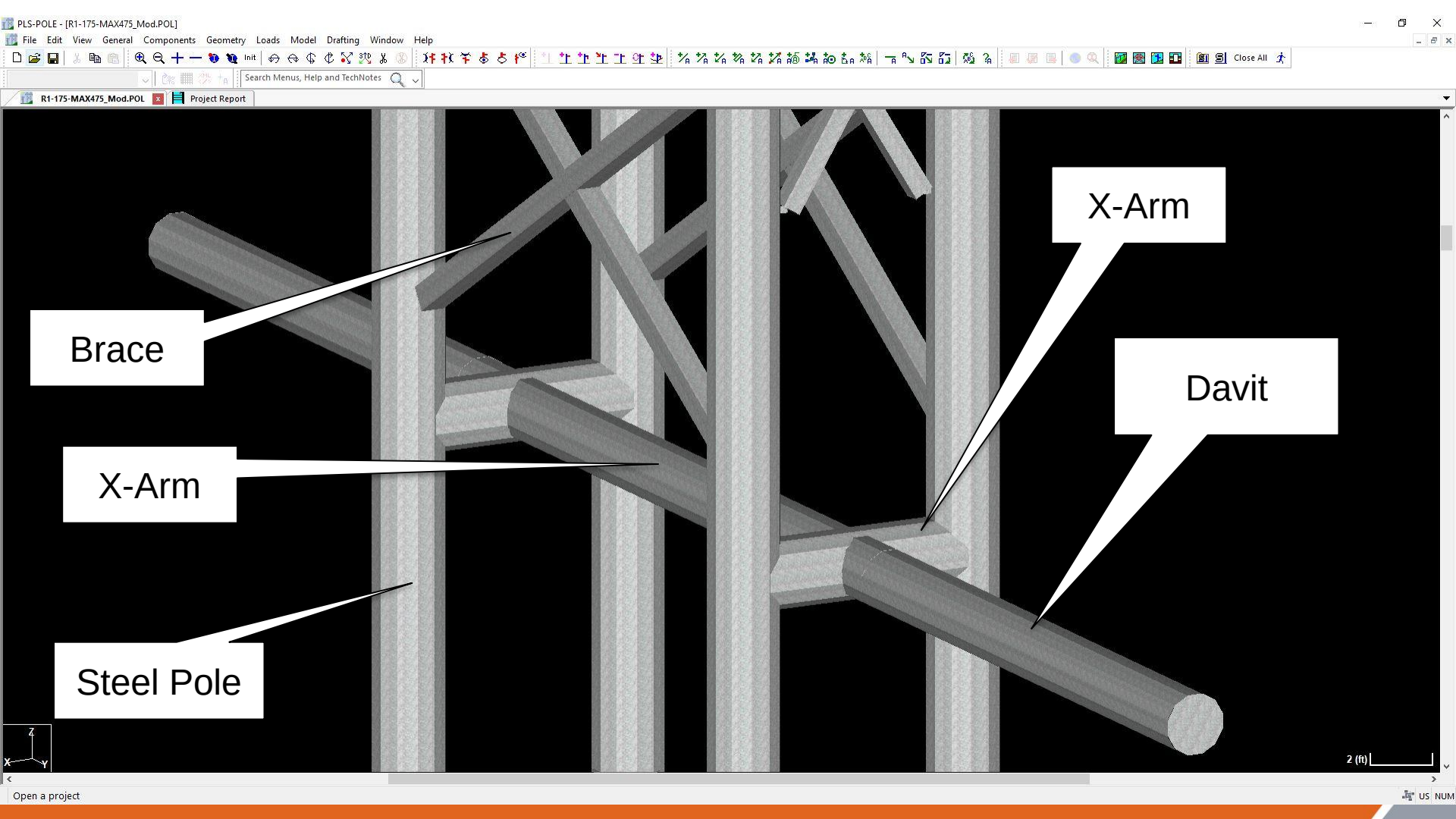
US NUM

Modeling

- Uses Steel Poles, Braces, Tubular X-Arm, Davit Arms, and Vangs
- 49 Primary Joints
  - Reduced to 13 with Symmetry
- Steel Pole Connectivity Defined by Tip and Base Joints
  - 44 Steel Poles

Modeling (cont.)

- 124 Vangs
- 62 Brace Members
- 9 Tubular X-Arms
- 4 Davit Arms

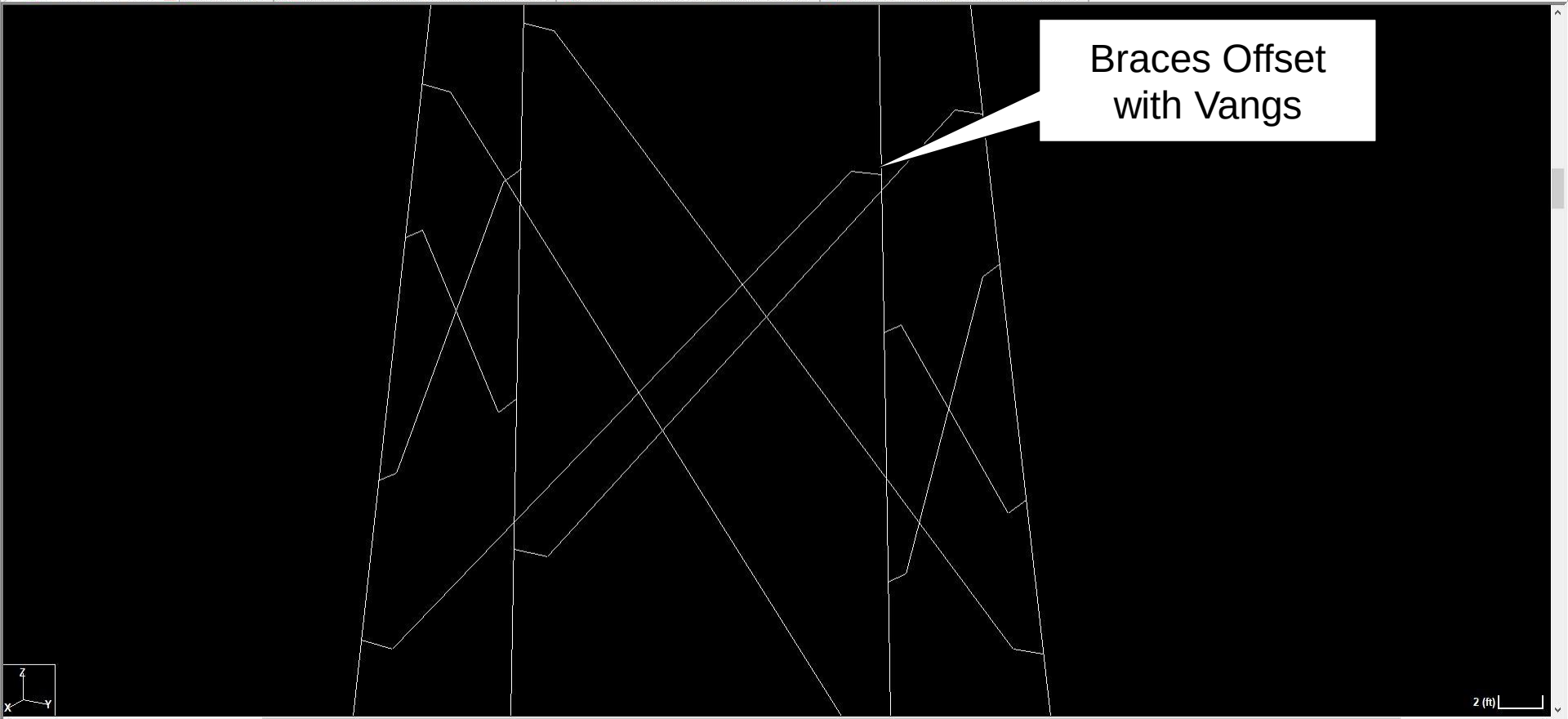

PLS-POLE - [R1-175-MAX475_Mod.POL]
File Edit View General Components Geometry Loads Model Drafting Window Help
Search Menus, Help and TechNotes
R1-175-MAX475_Mod.POL
Project Report
X-Arm
Brace
Davit
X-Arm
Steel Pole
Z
X
Y
2 (ft)
Open a project
US NUM

PLS-POLE - [R1-175-MAX475_Mod.POL]

File Edit View General Components Geometry Loads Model Drafting Window Help

Search Menus, Help and TechNotes

R1-175-MAX475_Mod.POL | Project Report | Run #1 Deformed Geometry for R1-175-MAX475_Mod.POL | Run #1 Analysis Results for R1-175-MAX475_Mod.POL | Run #1 Summary Results for R1-175-MAX475_Mod.POL



Entity Info (Left click for Entity menu, Right click for view menu): Member Info (Left Click): Member 'LF legH'

US NUM

Analysis Results Comparison – PLS-POLE to IMPAX

- Foundation Reactions
  - Controlling Case at each leg = < 6.2% diff.
  - One Case, all legs = < 5.6% diff.
- Member Forces – One Leg, One Load Case
  - Average Percent Diff, Axial Force = <10%
  - Moments and Shears more variable
- Differences due to:
  - Different point location along member
    - Closest points used in comparison
  - Connections included in IMPAX

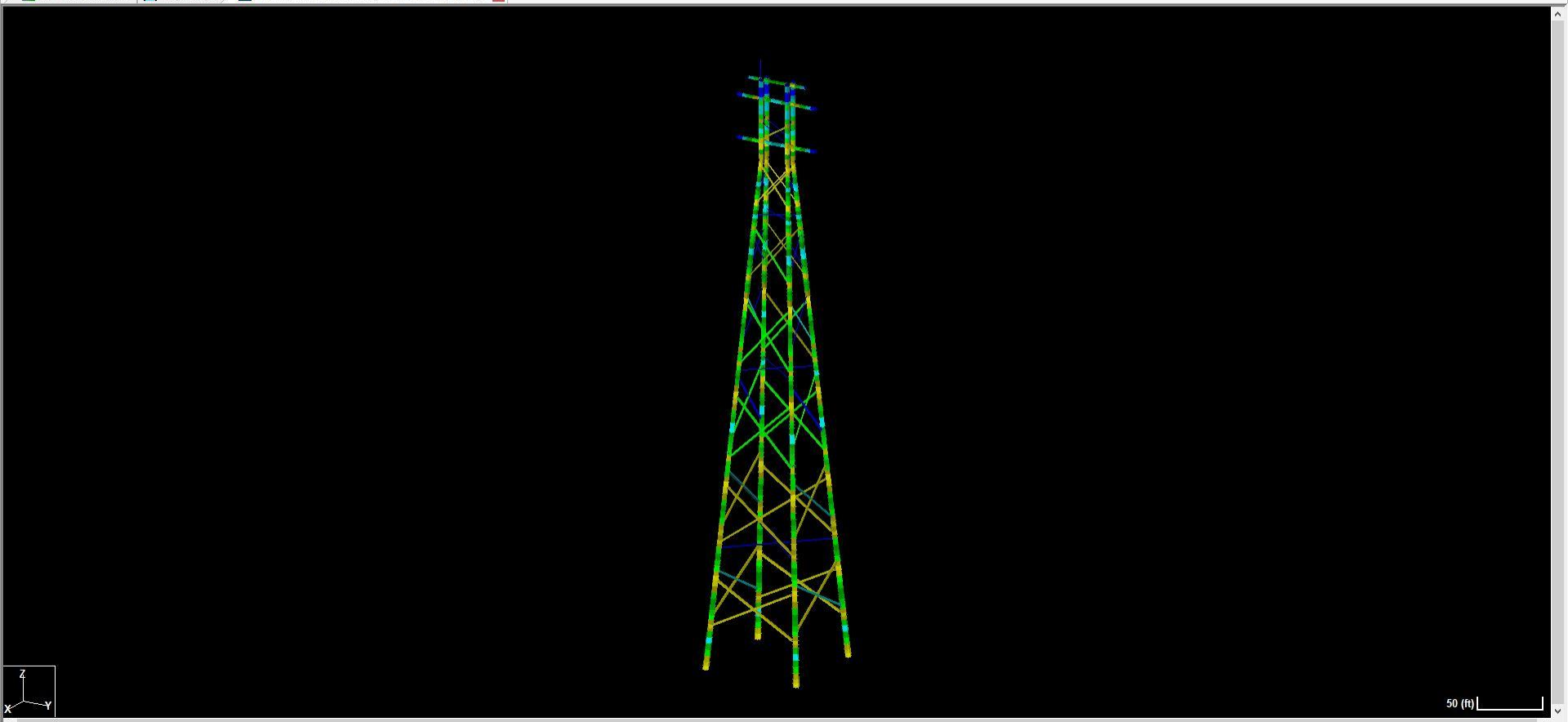
PLS-POLE - [Run #1 Deformed Geometry for R1-175-MAX475.POL]

File Edit View General Components Geometry Loads Model Drafting Window Help

Init Close All

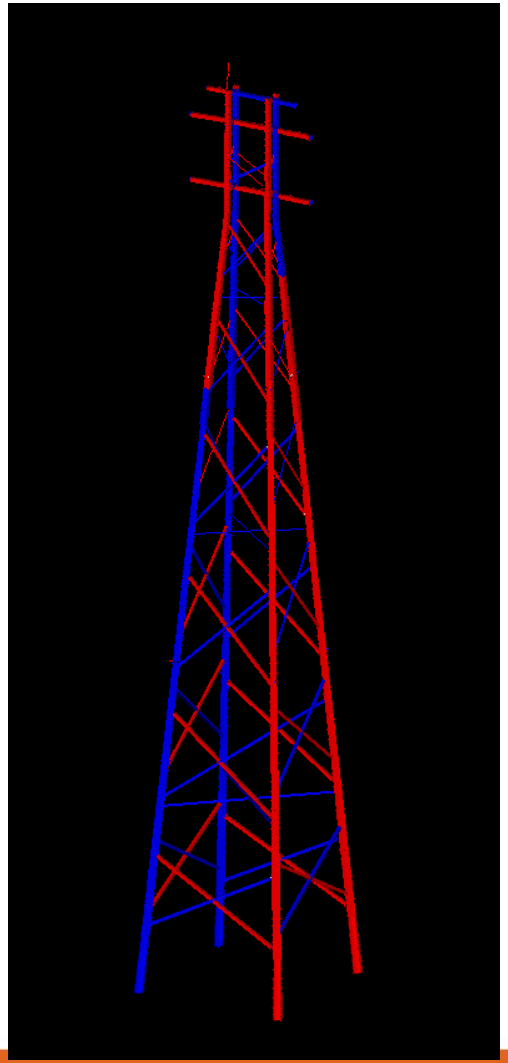
Search Menus, Help and TechNotes

R1-175-MAX475.POL | Project Report | Run #1 Deformed Geometry for R1-175-MAX475.POL



Entity Info (Left click for Entity menu, Right click for view menu):

US NUM

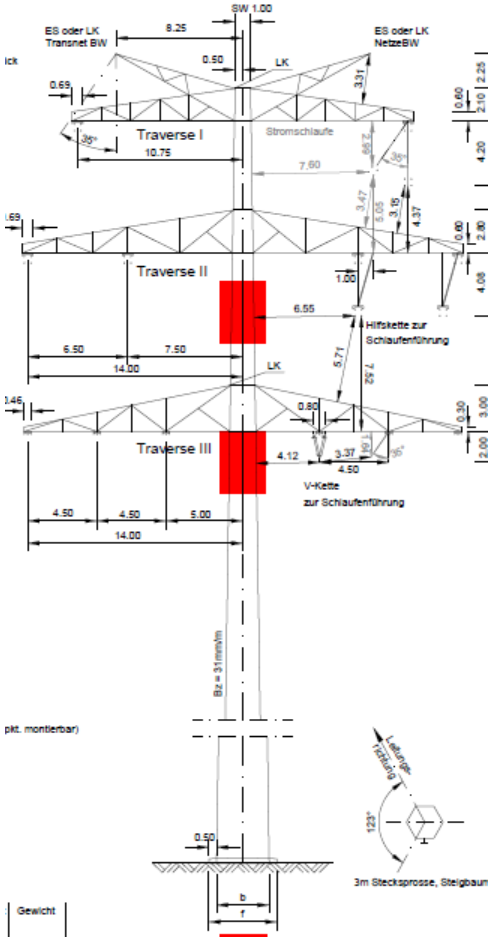


What Could Be Better?

- Symmetry, Symmetry, Symmetry
  - 44 “Poles” → 11
  - 124 Vangs → 31
  - 62 Brace Members → 17
  - 9 Tubular X-Arms → 6
  - 4 Davit Arms → 2
- Secondary Joints

OCEAN PRINCE

What if you wanted to do something like this?


SW 1.00
ES oder LK
Transnet BW
8.25
0.50
LK
ES oder LK
NetzeBW
0.69
Traverse I
35°
10.75
Stromschlaufe
7.60
3.31
2.25
0.60
2.10
4.20
3.47
3.05
3.95
4.37
0.60
2.00
4.08
Traverse II
1.00
6.55
Hilfskette zur
Schlaufenführung
6.50
7.50
14.00
LK
5.71
7.52
0.80
0.30
3.00
2.00
Traverse III
4.12
3.37
4.50
V-Kette
zur Schlaufenführung
4.50
4.50
5.00
14.00
Bz = 31mm/m
pkt. montierbar)
Laufrichtung
125°
0.50
b
f
Gewicht
3m Stecksprosse, Steigbaum

How to model?

- Could model separately: Arms in TOWER, transfer reactions as forces to PLS-POLE
  - Does not accurately account for pole flexibility
- Model Entire Structure:
  - TOWER?
    - No
  - PLS-POLE?
    - Not enough Brace (truss) elements
      - » 200; No symmetry
    - No connection checks
    - Code requirements?
- Or

SAPS

Structural **A**nalysis of **P**ower and communication **S**ystems.

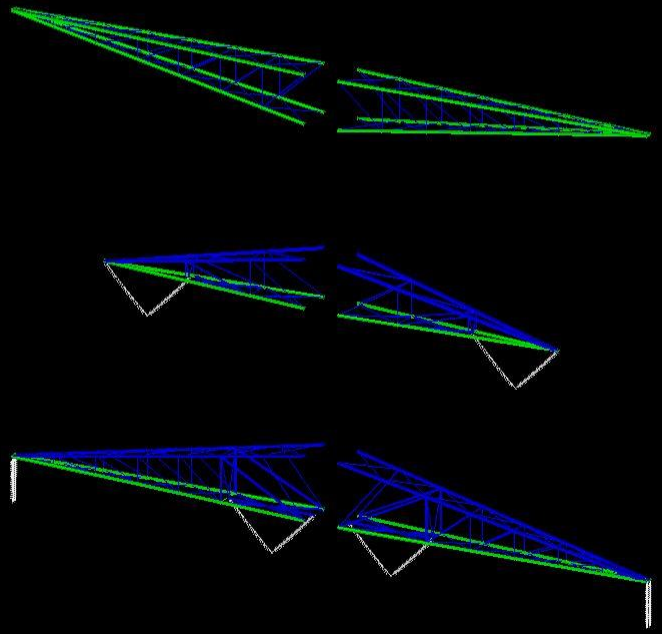
TOWER - [ex4.tow]

File Edit View General Components Geometry Loads Model Drafting Window Help

Search Menus, Help and TechNotes

ex4.tow | Project Report

Accurate TOWER model of arms; including loads

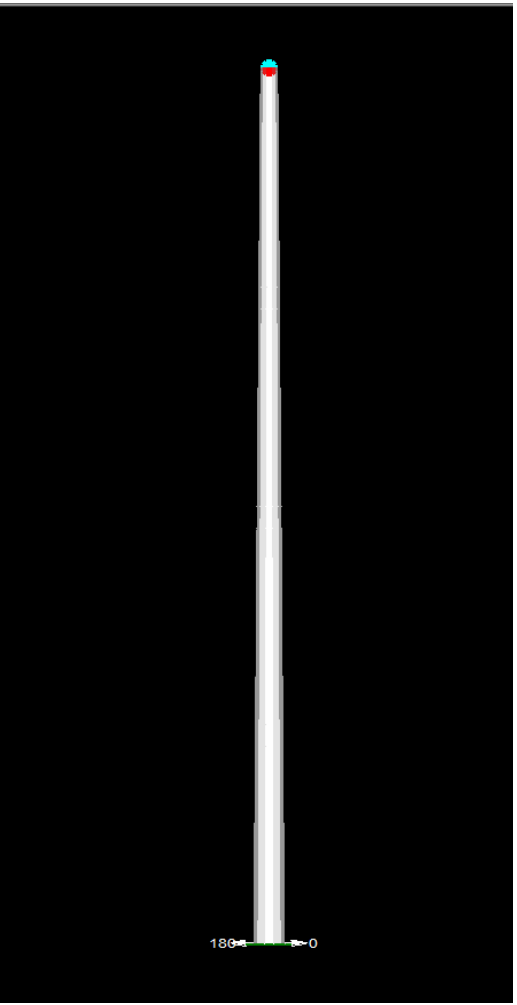


Z
X Y

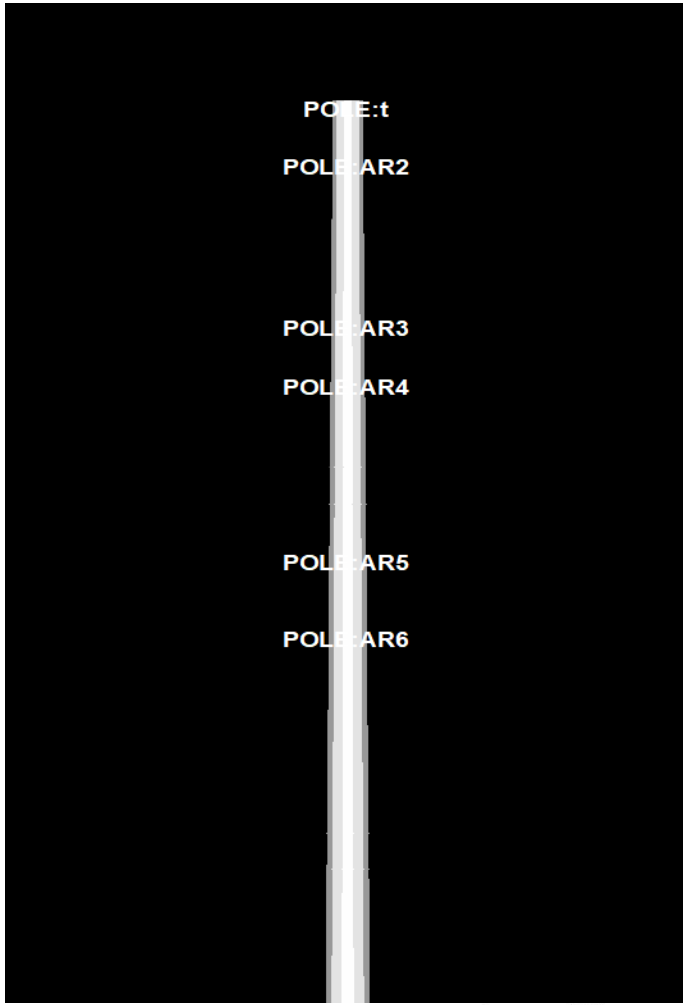
10 (ft)

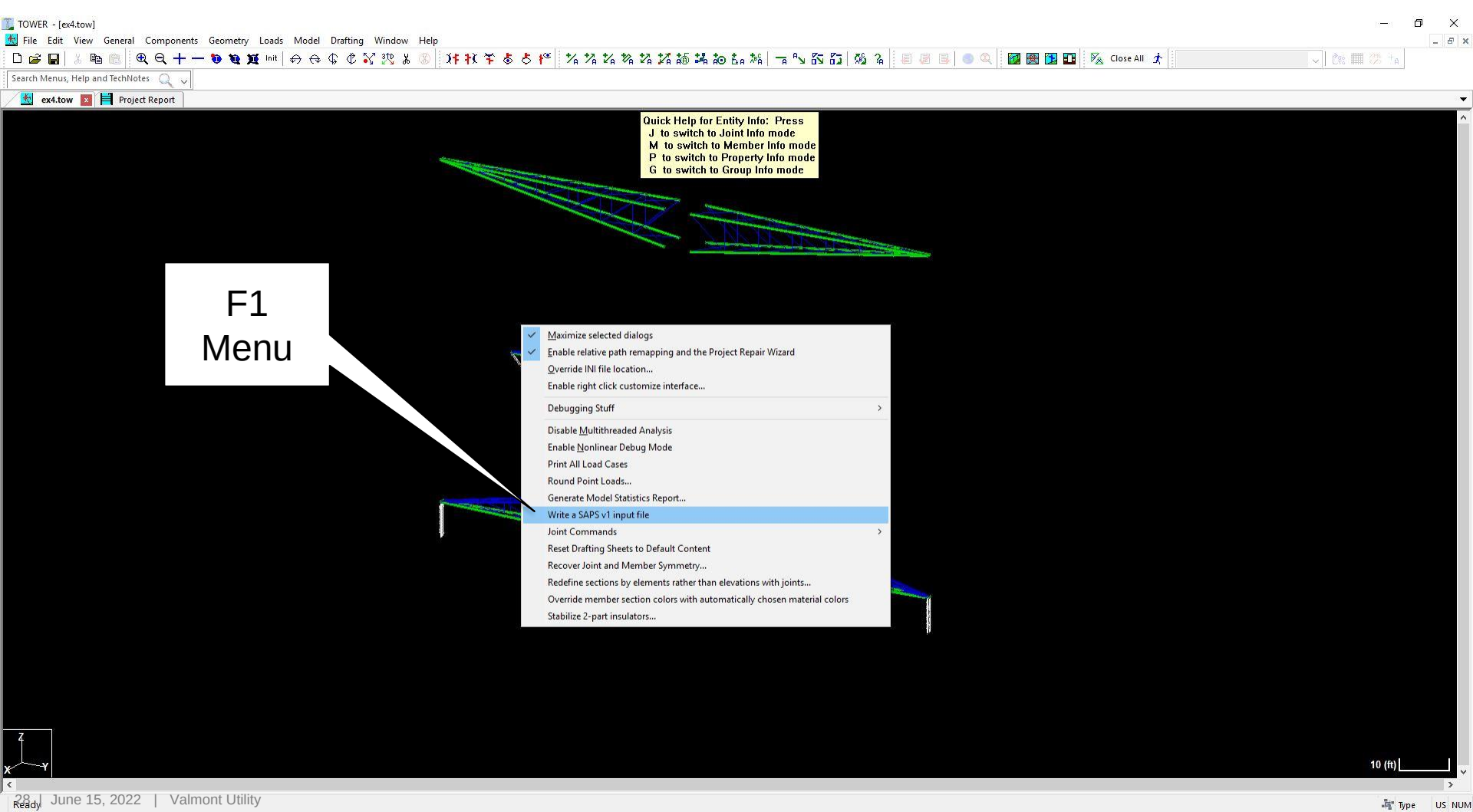
Ready

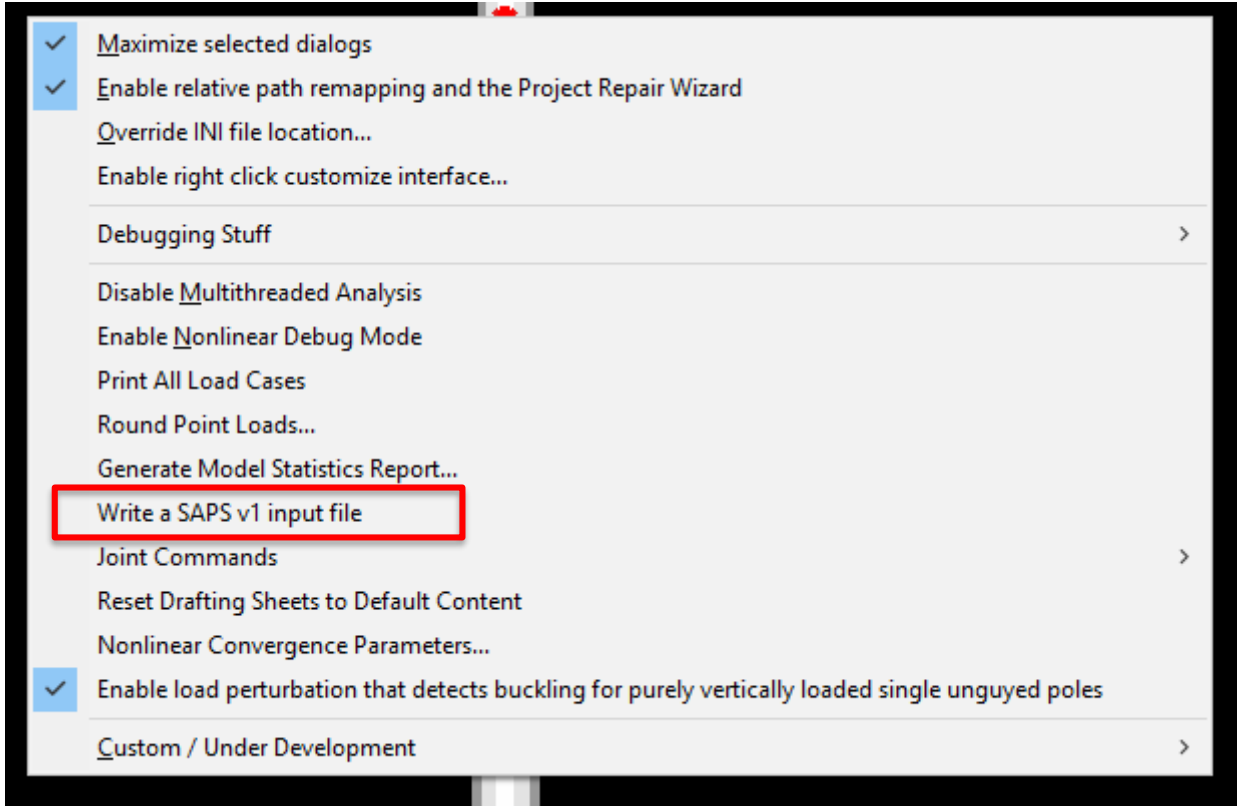
Type US NUM

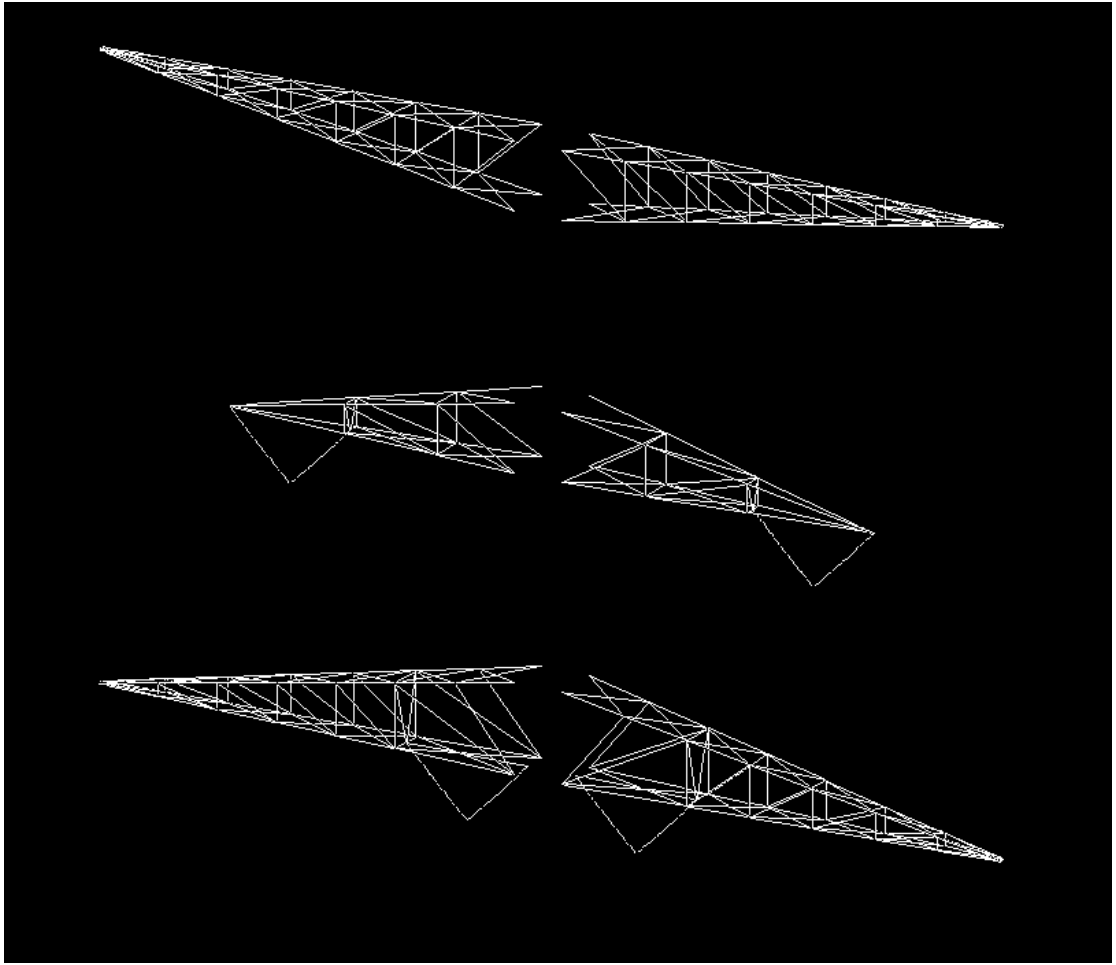


Accurate PLS-POLE model; including attachment locations




TOWER - [ex4.tow]
File Edit View General Components Geometry Loads Model Drafting Window Help
Search Menus, Help and TechNotes
ex4.tow
Project Report
Quick Help for Entity Info: Press
J to switch to Joint Info mode
M to switch to Member Info mode
P to switch to Property Info mode
G to switch to Group Info mode
F1 Menu
Maximize selected dialogs
Enable relative path remapping and the Project Repair Wizard
Override INI file location...
Enable right click customize interface...
Debugging Stuff
Disable Multithreaded Analysis
Enable Nonlinear Debug Mode
Print All Load Cases
Round Point Loads...
Generate Model Statistics Report...
Write a SAPS v1 input file
Joint Commands
Reset Drafting Sheets to Default Content
Recover Joint and Member Symmetry...
Redefine sections by elements rather than elevations with joints...
Override member section colors with automatically chosen material colors
Stabilize 2-part insulators...
Z
X
Y
10 (ft)
Ready
Type
US NUM


Maximize selected dialogs
Enable relative path remapping and the Project Repair Wizard
Override INI file location...
Enable right click customize interface...
Debugging Stuff
Disable Multithreaded Analysis
Enable Nonlinear Debug Mode
Print All Load Cases
Round Point Loads...
Generate Model Statistics Report...
Write a SAPS v1 input file
Joint Commands
Reset Drafting Sheets to Default Content
Nonlinear Convergence Parameters...
Enable load perturbation that detects buckling for purely vertically loaded single unguyed poles
Custom / Under Development



Merging Files

- Output SAPS v1 file for both models
- Open each file with SAPS
  - Save library files and SAPS (.sap) file
- Copy and paste to combine models
  - Copy model with fewer elements (usually pole elements)
  - Merge Libraries
  - Joints
  - Members
  - Loads*
- Joint Ties and Constraints

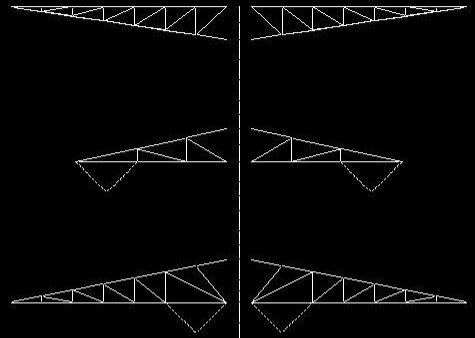
SAPS - [SAP Example.sap]

File Edit View General Properties Geometry Analysis Window Help

Run Close All

Search Menus, Help and TechNotes

SAP Example.sap



Z
X Y

20 (ft)

Ready

US NUM

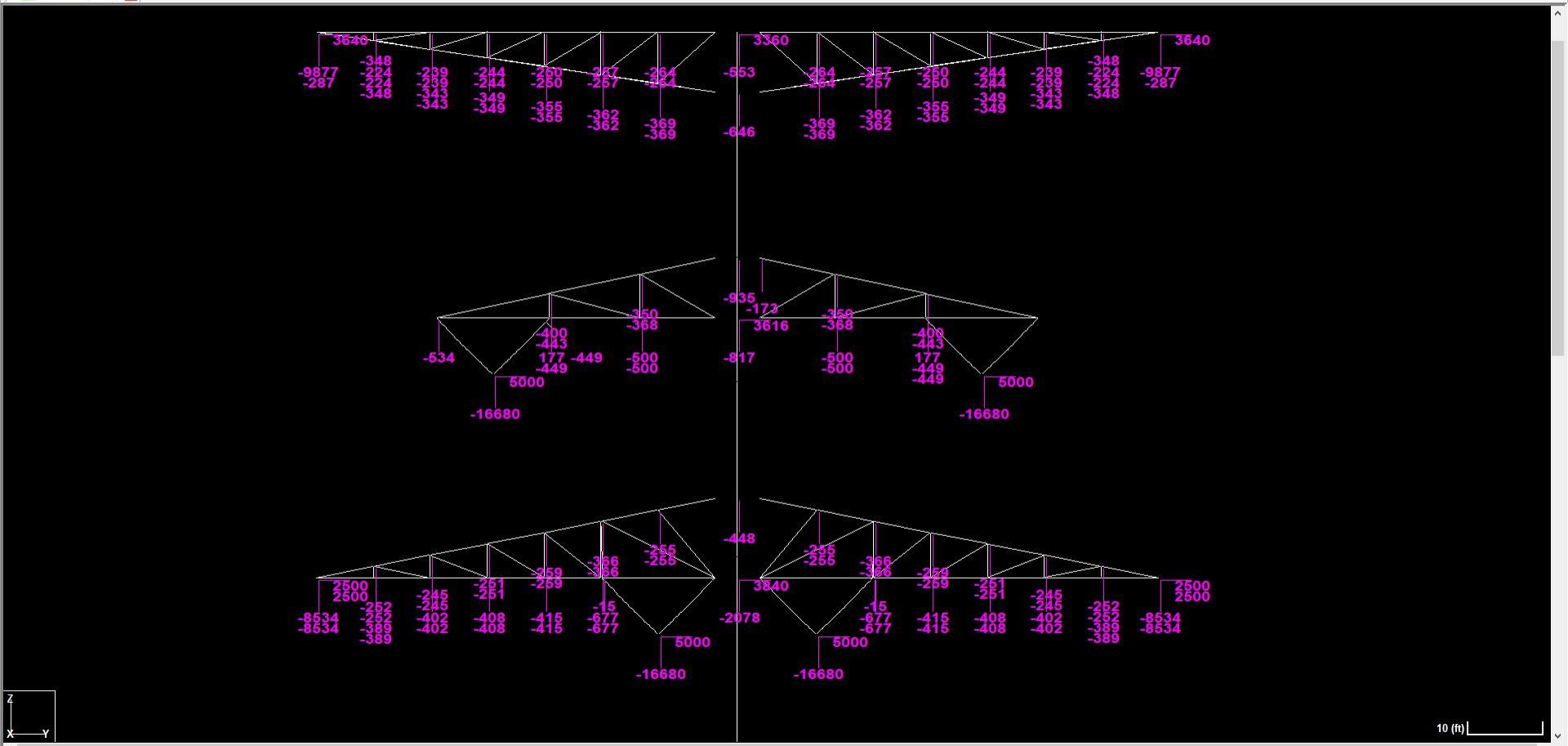
SAPS - [SAP Example.sap]

File Edit View General Properties Geometry Analysis Window Help

Run Close All

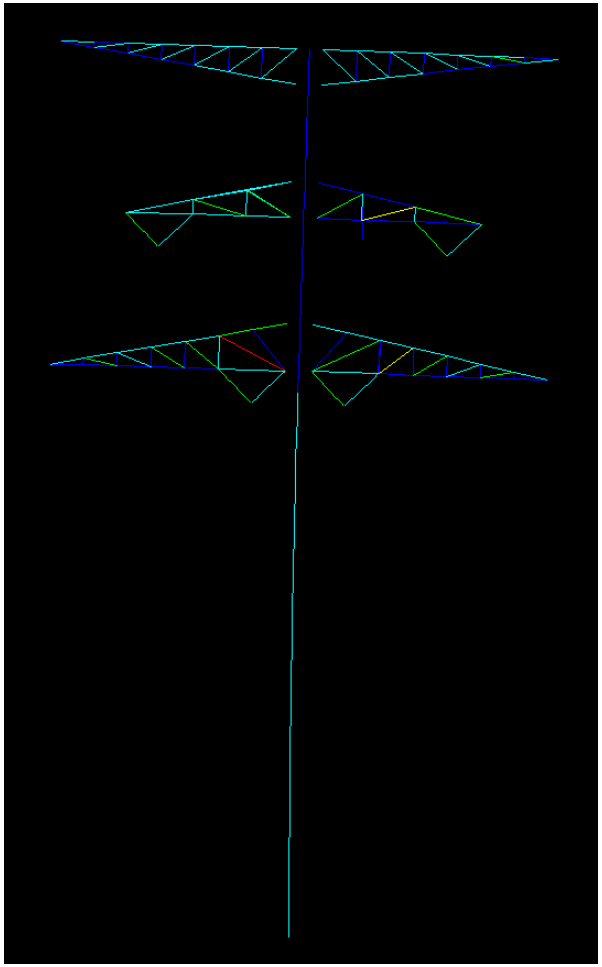
Search Menus, Help and TechNotes

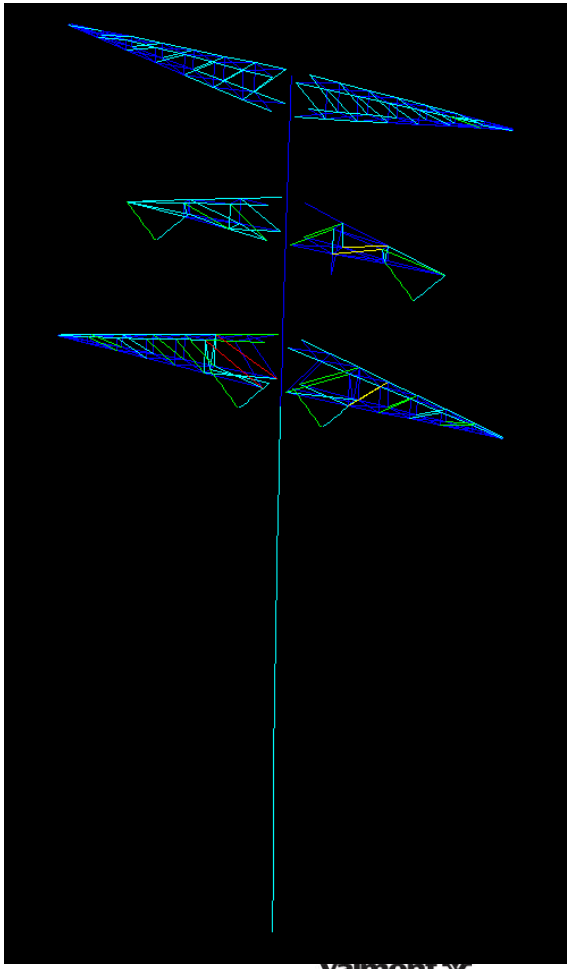
SAP Example.sap



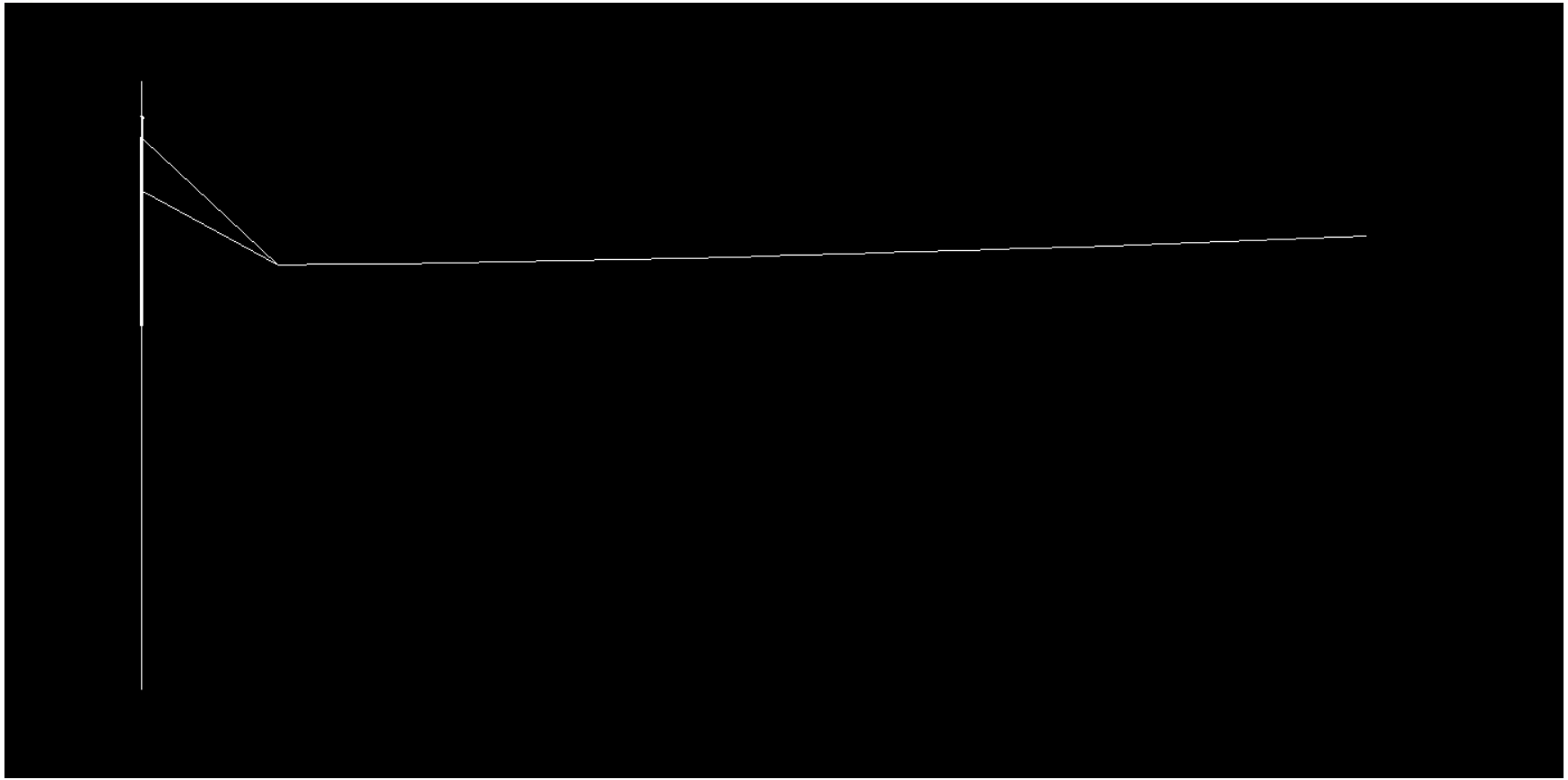
Entity Info (Left click for Entity menu, Middle click or <Enter> for view menu): Member Info (Left Click): Member '4', from joint '4-55' to joint '4-56'

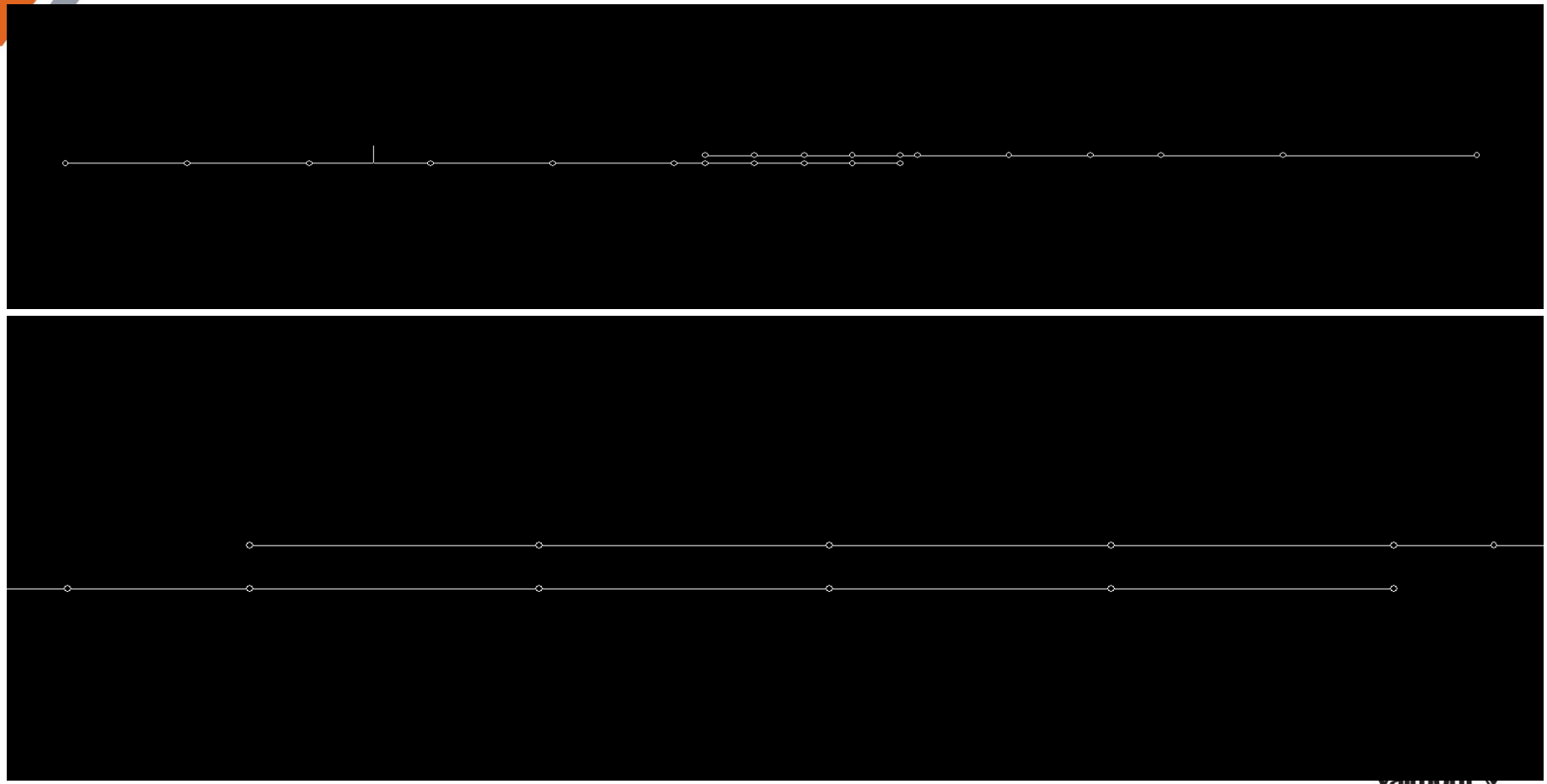
US NUM

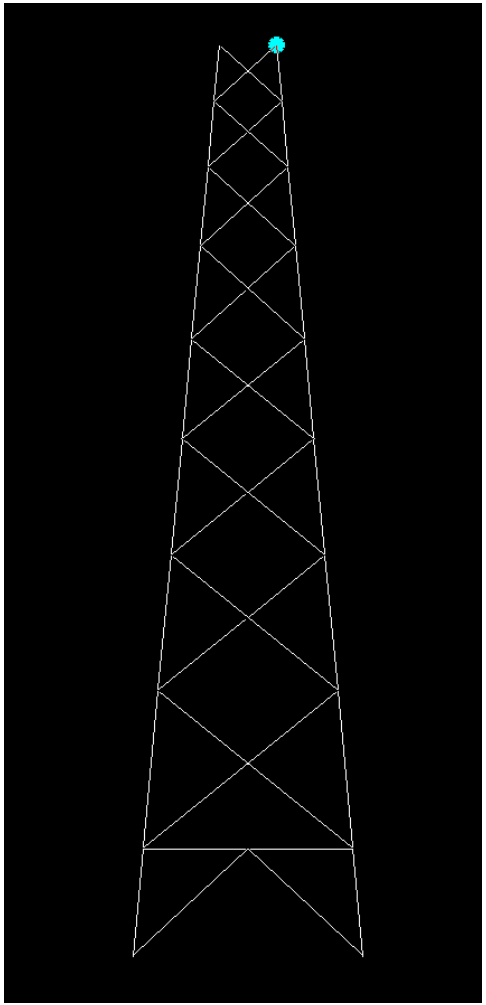


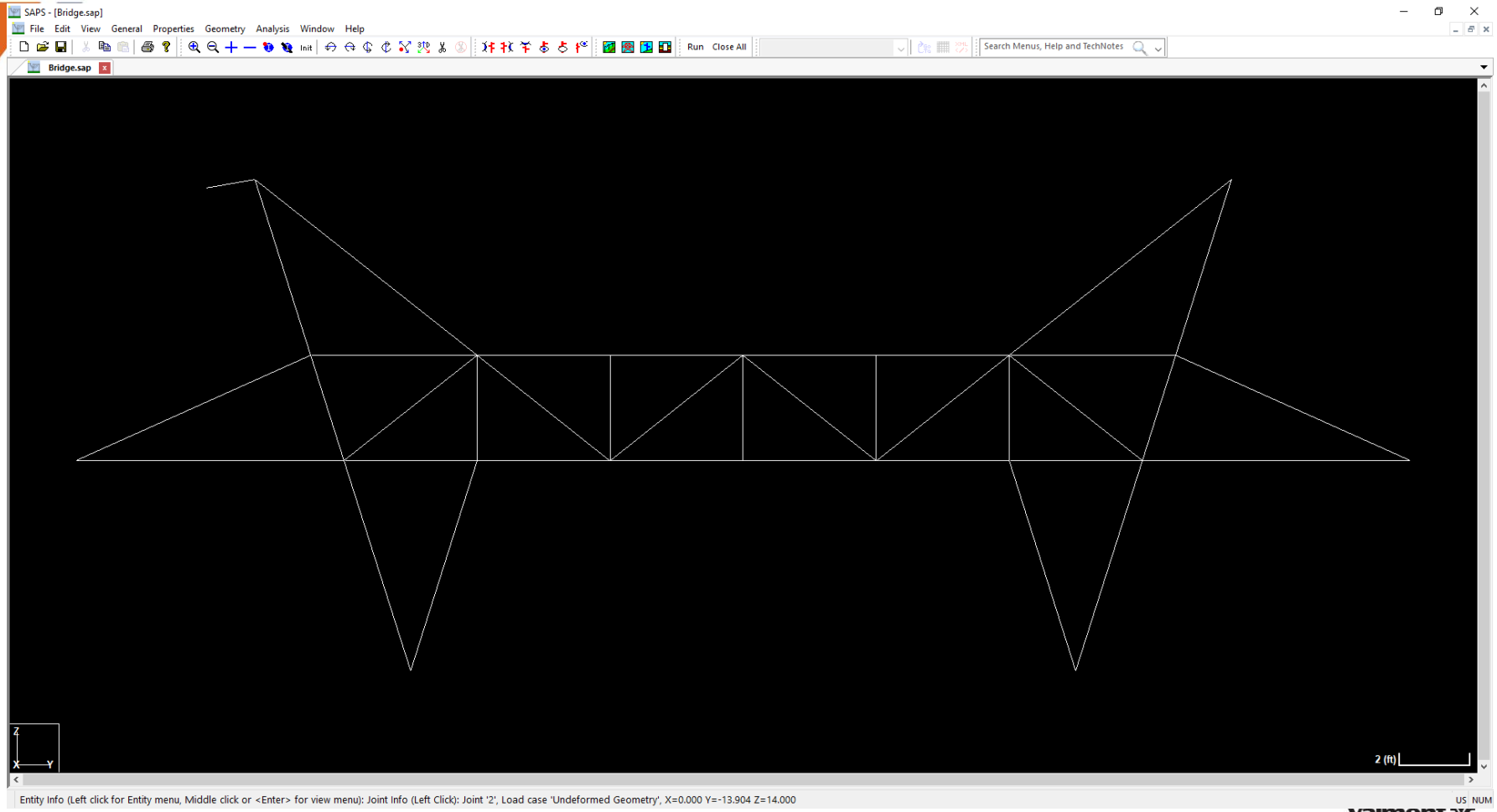


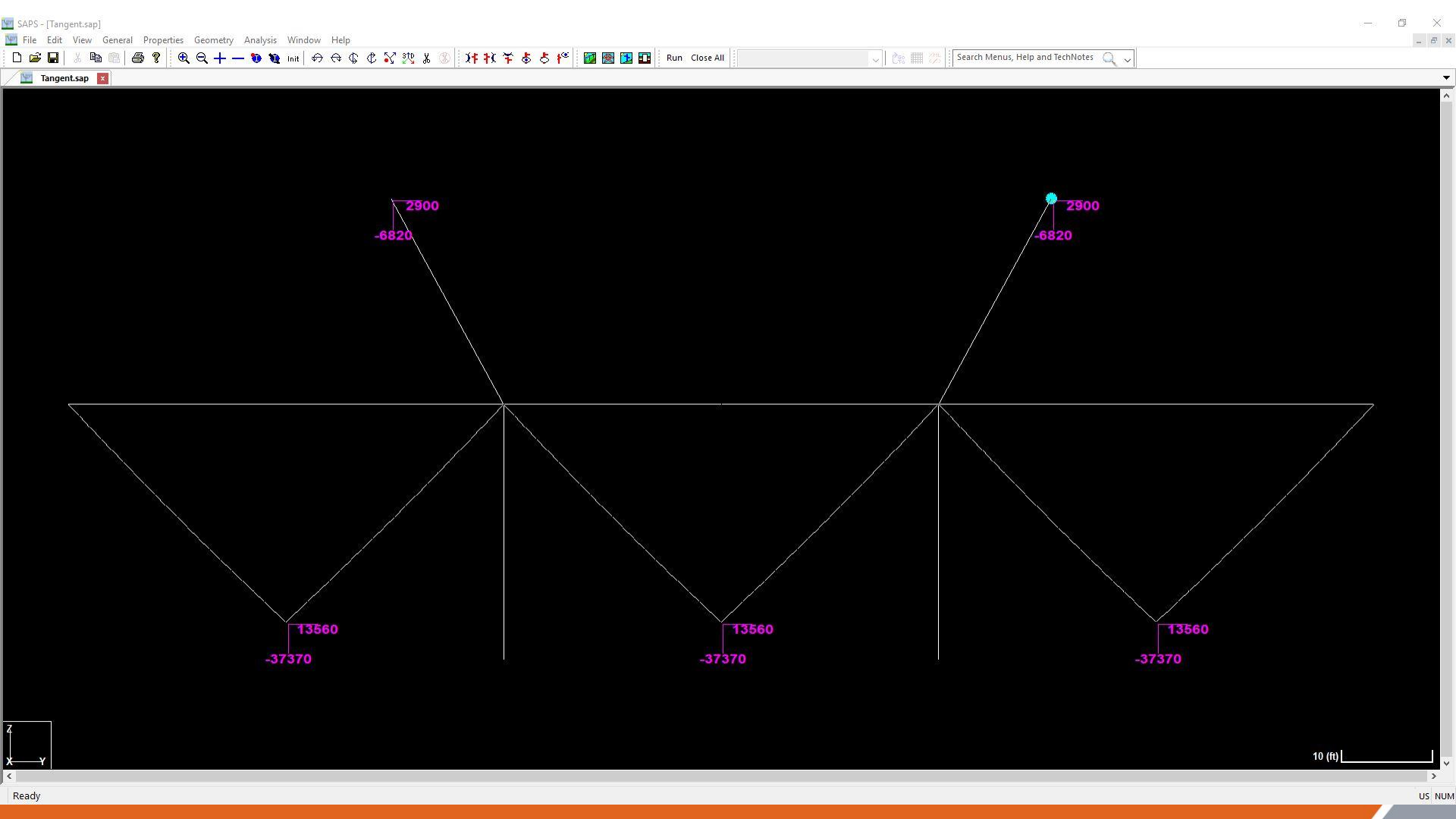
OTHER SAPS EXAMPLES








SAPS - [Bridge.sap]
File Edit View General Properties Geometry Analysis Window Help
Run Close All
Search Menus, Help and TechNotes
Bridge.sap
Z
X
Y
2 (ft)
Entity Info (Left click for Entity menu, Middle click or <Enter> for view menu): Joint Info (Left Click): Joint '2', Load case 'Undeformed Geometry', X=0.000 Y=-13.904 Z=14.000
US NUM


SAPS - [Tangent.sap]
File Edit View General Properties Geometry Analysis Window Help
Run Close All
Search Menus, Help and TechNotes
Tangent.sap
2900
-6820
2900
-6820
13560
-37370
13560
-37370
13560
-37370
Z
X
Y
10 (ft)
Ready
US NUM

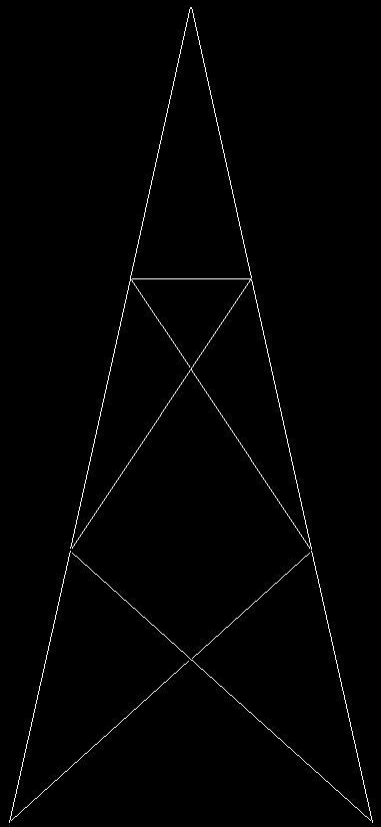
SAPS - [arm.sap]

File Edit View General Properties Geometry Analysis Window Help

Run Close All

Search Menus, Help and TechNotes

arm.sap



Z
X Y

1 (ft)

Entity Info (Left click for Entity menu, Middle click or <Enter> for view menu): Joint Info (Left Click): Joint '4', Load case 'Undeformed Geometry', X=0.000 Y=1.333 Z=6.000

US NUM

Concluding Questions

- Can ASCE 48 and ASCE 10 be combined where it makes sense?
  - Add clarifications for applicability to combined frame structures in the Commentaries
- Or, do we need a Transmission Frame Standard?

THANK YOU!