STRUCTURAL CALCULATIONS
for
AT&T LAND LINE SWITCH (SITE # CSL04566)

at
202 WEST OJAI AVENUE
OJAI, CA 93023
for
SMARTLINK
&
RAYCAP | STEALTH (AT20-02139H-29R0)

04/08/2021

BY: **JACOB PROCTOR, P.E.**
PROJECT ENGINEER

PROJECT #: **U0142.1150.211**

DATE: **January 27, 2021**
REVISED: **April 8, 2021**

DESIGNED BY TPH; CHECKED BY KJG

NOTE:
The calculations presented in this package are intended for a single use at the location indicated above, for the client listed above. These calculations shall not be reproduced, reused, "card filed", sold to a third party, or altered in any way without the written authorization of Vector Structural Engineering, LLC and RayCap | Stealth.

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PROJECT: AT&T LAND LINE SWITCH

Design Criteria:

Code: Structural design is based on the California Building Code, 2019 Edition (2018 IBC) and the ASCE 7-16 standard.

Wind: Basic wind speed = 93 mph (3-second gust) per the ASCE 7-16 standard
Risk Category: II
Wind exposure: B

Seismic: Component Importance Factor, Ip = 1.0
Risk Category: II
Mapped spectral response accelerations: S_S = 2.232g S_1 = 0.835g
Site class: D
Spectral response coefficients: S_{DS} = 1.786g S_{D1} = 0.946g
Seismic design category: E
Analysis procedure: Equivalent Lateral Force

General Notes:

1. The contractor shall verify dimensions, conditions and elevations before starting work. The engineer shall be notified immediately if any discrepancies are found.
2. The typical notes and details shall apply in all cases unless specifically detailed elsewhere. Where no detail is shown, the construction shall be as shown for other similar work and as required by the building code.
3. These calculations are limited to the structural members shown in these calculations only. The connection of the members shown in these calculations to the existing structure shall be by others, with the exception of those explicitly shown on the drawings.
4. The contractor shall be responsible for compliance with local construction safety orders. Approval of shop drawings by the architect or structural engineer shall not be construed as accepting this responsibility.
5. All structural framing members shall be adequately shored and braced during erection and until full lateral and vertical support is provided by adjoining members.

Structural Steel:

1. All structural steel code checks based on the AISC, 15th Edition per the ASCE 7 standard
2. All steel rectangular tubes (HSS) to be per ASTM A500 GR. B (46 KSI), U.N.O.
3. All other structural steel shapes & plates shall be per ASTM A36, U.N.O.
4. All bolts for steel-to-steel connections shall be per ASTM F3125 GR. A325 U.N.O.
5. All bolted connections shall be tightened per the "turn-of-nut" method as defined by AISC.
6. All welding shall be performed by certified welders in accordance with the latest edition of the American Welding Society (AWS) D1.1
7. All steel surfaces shall be galvanized in accordance with ASTM A123 and ASTM F2329 standards, thoroughly coated with a zinc-rich primer, or otherwise protected as noted on the structural drawings.

Fiberglass Reinforced Plastic (FRP):

1. All structural shapes shall be Bedford Reinforced Plastics produced using the pultrusion process.
2. All cut edges and holes shall be sealed with a resin compatible with the resin matrix used in the structural shape.
3. The fabricator and contractor shall exercise precautions necessary to protect the fiberglass pultruded structural shapes from abuse to prevent breakage, nicks, gouges, etc. during fabrication, handling, and installation.
4. Structural shapes shall be fabricated and assembled as indicated on the design drawings.
5. FRP threaded rods and nuts shall be tightened to snug tight and turned an additional 1/2 turn and locked with epoxy

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Flat Roof Parapet Component & Cladding Wind Load

Label: Screenwall

Note: Calculations per ASCE 7-16

INPUT DATA:

Basic Wind Speed, V [mph]:	93	
Exposure Category:	B	
Elevation Above Sea Level (ft):	760	
Top of Parapet Elevation, z = h_p (ft):	35.0	
Building Height w/o Parapet (ft):	24.4	
Parapet Around Perimeter and Greater than 3':	Yes	
Building Least Horizontal Dimension (ft):	50	
Component Width (ft):	5.5	
Component Height (ft):	9.0	

Velocity Pressure, q_p:

Velocity Pressure Exposure Coefficient, K_z:	0.73	Table 26.10-1
Topographic Factor, K_{zt}:	1.0	Section 26.8.2
Wind Directionality Factor, K_d:	0.85	Table 26.6-1
Ground Elevation Factor, K_e:	0.97	Table 26.9-1
Velocity Pressure, q_p:	13.4	Equation 30.9-1
$K_z = 2.01(z/z_g)^{(2/\alpha)}$		Table 26.11-1
Nom. Ht. of Atmospheric Bound Layer, z_g (ft):	1200	Table 26.11-1
3-s Gust-Speed Power Law Exponent, α:	7.0	Table 26.11-1
Minimum Height, z_{min} (ft):	30	Table 26.11-1
Component & Cladding Area (ft^2):	49.5	
Zone Dimensions, a (ft):	5	Figures 30.3-1 & 30.5-1
Gable Roofs θ ≤ 7° Zone Dimensions (ft):	21	Figure 30.3-2A

h ≤ 60 ft

Case A (Positive Wall - Negative Roof)				Case B (Positive Wall - Negative Wall)			
		Positive Wall Zones 4 & 5				Positive Wall Zones 4 & 5	
Negative Roof Zones	-2	36.5	psf (1.0 Wind)	Negative Wall	-4	22.4	psf (1.0 Wind)
	-3	36.5	psf (1.0 Wind)		-5	24.5	psf (1.0 Wind)

*If a parapet equal to or higher than 3 ft (0.9 m) is provided around the perimeter of the roof with θ ≤ 7°, the negative values of (GCp) in Zone 3 shall be equal to those for Zone 2, and positve values of (GCp) in Zones 2 & 3 shall be set equal to those for wall Zones 4 & 5, respectively, in Fig. 30.3-1.

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LOADS SUMMARY

Label: Representative section of screenwall FRP: Bedford

Dead Load, D:

Component:	Weight							
Stealth® ESSV Panel:	2.00	psf	Area =	49.5	ft^2	Total =	99	lb
4x4x3/8 FRP Angle:	2.23	plf	Length =	12	ft	Total =	27	lb
4x4x3/8 FRP Tube:	4.24	plf	Length =	10	ft	Total =	42	lb
HSS4-1/2x4-1/2x3/16:	10.70	plf	Length =	2.583333	ft	Total =	28	lb
3/4" Steel Plate:	30.63	psf	Area =	0.5625	ft^2	Total =	17	lb
Misc:	37	lb	Number =	1		Total =	37	lb
						W_p =	250	lb

Wind Load, W:

p =	21.9	psf	(ASD pressure - see wind calcs)			
Height, h:	9.0	ft				
Max. Horiz. Dim.:	5.5	ft	V_{trans}:	1084	lb	**Controls**
Min. Horiz. Dim.:	0.0	ft				

Seismic Load, E: Consider Seismic: Yes

Architectural Component: Cantilever element unbraced or braced below center of mass

Risk Category:	II	F_a =	1.2
Seismic Design Category:	E	F_v =	1.7
I_p =	1.0	S_{MS} =	2.678
Site Class:	D	S_{M1} =	1.420
R_p =	2.5	S_{DS} =	1.786
S_s =	2.232	S_{D1} =	0.946
S_1 =	0.835		

a_p =	2.5		0.7 * $F_{p,min}$ =	94	lb
z =	1.0	ft	0.7 * $F_{p,max}$ =	500	lb
h =	1.0	ft			
z/h =	1.0		0.7 * $F_{p,trans}$ =	375	lb
			0.7 * $F_{p,vert}$ =	63	lb

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ENCLOSURE CALCULATIONS

FRP Member Design for Bending & Shear:

Label: Max span girt

Beam assumed to be simply supported.
Note: The force is horizontal.

INPUT:

Notes:

Area Load [psf]:	21.9	(0.6W)				
Span, L [ft]:	5.5					
Tributary Width [ft]:	4.5					
Distributed Load, w [plf]:	98.5		I [in^4]:	4.36	A_w [in^2]:	2.86
Beam:	4x4x3/8 Angle		S [in^3]:	1.52	E [psi]:	2,800,000
			A [in^2]:	2.86	G [psi]:	450,000

OUTPUT:

Note: Calculated deflection is based on reduced wind pressure per Table 1604.3. Shear contribution is neglected.

Moment, M [lb-ft]:	372				
Shear, V [lb]:	271				Deflection, Δ =
Deflection, Δ [in]:	0.12	=	L / 568		5wL^4/(384EI)
f_b [psi]:	2,941	<	F_b [psi]:	10,000	**OK**
f_v [psi]:	95	<	F_v [psi]:	1,500	**OK**

Select 4x4x3/8 Angle FRP beam

See attached FRP material and section properties.

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FRP Cantilevered Column Design:

Label: Typical column

INPUT:

Notes:

W_1 [lb]:	542
W_2 [lb]:	542
h_1 [ft]:	7.5
h_2 [ft]:	0.5
Column:	4x4x3/8 Tube

I [in^4]:	12.04	A_w [in^2]:	2.44
S [in^3]:	6.02	E [psi]:	2,800,000
A [in^2]:	5.44	G [psi]:	450,000

OUTPUT:

Moment, M [lb-ft]:	4,334
Shear, V [lb]:	1,084

f_b [psi]:	8,640	<	F_b [psi]:	10,000	**OK**
f_v [psi]:	444	<	F_v [psi]:	1,500	**OK**

Select 4x4x3/8 Tube FRP column

FRP Shear Connection w/ FRP Bolts:

Label: Girt to clip angle

INPUT:

Notes:

Design Force, P [lb]:	542
FRP Bolt Diameter, d_b [in]:	1/2
# Bolts, n_b:	(2)
FRP Web Thickness, t_w [in]:	3/8
Double Shear:	No
Bearing Stress:	Crosswise
Factor of Safety, FS:	4

OUTPUT:

f_{brg} [psi]:	1,445	<	F_{brg} [psi]:	3,750	**OK**
p_{bolt} [lb]:	271	<	P_{bolt} [lb]:	850	**OK**

Select (2) 1/2" diameter FRP bolts

See attached FRP material and section properties.

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FRP Tension Connection w/ FRP Bolts:

Label: Clip angle to column

FRP bolt thread shear capacity will control.

INPUT:

		Notes:
Design Force, P [lb]:	542	
FRP Bolt Diameter, d_b [in]:	1/2	
# Bolts, n_b:	(2)	
# FRP Nuts/Bolt/End:	(1)	
Factor of Safety, FS:	4	

P_{allow} [lb]: 2,400

$$P'_{allow} = \frac{P_{allow} n_b}{FS}$$

OUTPUT:

Capacity, P'_{allow} [lb]: 1,200 > 542 **OK**

Select (2) 1/2" diameter FRP bolts

See attached FRP material and section properties.

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DESIGN APPROACH: ASD

MEMBER IN BENDING Location: HSS column base

Steel Shape:	HSS4-1/2x4-1/2x3/16		
Moment Capacity:	10800	ft-lbs	(AISC Chapter 3)
Maximum Moment:	6592	ft-lbs	
Check Member:	61.0%		
Result:	**Selected member size is adequate.**		
Note:			

PLATE IN BENDING Location: Base plate

Plate depth:	0.75	in	Intermediate Values		
Plate width:	6	in	$L_b d/t^2$	0.03645833	
Moment arm/unbraced length:	1.75	in	S_x	0.5625	in^3
Yield strength:	36	ksi	Z_x	0.844	in^3
Moment capacity:	1515.72	ft-lbs			
Load:	1163	lbs			
Moment:	170	ft-lbs			
Check Plate:	11.2%				
Result:	**Selected plate is adequate.**				
Note:	Condition A, joists parallel to screen.				

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PLATE IN BENDING

Location: Base plate

Plate depth:	0.75	in
Plate width:	6	in
Moment arm/unbraced length:	1.75	in
Yield strength:	36	ksi
Moment capacity:	1515.72	ft-lbs
Load:	9900	lbs
Moment:	1444	ft-lbs
Check Plate:	95.3%	

Intermediate Values

$L_b d/t^2$	0.03645833	
S_x	0.5625	in^3
Z_x	0.844	in^3

Result: **Selected plate is adequate.**

Note: Condition B, joists perpendicular to screen.

WELD

Location: Torsion tube to base plate

Type:	Groove	
Effective Groove Weld Size:	0.1875	in
Length of Weld:	6	in
Weld Strength:	42	ksi
Weld Capacity:	23625	lbs
Load:	17600	lbs
Check Weld:	74.5%	

Result: **Selected weld is adequate.**

Note:

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PROJECT: AT&T Land Line Switch

BOLTED SHEAR CONNECTION

Location: Span tube to base plate

Bolt Grade:	A307		
Bolt Diameter:	1	in	
Number of Bolts:	1		
Double Shear?	Yes		
Bolt Capacity:	21206	lbs	(AISC Equation J3-1)
Shear Load:	10040	lbs	
Check Bolt:	47.3%		
Result:	**Select (1) 1 in. dia. A307 bolt.**		
Note:	Center bolt is conservatively neglected. Overturning moment resolved between outside bolts.		

BOLT/PIN BEARING & MATERIAL TENSILE/SHEAR STRENGTH

Location: Span tube to base plate

Bolt or Pin Diameter:	1	in	
Hole Diameter or Slot Width:	1.0625	in	
Number of Bolts or Pins:	1		
Plate Thickness:	0.174375	in	
Plate Yield Strength (F_y):	46	ksi	
Plate Ultimate Strength (F_u):	58	ksi	
Bolt/Pin Parallel Edge Distance:	1.5	in	(measured from center of hole)
Bearing Capacity:	5879	lbs	
Perpendicular Edge Distance:	1.5	in	(measured from center of hole)
Effective Perp. Edge Distance:	1		
Tensile Rupture Capacity:	9798	lbs	(AISC Equation D5-1)
Shear Rupture Capacity:	8913	lbs	(AISC Equation D5-2)
Load:	5020	lbs	
Check Bearing:	85.4%		
Result:	**Selected connection type is adequate.**		
Note:			

Available AISC Checks:

Equation	Check?	Capacity
J3-6a	Yes	5879
J3-6b	No	
J3-6c	No	
J7-1	Yes	7219

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BOLTED SHEAR CONNECTION

Location: Torsion tube to base plate

Bolt Grade:	A307		
Bolt Diameter:	1	in	
Number of Bolts:	3		
Double Shear?	No		
Bolt Capacity:	31809	lbs	(AISC Equation J3-1)
Shear Load:	17600	lbs	
Check Bolt:	55.3%		
Result:	**Select (3) 1 in. dia. A307 bolts.**		
Note:	Overturning moment is resolved by the width of the torsion tube.		

BOLT/PIN BEARING & MATERIAL TENSILE/SHEAR STRENGTH

Location: Torsion tube to base plate

Bolt or Pin Diameter:	1	in	
Hole Diameter or Slot Width:	1.0625	in	
Number of Bolts or Pins:	3		
Plate Thickness:	0.174375	in	
Plate Yield Strength (F_y):	46	ksi	
Plate Ultimate Strength (F_u):	58	ksi	
Bolt/Pin Parallel Edge Distance:	1.5	in	(measured from center of hole)
Bearing Capacity:	17636	lbs	
Perpendicular Edge Distance:	1.5	in	(measured from center of hole)
Effective Perp. Edge Distance:	1		
Tensile Rupture Capacity:	29393	lbs	(AISC Equation D5-1)
Shear Rupture Capacity:	26738	lbs	(AISC Equation D5-2)
Load:	17600	lbs	
Check Bearing:	99.8%		
Result:	**Selected connection type is adequate.**		
Note:			

Available AISC Checks:

Equation	Check?	Capacity
J3-6a	Yes	5879
J3-6b	No	
J3-6c	No	
J7-1	Yes	7219

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PROJECT: AT&T Land Line Switch **SUBJECT:** WELD GROUP ANALYSIS

WELDED CONNECTION WITH FILLET WELDS TREATED AS LINES

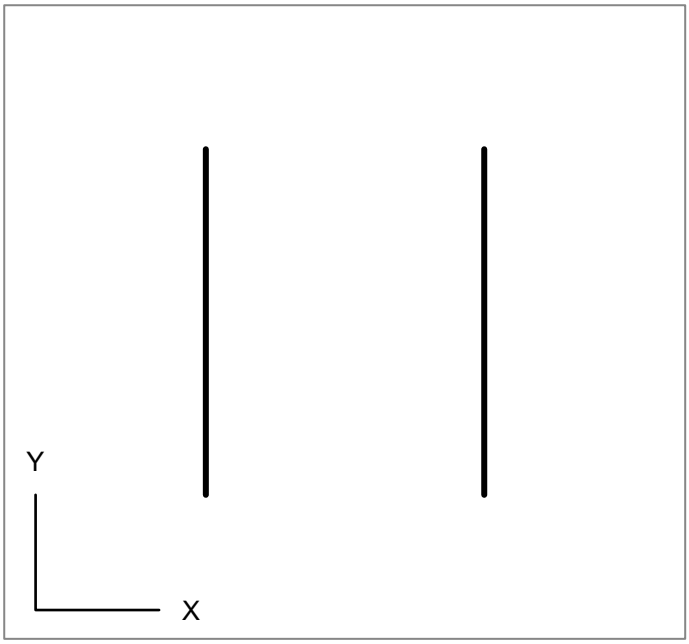
Description: Base sleeve to span tube

Geometry

Weld Pattern:	Double weld line, vertical	
b (in) =	4.5	(parallel to x-axis)
d (in) =	6	(parallel to y-axis)
S_{XWELD} (in^2) =	12.00	
S_{YWELD} (in^2) =	27.00	
Ip_{WELD} (in^3) =	96.75	
Lweld (in) =	12.00	
Torque arm (in) =	3.75	
Graphic Scale:	100%	

Results

Electrode Class Number (ksi):	70
Required leg size (in) =	0.106
Actual leg size (in) =	**3/16**
Stress ratio:	**56.6%**



Loads on Weld Group

Load Type:	ASD
$Axial_{(Z)}$ (lb) =	0
$Shear_X$ (lb) =	542
$Shear_Y$ (lb) =	125
$Moment_{XX}$ (ft-lb) =	0
$Moment_{YY}$ (ft-lb) =	0
$Torque_{(ZZ)}$ (ft-lb) =	3295.883

v_{axial} (lb/in) =	0
v_{shearx} (lb/in) =	45
v_{sheary} (lb/in) =	10
$v_{momentxx}$ (lb/in) =	0
$v_{momentyy}$ (lb/in) =	0
v_{torque} (lb/in) =	1533
v_{max} (lb/in) =	1575

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PROJECT: AT&T Land Line Switch **SUBJECT:** WELD GROUP ANALYSIS

WELDED CONNECTION WITH FILLET WELDS TREATED AS LINES

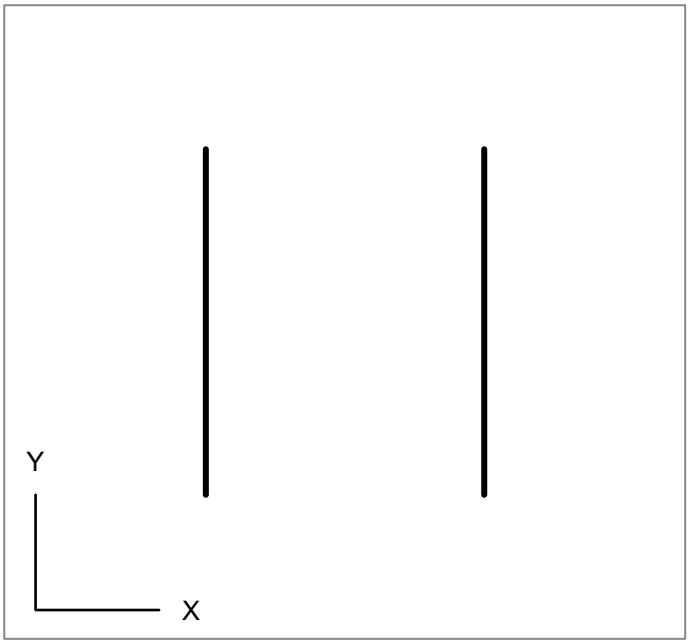
Description: Base sleeve to span tube

Geometry

Weld Pattern:	Double weld line, vertical	
b (in) =	4.5	(parallel to x-axis)
d (in) =	6	(parallel to y-axis)
S_{XWELD} (in^2) =	12.00	
S_{YWELD} (in^2) =	27.00	
Ip_{WELD} (in^3) =	96.75	
Lweld (in) =	12.00	
Torque arm (in) =	3.75	
Graphic Scale:	100%	

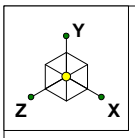
Results

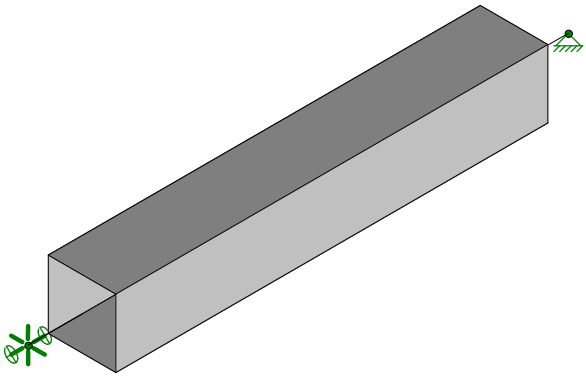
Electrode Class Number (ksi):	70
Required leg size (in) =	0.099
Actual leg size (in) =	**3/16**
Stress ratio:	**52.6%**

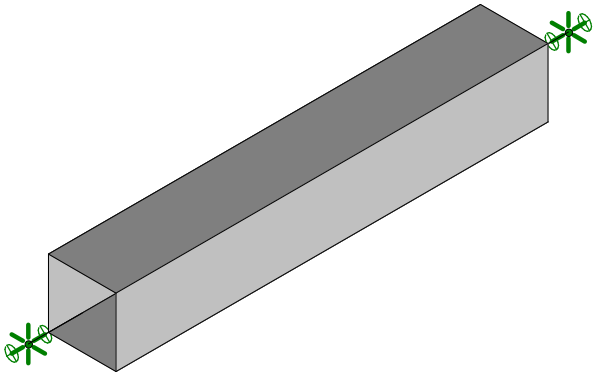


Loads on Weld Group

Load Type:	ASD			
$Axial_{(Z)}$ (lb) =	541.789	v_{axial} (lb/in) =	45	
$Shear_X$ (lb) =	0	v_{shearx} (lb/in) =	0	541.7890423
$Shear_Y$ (lb) =	17578.04	v_{sheary} (lb/in) =	1465	125
$Moment_{XX}$ (ft-lb) =	0	$v_{momentxx}$ (lb/in) =	0	
$Moment_{YY}$ (ft-lb) =	0	$v_{momentyy}$ (lb/in) =	0	
$Torque_{(ZZ)}$ (ft-lb) =	0	v_{torque} (lb/in) =	0	3295.883341
		v_{max} (lb/in) =	1466	

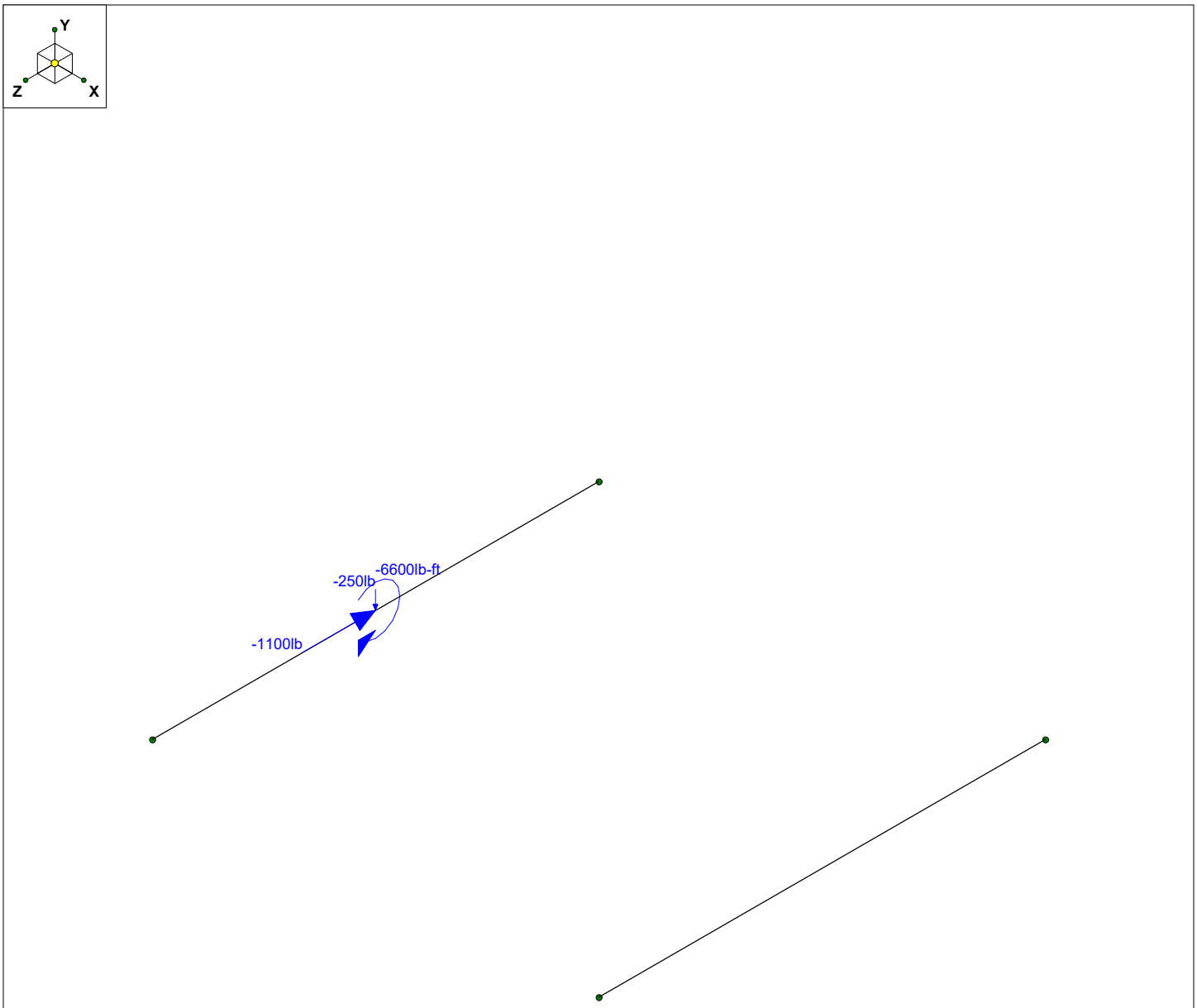






Loads: BLC 7,

Vector Structural Engineeri...		SK - 1
TPH		Apr 8, 2021 at 6:41 PM
		Base tubes.r3d



Loads: BLC 1, Reactions 1 Mid-Span

Vector Structural Engineeri...		SK - 2
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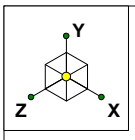

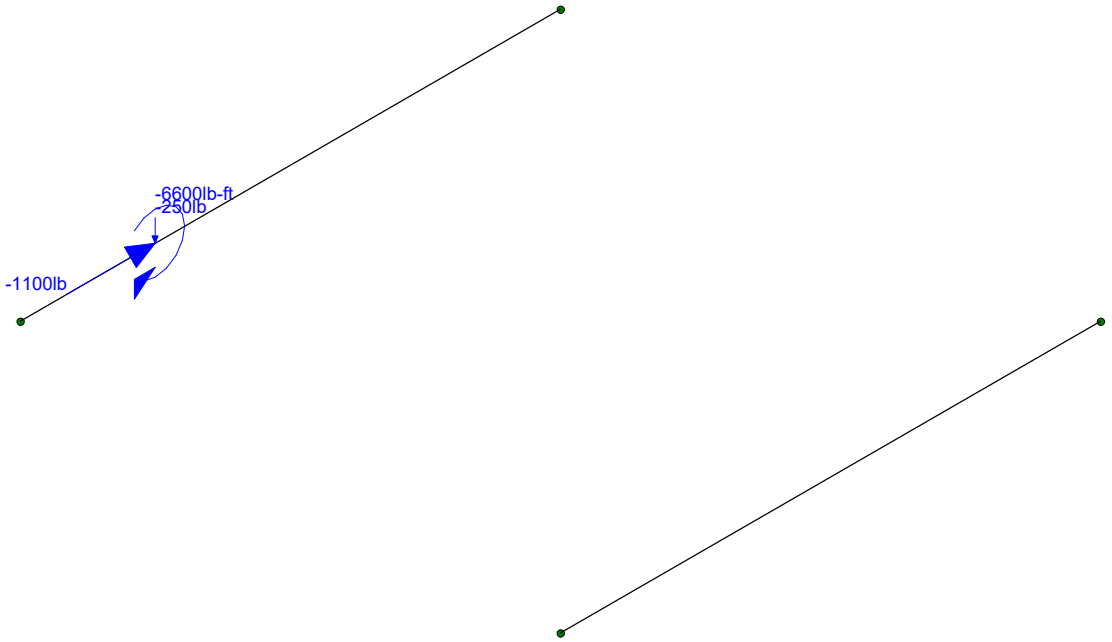

Loads: BLC 2, Reactions 1 Quarter Span

Vector Structural Engineeri...		SK - 3
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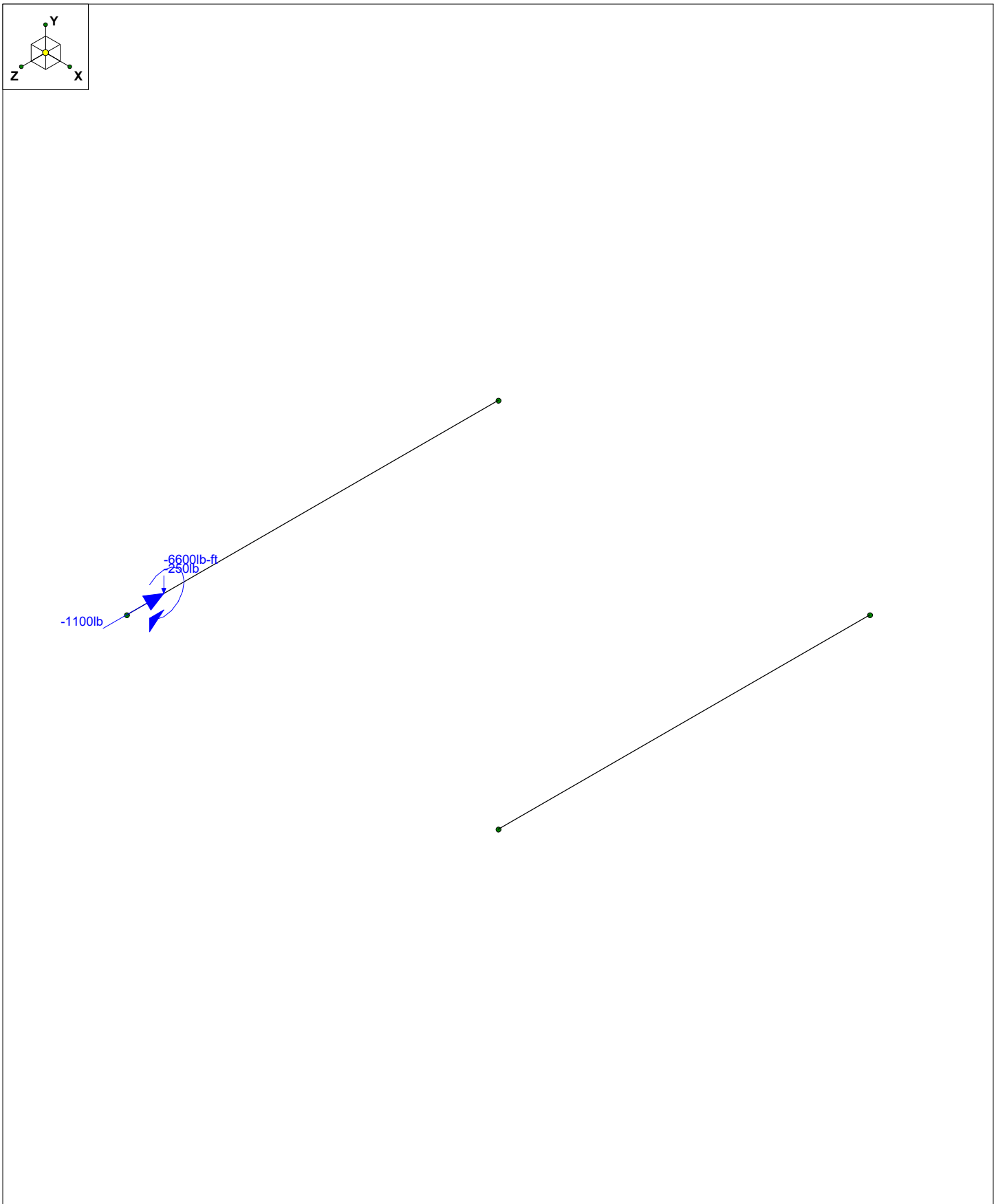

Loads: BLC 3, Reactions 1 1/10 Span

Vector Structural Engineeri...		SK - 4
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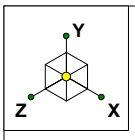

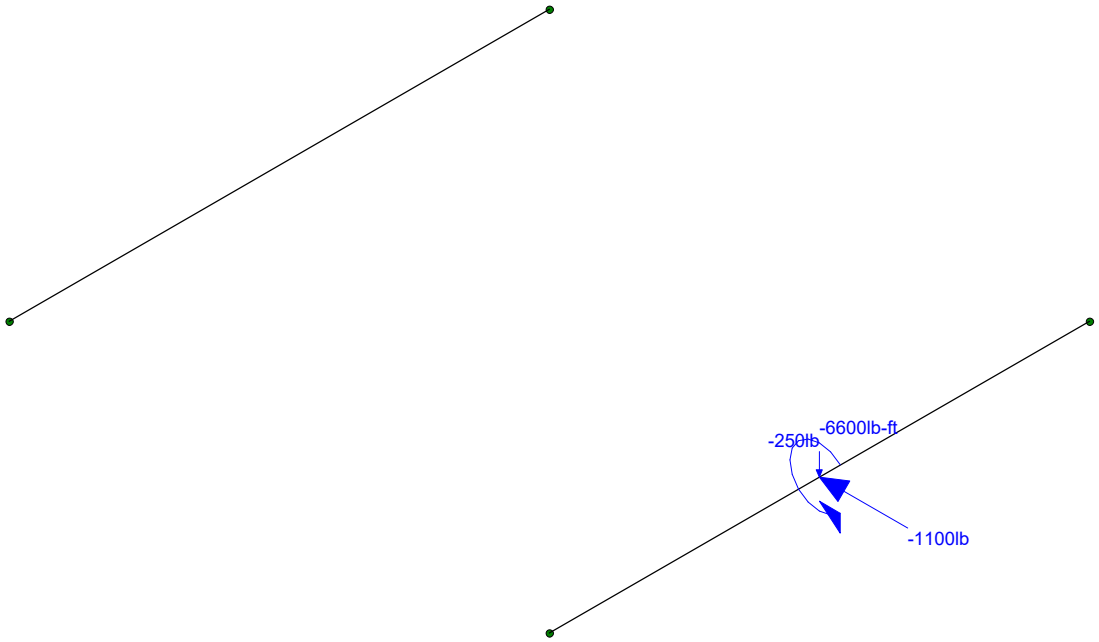

Loads: BLC 4, Reactions 2 Mid-Span

Vector Structural Engineeri...		SK - 5
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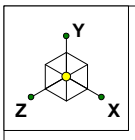
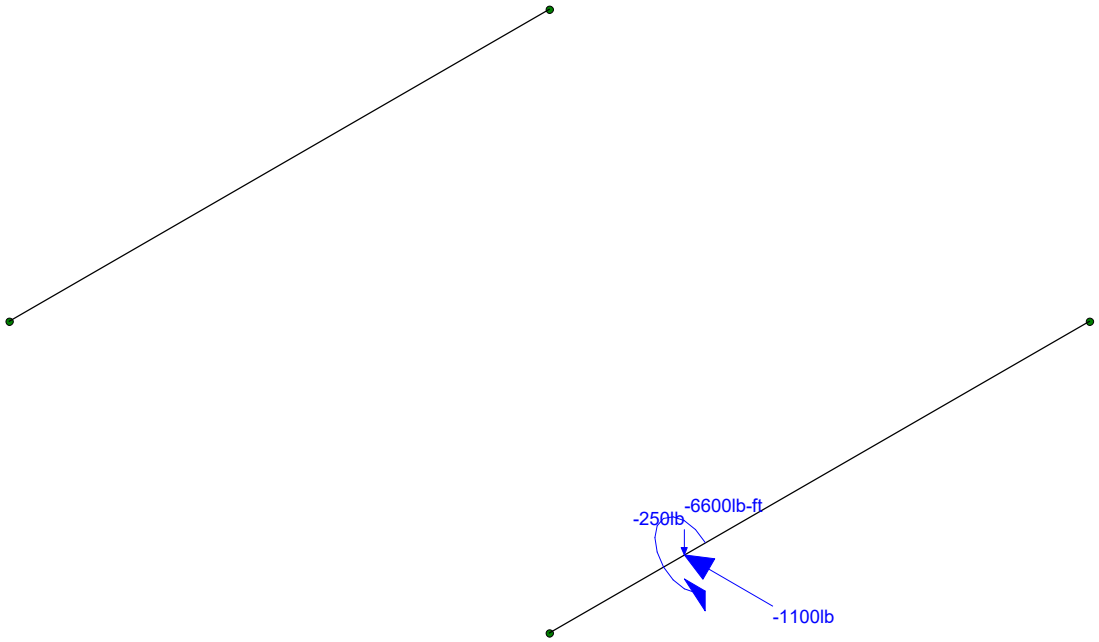
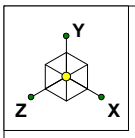
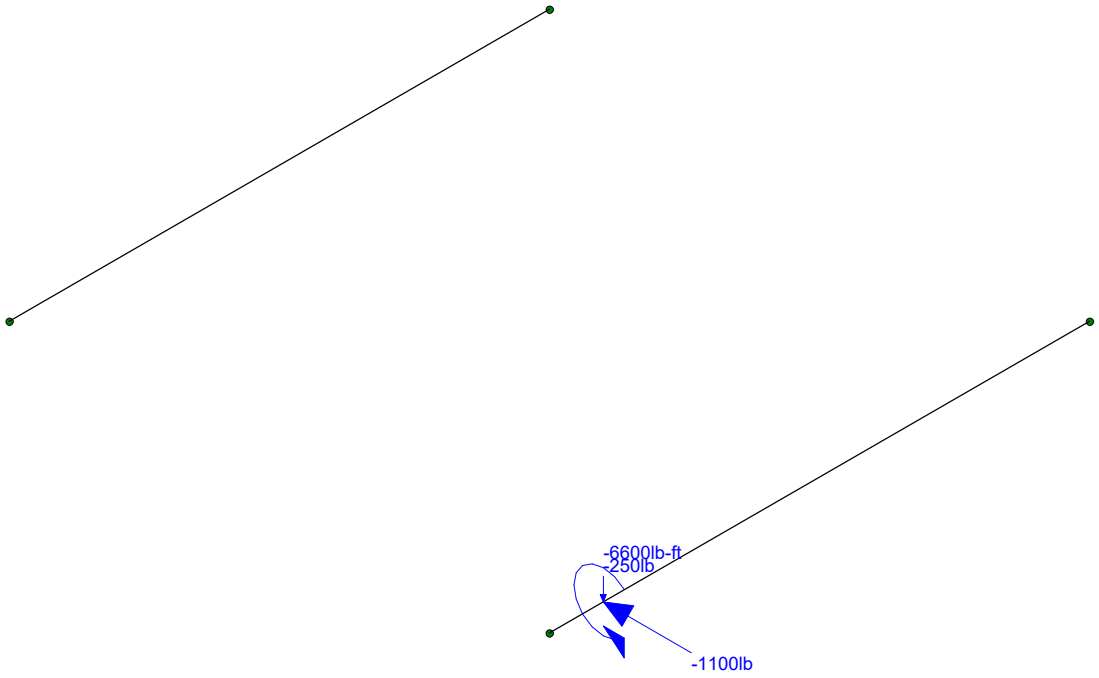




Loads: BLC 5, Reactions 2 Quarter Span

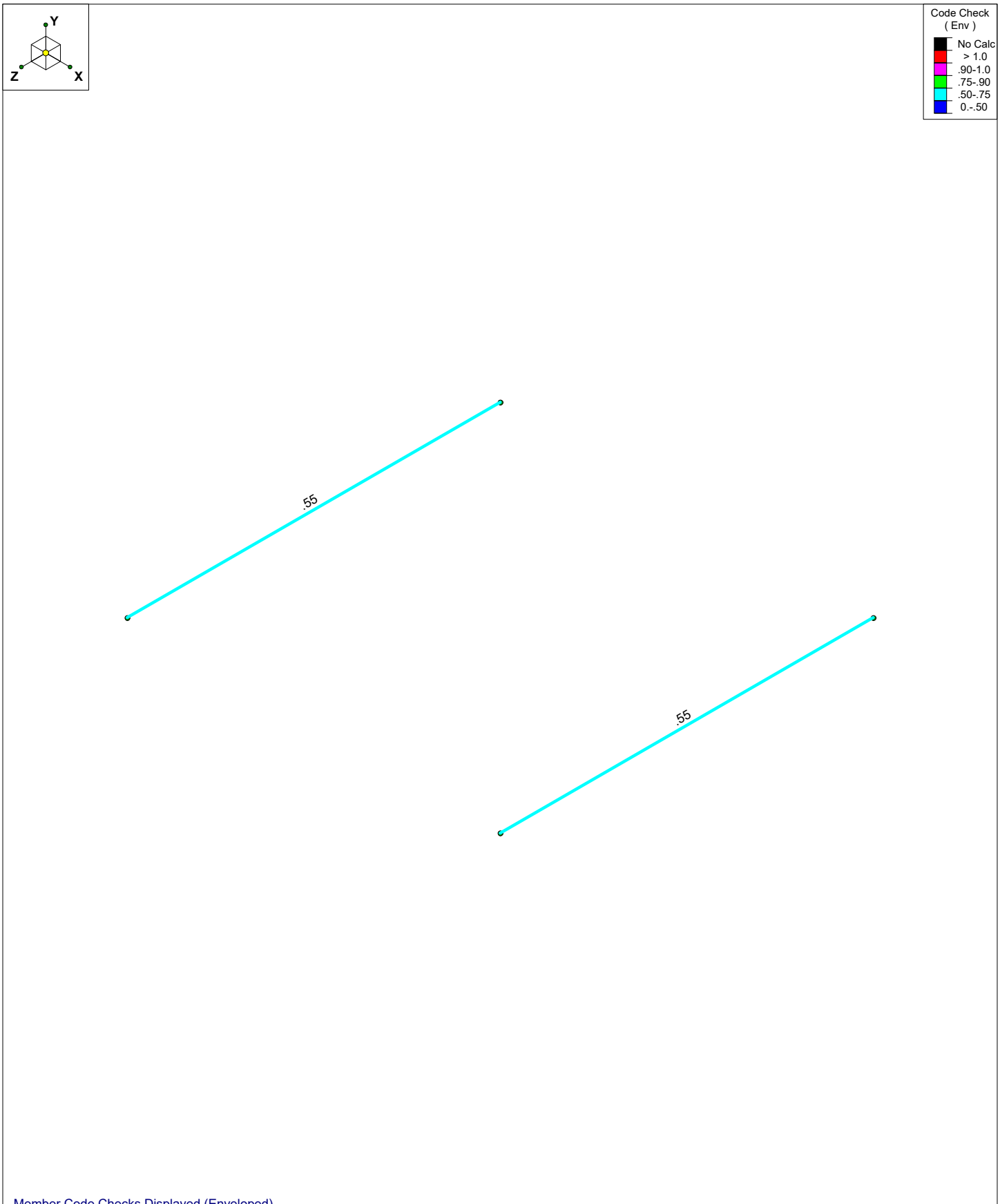
Vector Structural Engineeri...		SK - 6
TPH		Apr 8, 2021 at 6:42 PM
		Base tubes.r3d





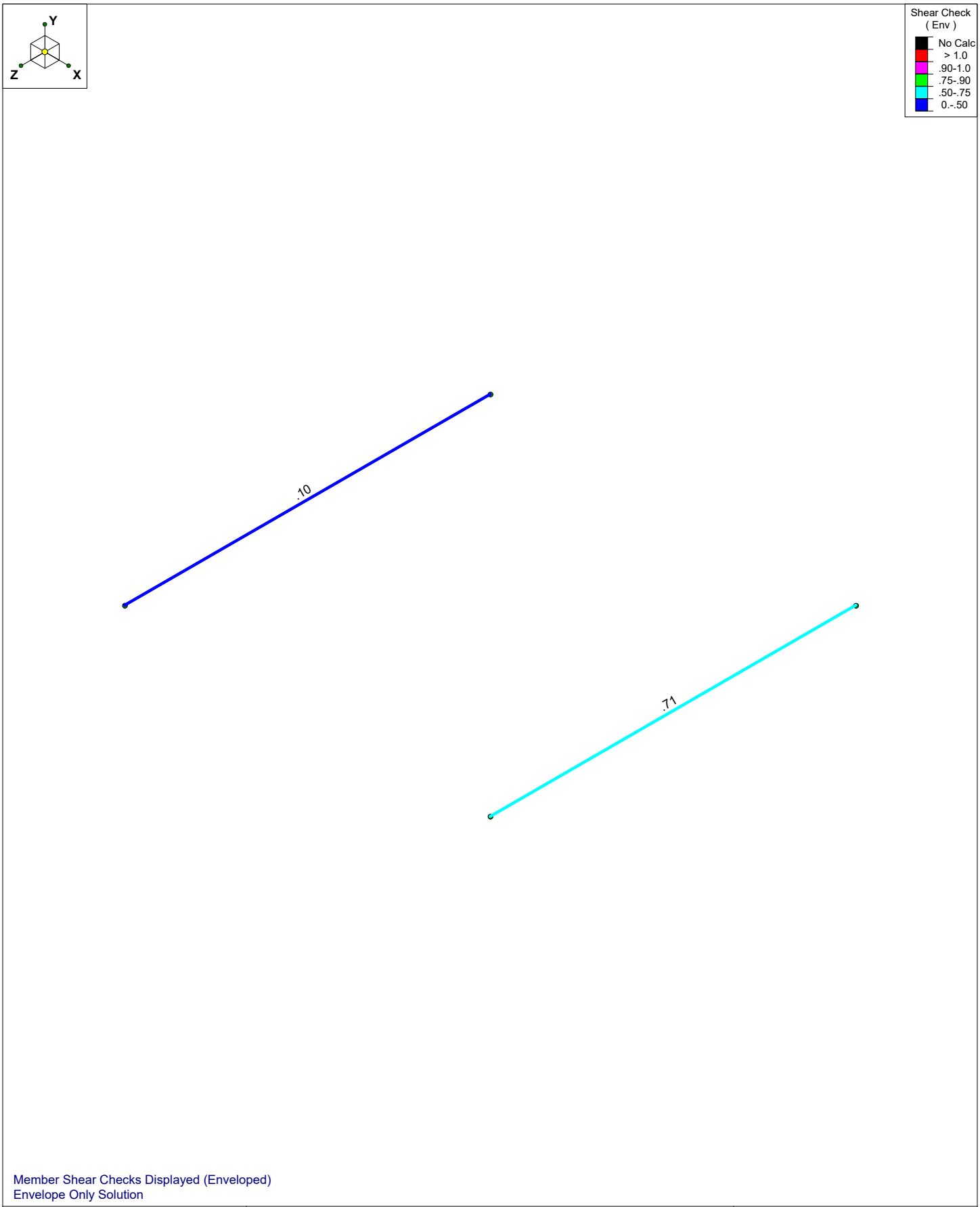
Loads: BLC 6, Reactions 2 1/10 Span

Vector Structural Engineeri...		SK - 7
TPH		Apr 8, 2021 at 6:42 PM
		Base tubes.r3d



Member Code Checks Displayed (Enveloped)
Envelope Only Solution

Vector Structural Engineeri...		SK - 8
TPH		Apr 8, 2021 at 6:42 PM
		Base tubes.r3d



Member Shear Checks Displayed (Enveloped)
Envelope Only Solution

Vector Structural Engineeri...		SK - 9
TPH		Apr 8, 2021 at 6:42 PM
		Base tubes.r3d

(Global) Model Settings

Display Sections for Member Calcs	5
Max Internal Sections for Member Calcs	97
Include Shear Deformation?	Yes
Increase Nailing Capacity for Wind?	Yes
Include Warping?	Yes
Trans Load Btwn Intersecting Wood Wall?	Yes
Area Load Mesh (in^2)	16
Merge Tolerance (in)	.12
P-Delta Analysis Tolerance	0.50%
Include P-Delta for Walls?	Yes
Automatically Iterate Stiffness for Walls?	Yes
Max Iterations for Wall Stiffness	3
Gravity Acceleration (ft/sec^2)	32.2
Wall Mesh Size (in)	24
Eigensolution Convergence Tol. (1.E-)	4
Vertical Axis	Y
Global Member Orientation Plane	XZ
Static Solver	Sparse Accelerated
Dynamic Solver	Accelerated Solver

Hot Rolled Steel Code	AISC 14th(360-10): ASD
Adjust Stiffness?	Yes(Iterative)
RISAConnection Code	None
Cold Formed Steel Code	None
Wood Code	None
Wood Temperature	< 100F
Concrete Code	None
Masonry Code	None
Aluminum Code	None - Building
Stainless Steel Code	None

Number of Shear Regions	4
Region Spacing Increment (in)	4
Biaxial Column Method	Exact Integration
Parme Beta Factor (PCA)	.65
Concrete Stress Block	Rectangular
Use Cracked Sections?	Yes
Use Cracked Sections Slab?	No
Bad Framing Warnings?	No
Unused Force Warnings?	Yes
Min 1 Bar Diam. Spacing?	No
Concrete Rebar Set	REBAR_SET_ASTMA615
Min % Steel for Column	1
Max % Steel for Column	8

(Global) Model Settings, Continued

Seismic Code	None
Seismic Base Elevation (ft)	Not Entered
Add Base Weight?	Yes
Ct X	.02
Ct Z	.02
T X (sec)	Not Entered
T Z (sec)	Not Entered
R X	3
R Z	3

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (/1E...	Density[k/ft...	Yield[ksi]	Ry	Fu[ksi]	Rt
1	A992	29000	11154	.3	.65	.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	.3	.65	.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	.3	.65	.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	.3	.65	.527	42	1.4	58	1.3
5	A500 Gr.B Rect	29000	11154	.3	.65	.527	46	1.4	58	1.3
6	A53 Gr.B	29000	11154	.3	.65	.49	35	1.6	60	1.2
7	A1085	29000	11154	.3	.65	.49	50	1.25	65	1.15
8	A913 Gr.65	29000	11154	.3	.65	.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design R...	A [in2]	Iyy [in4]	Izz [in4]	J [in4]
1	Span 1	HSS4.5X4.5X3	Beam	None	A500 Gr.B Rect	Typical	2.93	9.02	9.02	14.4
2	Span 2	HSS4.5X4.5X3	Beam	None	A500 Gr.B Rect	Typical	2.93	9.02	9.02	14.4

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Z [k/in]	X Rot.[k-ft/rad]	Y Rot.[k-ft/rad]	Z Rot.[k-ft/rad]
1	N1	Reaction	Reaction	Reaction			
2	N2	Reaction	Reaction	Reaction			Reaction
3	N3	Reaction	Reaction	Reaction			Reaction
4	N4	Reaction	Reaction	Reaction			Reaction

Member Primary Data

	Label	I Joint	J Joint	K Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N2	N1			Span 1	Beam	None	A500 Gr.B...	Typical
2	M2	N4	N3			Span 2	Beam	None	A500 Gr.B...	Typical

Member Advanced Data

	Label	I Release	J Release	I Offset[in]	J Offset[in]	T/C Only	Physical	Defl Rat...	Analysis ...	Inactive	Seismic...
1	M1						Yes				None
2	M2						Yes				None

Hot Rolled Steel Design Parameters

	Label	Shape	Length[ft]	Lbyy[ft]	Lbzz[ft]	Lcomp top[ft]	Lcomp bot[ft]	L-torqu...	Kyy	Kzz	Cb	Function
1	M1	Span 1	3			Lbyy						Lateral
2	M2	Span 2	3			Lbyy						Lateral

Basic Load Cases

	BLC Description	Category	X Grav...	Y Grav...	Z Grav...	Joint	Point	Distrib...	Area(M...	Surfac...
1	Reactions 1 Mid-Span	None					3			
2	Reactions 1 Quarter Span	None					3			
3	Reactions 1 1/10 Span	None					3			
4	Reactions 2 Mid-Span	None					3			
5	Reactions 2 Quarter Span	None					3			
6	Reactions 2 1/10 Span	None					3			

Load Combinations

	Description	S...	P...	S...	B...	Fa...	BLC	Fa...	BLC	Fa...	BLC	Fa...	BLC	Fa...	BLC	Fa...	B...	Fa...	B...	Fa...	B...	Fa...	B...	Fa...
1		Y...	Y		1	1																		
2		Y...	Y		2	1																		
3		Y...	Y		3	1																		
4		Y...	Y		4	1																		
5		Y...	Y		5	1																		
6		Y...	Y		6	1																		

Envelope Joint Reactions

	Joint		X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb-ft]	LC	MY [lb-ft]	LC	MZ [lb-ft]	LC
1	N1	max	0	6	2325	1	550	1	0	6	0	6	0	6
2		min	0	1	0	4	0	4	0	1	0	1	0	1
3	N2	max	0	6	0	6	990	3	0	6	0	6	0	6
4		min	0	1	-2075	1	0	4	0	1	0	1	0	1
5	N3	max	550	4	125	4	0	6	0	6	0	6	0	3
6		min	0	1	0	1	0	1	0	1	0	1	-3300	4
7	N4	max	990	6	225	6	0	6	0	6	0	6	0	3
8		min	0	1	0	1	0	1	0	1	0	1	-5940	6
9	Totals:	max	1100	6	250	6	1100	3						
10		min	0	1	250	1	0	4						

Envelope Member Section Forces

	Member	Sec		Axial[lb]	LC	y Shear[lb]	LC	z Shea...	LC	Torque...	LC	y-y Moment[lb-ft]	LC	z-z Mo...	LC
1	M1	1	max	0	6	0	6	0	6	0	6	0	6	0	6
2			min	-990	3	-2075	1	0	1	0	1	0	1	0	1
3		2	max	275	2	0	6	0	6	0	6	0	6	1556.25	1
4			min	-550	1	-2262.5	2	0	1	0	1	0	1	-5090....	2
5		3	max	550	1	0	6	0	6	0	6	0	6	0	6
6			min	0	4	-2325	1	0	1	0	1	0	1	-3487.5	1
7		4	max	550	1	0	6	0	6	0	6	0	6	0	6
8			min	0	4	-2325	1	0	1	0	1	0	1	-1743.75	1
9		5	max	550	1	0	6	0	6	0	6	0	6	0	6
10			min	0	4	-2325	1	0	1	0	1	0	1	0	1
11	M2	1	max	0	6	225	6	990	6	5940	6	0	6	0	6
12			min	0	1	0	1	0	1	0	1	0	1	0	1
13		2	max	0	6	125	4	550	4	3300	4	618.75	5	0	3
14			min	0	1	-62.5	5	-275	5	-1650	5	0	1	-140.625	5
15		3	max	0	6	0	3	0	3	0	3	825	4	0	3
16			min	0	1	-125	4	-550	4	-3300	4	0	1	-187.5	4
17		4	max	0	6	0	3	0	3	0	3	412.5	4	0	3
18			min	0	1	-125	4	-550	4	-3300	4	0	1	-93.75	4
19		5	max	0	6	0	3	0	3	0	3	0	6	0	6
20			min	0	1	-125	4	-550	4	-3300	4	0	1	0	1

Envelope AISC 14th(360-10): ASD Steel Code Checks

	Member	Shape	Code ...	Loc[ft]	LC	Shear ...	Loc[ft]	Dir	LC	Pnc/om [l..	Pnt/om [lb]	Mnyy/om...	Mnzz/om...	Cb	Eqn
1	M1	HSS4.5X4.5...	.554	.313	3	.102	1.5	y	1	78453.136	80706.587	10811.377	10811.377	1....	H1-1b
2	M2	HSS4.5X4.5...	.546	.281	6	.706	0	z	6	78453.136	80706.587	10811.377	10811.377	1....	H3-6

TYPICAL COUPON PROPERTIES

Below are test results for typical coupon properties of Bedford Reinforced Plastics' structural fiberglass profiles (Standard, Fire Retardant, & Vinylester shapes). Properties are derived per the ASTM test method shown. Synthetic surfacing veil and ultraviolet inhibitors are standard.

		ENGLISH		METRIC	
MECHANICAL PROPERTIES	**ASTM**	**Units**	**Value**	**Units**	**Value**
Tensile Stress, LW	D-638	psi	30,000	*MPa*	*206.8*
Tensile Stress, CW	D-638	psi	7,000	*MPa*	*48.2*
Tensile Modulus, LW	D-638	10^6 psi	2.5	*GPa*	*17.2*
Tensile Modulus, CW	D-638	10^6 psi	.8	*GPa*	*5.5*
Compressive Stress, LW	D-695	psi	30,000	*MPa*	*206.8*
Compressive Stress, CW	D-695	psi	15,000	*MPa*	*103.4*
Compressive Modulus, LW	D-695	10^6 psi	2.5	*GPa*	*17.2*
Compressive Modulus,CW	D-695	10^6 psi	1.0	GPa	6.9
Flexural Stress, LW	D-790	psi	30,000	*MPa*	*206.8*
Flexural Stress, CW	D-790	psi	10,000	*MPa*	*68.9*
Flexural Modulus, LW	D-790	10^6 psi	1.8	*GPa*	*12.4*
Flexural Modulus, CW	D-790	10^6 psi	.8	*GPa*	*5.5*
Modulus of Elasticity, E	Full Section	10^6 psi	2.8	*GPa*	*19.3*
Shear Modulus	——	10^6 psi	0.450	*GPa*	*3.1*
Short Beam Shear	D-2344	psi	4,500	*MPa*	*31.0*
Punch Shear	D-732	psi	10,000	*MPa*	*68.9*
Notched Izod Impact, LW	D-256	ft.-lbs./in.	25	*J/mm*	*1.33*
Notched Izod Impact, CW	D-256	ft.-lbs./in.	4	*J/mm*	*.21*

PHYSICAL PROPERTIES	**ASTM**	**Units**	**Value**	**Units**	**Value**
Barcol Hardness	D-2583	—-	45	—-	*45*
24 Hour Water Absorbtion	D-570	% max.	0.45	*% max.*	*0.45*
Density	D-792	lbs./in.^{3}	.062-.070	*g/cc*	*1.72-1.94*
Coefficient of Thermal Expansion, LW	D-696	10^6 in./in./°F	4.4	10^6 *cm./cm./°C*	*8*

ELECTRICAL PROPERTIES	**ASTM**	**Units**	**Value**	**Units**	**Value**
Arc Resistance, LW	D-495	seconds	120	*seconds*	*120*
Dielectric Strength, LW	D-149	kv./in.	35	*kv./mm*	*1.37*
Dielectric Strength, PF	D-149	volts/mil.	200	*volts/mil.*	*200*
Dielectric Constant, PF	D-150	@60hz	5	*@60hz*	*5*

Fire Retardant Polyester and Fire Retardant Vinylester Structural Profiles:

FLAMMABILITY PROPERTIES	**ASTM**	**Units**	**Value**
Tunnel Test	E-84	Flame Spread	25 max.
Flammability	D-635	——	Nonburning
UL	94	VO	
NBS Smoke Chamber	E-662	Smoke Density 600-700	

LW = Lengthwise CW = Crosswise PF = Perpendicular to Laminate Face

TYPICAL PROPERTIES OF THREADED ROD / NUTS

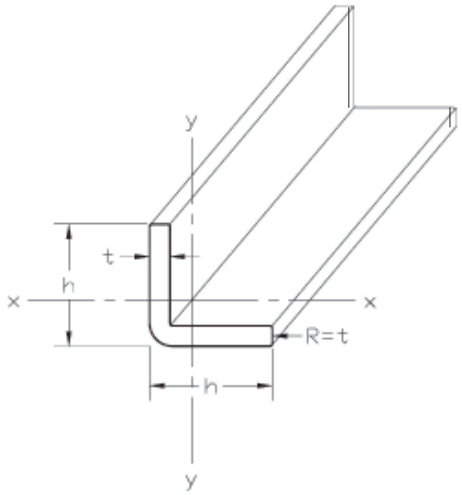
Bedford Reinforced Plastics' threaded rod and nuts are manufactured using premium vinylester resin containing UV inhibitors. The properties listed below are the result of the ASTM test method indicated.

PROPERTIES	ASTM	UNITS English *Metric*	VALUE (Diameter - Threads Per Inch (UNC)) 3/8-16 *9.5mm*	1/2-13 *12.7mm*	5/8-11 *15.9mm*	3/4-10 *19.0mm*	1-8 *25.4mm*
Ultimate Transverse Shear (Double Shear)	B-565	lb. *Newton*	4,200 *18,680*	6,800 *30,240*	10,000 *44,480*	13,400 *59,600*	24,000 *106,750*
Longitudinal Compressive Strength	D-695	psi *MPa*	50,000 *344*	50,000 *344*	50,000 *344*	50,000 *344*	50,000 *344*
Flexural Strength	D-790	psi *MPa*	70,000 *482*	70,000 *482*	70,000 *482*	70,000 *482*	70,000 *482*
Flexural Modulus	D-790	psi x 10^6 *GPa*	2.5 *17.2*	2.5 *17.2*	2.5 *17.2*	2.5 *17.2*	2.5 *17.2*
Flammability	D-635			Self-extinguishing for all			
Fire Retardant	E-84				Class 1		
Water Absorption (24 hr. immersion)	D-570	% max.	0.8	0.8	0.8	0.8	0.8
Longitudinal Coefficient of Thermal Expansion	D-696	10^{-6} in./in./°F *10^{-6} mm/mm/°C*	6 *11*	6 *11*	6 *11*	6 *11*	6 *11*
Ultimate Thread Shear using fiberglass nut	— —	lb. *Newton*	1,200 *5,337*	2,400 *10,670*	3,600 *16,010*	4,000 *17,790*	8,200 *36,470*
Ultimate Torque Strength fiberglass nut lubricated with SAE 10W30 motor oil		ft.-lb. *NewtonMeter*	8 *10*	16 *21*	35 *47*	50 *67*	110 *149*
Rod Weight	— —	lb./ft. *Kg./m*	0.07 *0.104*	0.14 *0.119*	0.2 *0.297*	0.3 *0.447*	0.5 *0.789*
Nut Weight	— —	lb. *grams*	0.01 *4.5*	0.02 *9.1*	0.04 *18.1*	0.06 *27.2*	0.14 *63.6*
Nut Dimensions	— —	in. (square) x in. (thick) *mm. (square) x mm. (thick)*	.68 x .45 *17.2x11.4*	.86 x .56 *21.8x14.2*	1.06 x .69 *26.9x17.5*	1.24 x .82 *31.5x20.8*	1.63 x 1.1 *41.4x27.9*
Color					Gray		

EQUAL LEG ANGLE

SECTION DIMENSIONS				SECTION PROPERTIES			
Depth	Wall			X - X / Y - Y			
h	t	A	Wt.	I	S	r	x/y
in. / *mm.*	in. / *mm.*	in.^{2} / *mm.*^{2}	lb./ft. *Kg./m*	in.^{4} / *mm.*^{4}	in.^{3} / *mm.*^{3}	in. / *mm.*	in. / *mm.*
1.00	0.125	0.23	0.18	0.02	0.05	0.31	0.29
25.4	*3.2*	*148.4*	*0.27*	*8325*	*819*	*7.9*	*7.4*
1.25	0.125	0.29	0.22	0.04	0.05	0.38	1.36
31.8	*3.2*	*187.1*	*0.33*	*16649*	*819*	*9.7*	*34.5*
1.50	0.187	0.52	0.40	0.11	0.10	0.46	0.44
38.1	*4.7*	*335.5*	*0.60*	*45785*	*1639*	*11.7*	*11.2*
1.50	0.250	0.67	0.54	0.14	0.13	0.46	0.47
38.1	*6.4*	*432.3*	*0.80*	*58272*	*2130*	*11.7*	*11.9*
2.00	0.250	0.92	0.70	0.33	0.23	0.59	0.59
50.8	*6.4*	*593.5*	*1.04*	*137356*	*3769*	*15.0*	*15.0*
3.00	0.250	1.42	1.08	1.24	0.58	0.93	0.84
76.2	*6.4*	*916.1*	*1.61*	*516127*	*9504*	*23.6*	*21.3*
3.00	0.375	2.09	1.61	1.76	0.83	0.91	0.89
76.2	*9.5*	*1348.4*	*2.40*	*732567*	*13601*	*23.1*	*22.6*
3.00	0.500	2.70	2.11	2.22	1.07	0.91	0.93
76.2	*12.7*	*1741.9*	*3.14*	*924034*	*17534*	*23.1*	*23.6*
4.00	0.250	1.90	1.45	3.04	1.04	1.26	1.09
101.6	*6.4*	*1225.8*	*2.16*	*12653.44*	*17043*	*32.0*	*27.7*
4.00	0.375	2.84	2.18	4.35	1.52	1.24	1.14
101.6	*9.5*	*1832.3*	*3.24*	*1810607*	*24908*	*31.5*	*29.0*
4.00	0.500	3.70	2.89	5.56	1.97	1.23	1.18
101.6	*12.7*	*2387.1*	*4.30*	*2314247*	*32283*	*31.2*	*30.0*
6.00	0.375	4.28	3.46	15.76	3.60	1.89	1.64
152.4	*9.525*	*2761.3*	*5.149*	*6559807*	*58993*	*48.03*	*41.66*
6.00	0.500	5.70	4.45	19.91	4.60	1.87	1.68
152.4	*12.7*	*3677.4*	*6.62*	*8287168*	*75380*	*47.5*	*42.7*

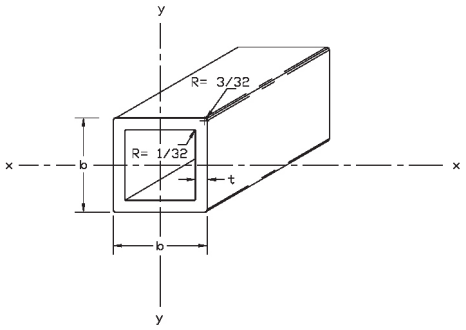
*ENGLISH / *METRIC*



SQUARE TUBE

SECTION DIMENSIONS				SECTION PROPERTIES		
d	b	A	Wt.	I	S	r
in. *mm.*	in. *mm.*	in^2 *$mm.^2$*	lb./ft. *kg./m*	$in.^4$ *$mm.^4$*	in^3 *$mm.^3$*	in. *mm.*
1	1/8	0.43	0.32	0.06	0.11	0.36
25.4	*3.2*	*277.4*	*0.48*	*24974*	*1803*	*9.1*
1	1/4	0.74	0.55	0.08	0.16	0.33
25.4	*6.4*	*477.4*	*0.82*	*33299*	*2622*	*8.4*
1 1/4	1/8	0.56	0.41	0.12	0.19	0.46
31.8	*3.2*	*361.3*	*0.61*	*49948*	*3114*	*11.7*
1 1/4	1/4	0.99	0.75	0.18	0.28	0.42
31.8	*6.4*	*638.7*	*1.12*	*74922*	*4588*	*10.7*
1 1/2	1/8	0.68	0.50	0.22	0.29	0.56
38.1	*3.2*	*438.7*	*0.74*	*91571*	*4752*	*14.2*
1 1/2	1/4	1.24	0.98	0.34	0.45	0.52
38.1	*6.4*	*800.0*	*1.46*	*141519*	*7374*	*13.2*
1 3/4	1/8	0.81	0.61	0.36	0.41	0.67
44.5	*3.2*	*522.6*	*0.91*	*149843*	*6719*	*17.0*
1 3/4	1/4	1.49	1.13	0.58	0.66	0.62
44.5	*6.4*	*961.3*	*1.68*	*241414*	*10815*	*15.7*
2	1/8	0.93	0.70	0.55	0.55	0.77
50.8	*3.2*	*600.0*	*1.04*	*228927*	*9013*	*19.6*
2	1/4	1.74	1.32	0.91	0.91	0.73
50.8	*6.4*	*1122.6*	*1.96*	*378771*	*14912*	*18.5*
2	3/8	2.44	1.85	1.13	1.13	0.68
50.8	*9.5*	*1574.2*	*2.75*	*470342*	*18517*	*17.3*
2 1/4	1/8	1.06	0.81	0.80	0.71	0.87
57.2	*3.2*	*683.9*	*1.21*	*332985*	*11635*	*22.1*
2 1/4	1/4	1.99	1.51	1.35	1.20	0.83
57.2	*6.4*	*1283.9*	*2.25*	*561912*	*19664*	*21.1*
3	1/8	1.43	1.08	1.98	1.32	1.18
76.2	*3.2*	*922.6*	*1.61*	*824138*	*21631*	*30.0*
3	1/4	2.74	2.07	3.50	2.33	1.13
76.2	*6.4*	*1767.7*	*3.08*	*1456810*	*38182*	*28.7*
3 1/2	1/4	3.24	2.49	5.73	3.27	1.32
88.9	*6.4*	*2090.3*	*3.71*	*2385006*	*53586*	*33.5*
4	3/8	5.43	4.24	12.03	6.01	1.48
101.6	*9.5*	*3503.2*	*6.31*	*5007264*	*98486*	*37.6*
4	1/4	3.74	2.83	8.82	4.41	1.53
101.6	*6.4*	*2412.9*	*4.21*	*3671161*	*72267*	*38.9*
6	3/8	8.27	6.54	22.35	7.45	2.29
152.4	*9.5*	*5335.4*	*9.73*	*9302772*	*122083*	*58.2*

*ENGLISH
METRIC



BEAMS

Properties / Allowables

$E = 2.8 \times 10^6$ lbs./in.^{2}
E = 19.3 GPa

$G = 450{,}000$ lbs./in.^{2}
G = 3.1 GPa

$F_b = 10{,}000$ lbs./in.^{2}
F_b = 68.9 MPa

$F_v = 1500$ lbs./in.^{2}
F_v = 10.3 MPa

Formulas

$$\Delta = \frac{5wL^4}{384EI} + \frac{wL^2}{8A_wG}$$

$$f_b = \frac{M}{S_x}$$

$$f_v = \frac{V}{A_w}$$

Allowable Critical Buckling Stress for laterally supported H and I Beams

$$F_{aCB} = \frac{\pi^2}{b_h^{\,2}t}\left[.935\sqrt{\left(\frac{Et^3}{12\lambda}\right)\left(\frac{\nu_T Et^3}{12\lambda}\right)} - (.656)\left(\frac{\nu_T Et^3}{12\lambda}\right) + (2.082)\left(\frac{Gt^3}{12}\right)\right] / 2.5$$

$$\lambda = (1 - \nu_L \nu_T)$$

Allowable Lateral-Torsional Buckling Stress for laterally unsupported H and I Beams

$$F_{aLTB} = \left[\frac{C\pi}{S(KL)}\sqrt{EI_yGJ + \frac{d^2\pi^2E^2I_y^{\,2}}{(4)(KL)^2}}\right] / 2.5$$

C = 1.13 and K = 1.0 for uniform load simple beam*

Allowable Critical Buckling Stress for Channels laterally supported to eliminate warping and twist

$F_{aCB} = G(t/b_c)^2/2.5$

Allowable Bending Stress for Square Tube (b/t <=16)

$F_b = 10{,}000$ psi.

* ASCE Manuals and Reports on Engineering Practice No. 63, Structural Plastics Design Manual Volumes 1 & 2, 1984

COLUMNS

Full section column testing was conducted on Bedford Reinforced Plastics' Equal Leg Angles, I-Beams, H-Beams, and Square Tubes.

Ultimate stress vs. slenderness ratio curves were developed from the testing. The curves developed are based on the Euler Buckling Stress Equation $\left[\pi^2 E/\left(\frac{KL}{r}\right)^2\right]$ and a straight line transition from Euler Buckling to ultimate stress.
The allowable concentric axial load tables were generated from these curves.

The tables are based on a safety factor of three.

COLUMN TABLES

ALLOWABLE CONCENTRIC AXIAL STRESSES AND LOADS

Notation

A area (in.^{2} / *mm.*^{2})

b width of flange/leg/wall (in. / *mm.*)

t thickness of flange (in. / *mm.*)

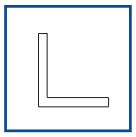
r minimum radius gyration (in. / *mm.*)

l length (in. / m.)

K effective column length factor

F_a allowable column concentric axial stress (psi / *MPa*)

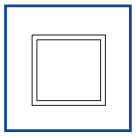
P_a allowable column centric axial load (lbs. / *N.*)



Angle

Maximum allowable stress:

b/t = 6	6,000 psi / *41.3MPa*
b/t = 8	4,862 psi / *33.5MPa*
b/t = 10.7	3,501 psi / *24.1MPa*
b/t = 12	2,833 psi / *19.5MPa*
b/t = 16	1,833 psi / *12.6MPa*



Square Tube (1/4" wall)

Maximum allowable stress:

b/t ≤ 16	10,000 psi / *68.9MPa*

H- & I-Beam

Maximum allowable stress:

b/t ≤ 12	10,000 psi / *68.9MPa*
b/t = 13.3	10,000 psi / *68.9MPa*
b/t = 16	7,318 psi / *50.5MPa*
b/t = 20	*4,684* psi / *32.3MPa*
b/t = 21.3	4,117 psi / *28.4MPa*
b/t = 24	3,253 psi / *22.4MPa*
b/t = 26.7	2,635 psi / *18.1MPa*