Consulting Structural &
Forensic Engineers
3600 E University Dr, Suite 1400, Phoenix, AZ 85034
(602) 438-2500 www.smleng.com

Structural Calculations

for

Half Palm Arch Vacuum Canopies
&
Full Palm Arch POS Canopies

at the

CLUB CAR WASH - EVANS
18318 Evans St.
Omaha, NE 68022

6/6/2025

PROFESSIONAL STRUCTURAL ENGINEER
JESSE JEROME
LIGHT
E-18764
STATE OF NEBRASKA
Exp: 12/31/2026

Jesse Light, S.E.

Digitally signed by Jesse Light, S.E.
DN: O="Starling Madison Lofquist, Inc.", CN="Jesse Light, S.E.", E=jlight@smleng.com
Reason: I am approving this document with my legally binding signature
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Prepared for
Vacutech
1350 Hi-Tech Drive
Sheridan, WY 82801

June 06, 2025
Job # 25-0333

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Ph enix, AZ 85034
(602) 438-2500

Job. No. 25-0333
6/02/25
By: CS
Check by: JL, SE

TABLE OF CONTENTS:

Project Description:

These calculations cover the structural design of a Half Palm Arch Vacuum Canopy & Full Palm Arch POS Canopy for Club Car Wash, in Omaha, NE. The structural scope of work includes:

- Structural analysis of a new half palm arch vacuum canopy and foundation
- Structural analysis of a new half palm arch Point of Sale canopy and foundation

SML, Inc. assumes no liability beyond what is specifically shown in these calculations.

Code References:

California Building Code, 2018 Edition (2018 IBC)

SEI/ASCE 7-16 Minimum Design Loads for Buildings & Other Structures (ASCE)

ACI 318-14 Building Code Requirements for Structural Concrete, (ACI)

ANSI/AISC 360-16 Specification for Structural Steel Buildings (AISC)

Foundation:

Soil bearing pressure per IBC Table 1806.2:

Allowable Bearing Pressure $q_{lat} := 1500psf$

Allowable Lateral Bearing $p_{lat} := 100psf \cdot 2 = 200 \cdot psf$

w/ 2x increase for isolated pole
foundations per IBC Section 1806.3.4

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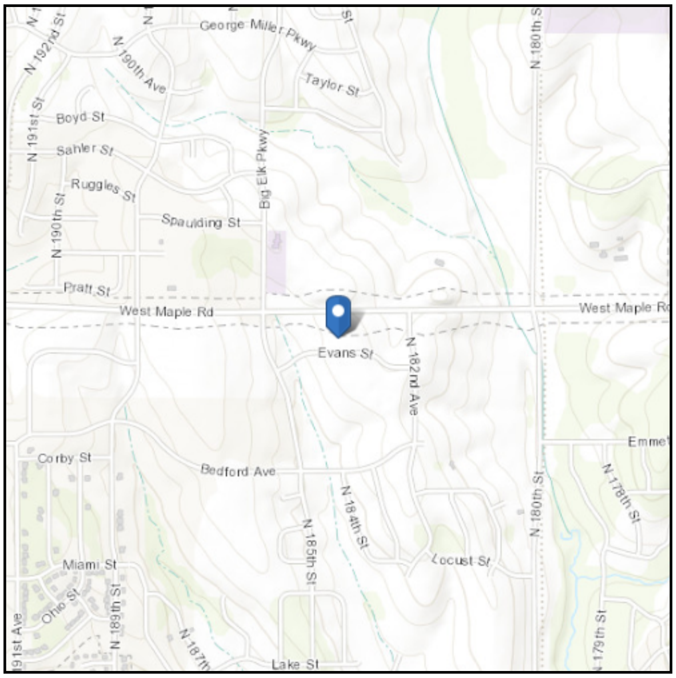
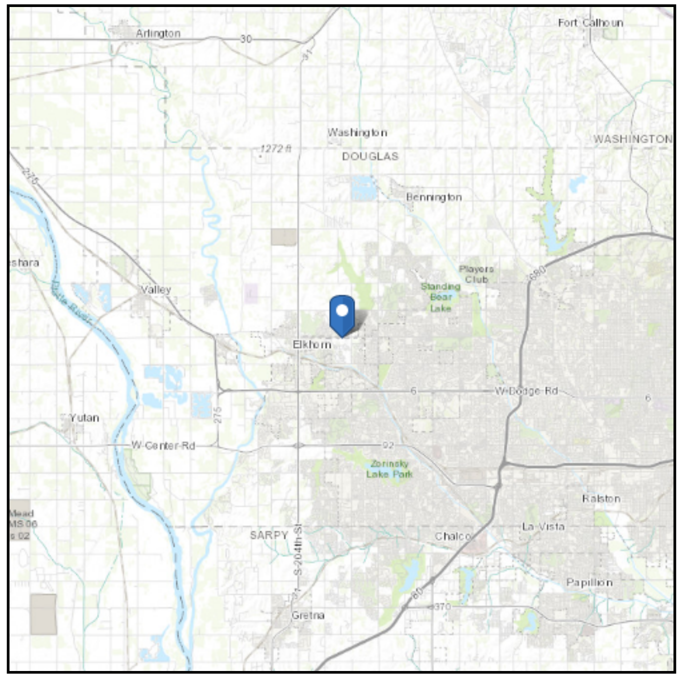
ASCE Hazards Report

Address:
No Address at This Location

Standard:	ASCE/SEI 7-16	**Latitude:**	41.291165
Risk Category:	I	**Longitude:**	-96.203629
Soil Class:	D - Default (see Section 11.4.3)	**Elevation:**	1249.7519344835305 ft (NAVD 88)





Wind

Results:

Wind Speed	105 Vmph
10-year MRI	77 Vmph
25-year MRI	85 Vmph
50-year MRI	90 Vmph
100-year MRI	96 Vmph

Data Source:	ASCE/SEI 7-16, Fig. 26.5-1A and Figs. CC.2-1–CC.2-4, and Section 26.5.2
Date Accessed:	Fri May 30 2025

Value provided is 3-second gust wind speeds at 33 ft above ground for Exposure C Category, based on linear interpolation between contours. Wind speeds are interpolated in accordance with the 7-16 Standard. Wind speeds correspond to approximately a 15% probability of exceedance in 50 years (annual exceedance probability = 0.00333, MRI = 300 years).

Site is not in a hurricane-prone region as defined in ASCE/SEI 7-16 Section 26.2.

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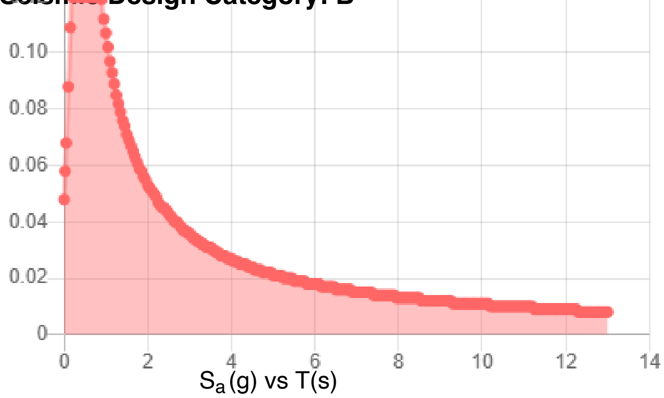
Seismic

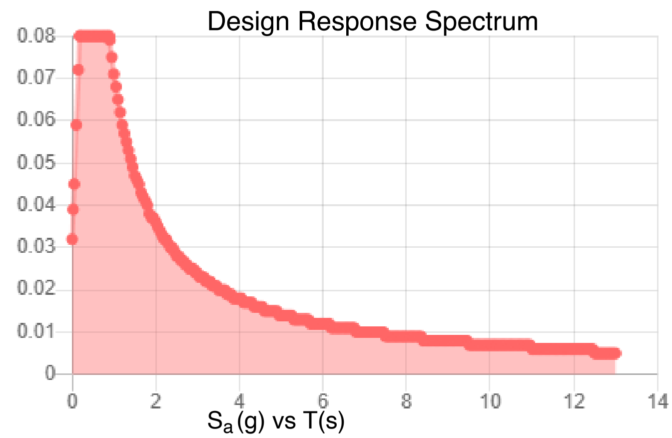
Site Soil Class: D - Default (see Section 11.4.3)

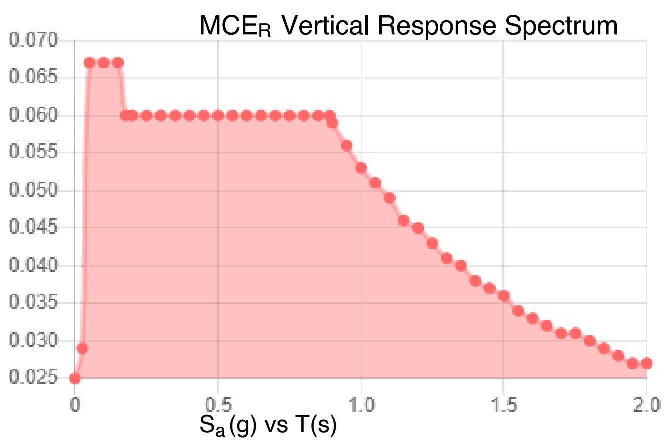
Results:

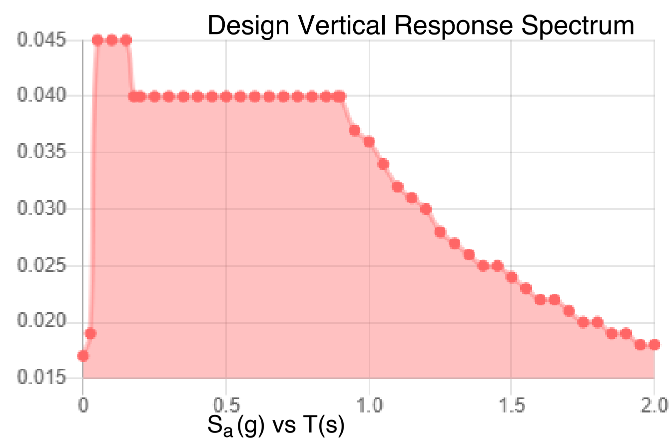
S_S :	0.075	S_{D1} :	0.071
S_1 :	0.045	T_L :	12
F_a :	1.6	PGA :	0.036
F_v :	2.4	PGA_M :	0.058
S_{MS} :	0.12	F_{PGA} :	1.6
S_{M1} :	0.107	I_e :	1
S_{DS} :	0.08	C_v :	0.7

Seismic Design Category: B









Data Accessed: **Fri May 30 2025**

Date Source:

USGS Seismic Design Maps based on ASCE/SEI 7-16 and ASCE/SEI 7-16 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-16 Ch. 21 are available from USGS.

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Ice

Results:

Ice Thickness:	1.50 in.
Concurrent Temperature:	-5 F
Gust Speed	40 mph
Data Source:	Standard ASCE/SEI 7-16, Figs. 10-2 through 10-8
Date Accessed:	Fri May 30 2025

Ice thicknesses on structures in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.

Values provided are equivalent radial ice thicknesses due to freezing rain with concurrent 3-second gust speeds, for a 500-year mean recurrence interval, and temperatures concurrent with ice thicknesses due to freezing rain. Thicknesses for ice accretions caused by other sources shall be obtained from local meteorological studies. Ice thicknesses in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.

Snow

Results:

Ground Snow Load, p_g :	25 lb/ft^2
Mapped Elevation:	1249.8 ft
Data Source:	ASCE/SEI 7-16, Table 7.2-8
Date Accessed:	Fri May 30 2025

Values provided are ground snow loads. In areas designated "case study required," extreme local variations in ground snow loads preclude mapping at this scale. Site-specific case studies are required to establish ground snow loads at elevations not covered.

Snow load values are mapped to a 0.5 mile resolution. This resolution can create a mismatch between the mapped elevation and the site-specific elevation in topographically complex areas. Engineers should consult the local authority having jurisdiction in locations where the reported ‘elevation’ and ‘mapped elevation’ differ significantly from each other.

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Half Palm Arch Vacuum Stanchion Canopy Analysis

Materials:

Aluminum: $\gamma_{al} := 173pcf = 0.1 \cdot pci$ $E_{al} := 10100ksi$ $G_{al} := 3800ksi$

Tube Extrusions, B211 6061-T6 $F_{ty} := 35ksi$ $F_{tu} := 42ksi$

$F_{cy} := F_{ty} = 35 \cdot ksi$

Steel: $E_s := 29000ksi$

Round HSS Tube Steel, ASTM A500-Gr.B, 50 KSI $f_{ya500} := 50.0 \cdot ksi$ $f_{ua500} := 62ksi$

Other Rolled Sections Plates, Angles,
and Bars ASTM A36 $f_{yA36} := 36.0ksi$

Bent Plate Trellis Connector Bar ASTM A1008 $f_{ya1008} := 41.3ksi$

Base Plates - ASTM A1018 $f_y := 53ksi$

SAE J429 Grade 5 Bolts $F_u := 150ksi$

Welds:

Carbon Steel to Carbon Steel $F_{u\_cs} := 70 \cdot ksi$

Carbon Steel ASD Safety factor $\Omega_{cs} := 2.0$

Area of weld $A_w := \left(\frac{\sqrt{2}}{2}\right) \cdot \left(\frac{D}{16}\right) \cdot l$

Allowable Loads:

Carbon to carbon $R_{c\_cs} := \frac{0.6}{\Omega_{cs}} \cdot F_{u\_cs} \cdot A_w$

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Half Palm Arch Vacuum Stanchion Canopy Analysis

Canopy Data:

Canopy Height $H_T := 11.0ft$

Average Spacing of Supports $B := 12.50ft$

Separator Dimensions $D_S := 1ft$ $L_S := 2ft$ $A_S := D_S \cdot L_S = 2\,ft^2$

Post Section Set : $A :=$ HSS 6.625 x 0.280

Mast & Support Arm Section Set : $B :=$ HSS 3.5 x 0.216

Dead and Live Loads:

Length of Canopy Tube $L_{canopy} := 14ft$

Canopy Tube Diameter $D_{canopy} := pprop_{2,B} \cdot in = 3.50 \cdot in$

Post Tube Diameter $D_{post} := prop_{2,A}\,in = 6.625 \cdot in$

Aluminum Trellis Geometry

$D_{cb} := 2.0in$ $l_{cb} := 2.0in$ $t_{cb} := 0.125in$

Area Calculation:

$A_{cb} := D_{cb} \cdot l_{cb} - \left[\left(D_{cb} - 2 \cdot t_{cb}\right)\left(l_{cb} - 2 \cdot t_{cb}\right) \right] = 0.94 \cdot in^2$ $w_{sw} := A_{cb} \cdot \gamma_{al} = 1.13 \cdot plf$

Length of Cross Bar $L_{cb} := 15.0ft$ <— Ref. Arch. Drawings

Cross Bar Spacing $S_{trellis} := 10.375in$

Number of Cross Bars $N_{bars} := 16$

Percent Solid $\alpha := D_{cb} \div S_{trellis} = 0.19$

Additional Loads

Trellis Dead Load

$$W_{DL} := \frac{\left(\gamma_{al} \cdot A_{cb} \cdot L_{cb} \cdot N_{bars}\right)}{L_{canopy}} = 19.31 \cdot plf$$ $W_{DL} = 19.31 \cdot plf$

Vacuum Eq. $P_{DLm} := 150lb$

6" Dia. Aluminum Vacuum Tube $w_{pipe} := 6.654plf$

$P_{DLp} := w_{pipe} \cdot B = 83.2\,lb$ $e := 15in$

$P_{DL} := P_{DLp} + P_{DLm} = 233.17\,lb$

Dead Load Moment - created by vacuum and aluminum tube $M_{DL} := P_{DL} \cdot e = 291.5\,ft \cdot lb$

Live Loads $w_{LL} := 20psf$

$W_{LL} := \max\left(B \cdot w_{LL} \cdot \alpha, 5psf \cdot B\right) = 62.5 \cdot plf$

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Seismic Loading   Non-Building Structure (ASCE Chp. 15)   Ref. Appendix for ATC Output

Importance Factor $I_e := 1.0$

Site Class $SC := \text{"D"}$

Mapped Acceleration Parameters
Ref. USGS Seismic Output $S_s := 0.075$ $S_1 := 0.045$

Site Amplification Factors
ASCE Table 11.4-1 & 11.4-2 $F_a := 1.6$ $F_v := 2.4$

Long-Period Transition $T_L := 12$

Site-Modified Spectral
Acceleration Values $S_{MS} := F_a \cdot S_s = 0.12$

$S_{M1} := F_v \cdot S_1 = 0.108$

Seismic Design Values $S_{DS} := \frac{2}{3} \cdot S_{MS} = 0.08$ $S_{D1} := \frac{2}{3} \cdot S_{M1} = 0.072$

Seismic Design Category   "B"

Response Modification Factor $R := 1.25$

Values for Approx. Period Parameters
ASCE Table 12.8-2 $C_t := 0.02$ $x := 0.75$

Approx. Fundamental Period $T_a := C_t \cdot \left(\frac{H_T}{ft}\right)^x = 0.121$

$T_s := \frac{S_{D1}}{S_{DS}} = 0.9$ $T := T_a = 0.121 <= 1.5 \cdot T_s = 1.35$

query = "USE EQUATIONS 12.8-2 THROUGH 12.8-6"

$$C_{smin} := \begin{vmatrix} \max(0.44 \cdot S_{DS} \cdot I_e, 0.01) \text{ if } S_1 < 0.6 \\ \max[0.44 \cdot S_{DS} \cdot I_e, 0.01, 0.5S_1 \div (R \div I_e)] \text{ otherwise} \end{vmatrix} = 0.035$$

$$C_{s1} := \frac{S_{DS}}{\left(\frac{R}{I_e}\right)} = 0.064 \qquad C_{smax} := \text{if}\left[T \le T_L, \frac{S_{D1}}{T \cdot \left(\frac{R}{I_e}\right)}, \frac{S_{D1} \cdot T_L}{T^2 \cdot \left(\frac{R}{I_e}\right)}\right] = 0.477$$

$$C_s := \text{if}(C_{smax} \ge C_{s1}, \text{if}(C_{s1} \le C_{smin}, C_{smin}, C_{s1}), C_{smax}) = 0.06$$

$$C_s := \begin{vmatrix} C_s \text{ if } \sum Q = 0 \\ C_{se} \text{ otherwise} \end{vmatrix} = 0.06$$

Use $C_s = 0.06$

Seismic Loading

Vertical Component Coefficient $C_{sy} := 0.2S_{DS} = 0.02$

Mechanical Dead Load $P_{DL} \cdot C_s = 15\,lb$ $P_{DL} \cdot 0.2 \cdot S_{DS} = 4\,lb$

Trellis Load $W_{DL} \cdot C_s = 1.2 \cdot plf$ $W_{DL} \cdot 0.2 \cdot S_{DS} = 0.31 \cdot plf$

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Wind Loading

Directional Procedure per ASCE 7-16, Chapter 27

3 Second Gust Speed (Ultimate)	$V := 105 \cdot mph$	$V_o := V \cdot mph^{-1}$
Risk Category	I	Table 1.5-1
Exposure Category	C	26.7
Height (average)	$h := H_T = 11\ ft$	
Velocity Pressure Exposure Coefficient	$K_z := 0.85$	Table 27.10-1
Topographic Factor	$K_{zt} := 1.0$	no topographic effects
Directionality Factor	$K_d := 0.85$	Table 26.6-1
Elevation Factor	$K_e := 1.0$	Table 26.9-1

Velocity Pressure $q_h := 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \cdot K_e \cdot V_o^{2} \cdot psf = 20.39 \cdot psf$ Eq. 26.10-1

Gust Effect Factor	$G := 0.85$	26.11
Width of Tributary =	$B_f := B = 12.50\ ft$	
Trellis Percent Solid	$\alpha = 0.19$	

Wind Load Analysis - Open Bldg, per Fig 27.3-4 & 27.3-5

Slope = $\theta := 0.0 \cdot deg$ $\Theta < 7.5$ deg Slope = $\theta := 24 \cdot deg$ $\Theta = 22.5$ deg

Wind Direction $\gamma = 0$ deg (Worst pressure coefficents applied)

Load Case A $C_{NW} := 1.2$ $C_{NL} := 0.3$

$pW := q_h \cdot G \cdot C_{NW}$ $pW = 20.8 \cdot psf$

$PWva := pW \cdot B_f \cdot \alpha$ $PWva = 50.1 \cdot plf$

$pL := q_h \cdot G \cdot C_{NL}$ $pL = 5.2 \cdot psf$

$PLva := pL \cdot B_f \cdot \alpha$ $PLva = 12.5 \cdot plf$

Load Case B $C_{NW} := -1.1$ $C_{NL} := -0.1$

$pW := q_h \cdot G \cdot C_{NW}$ $pW = -19.07 \cdot psf$

$PWvb := pW \cdot B_f \cdot \alpha$ $PWvb = -45.9 \cdot plf$

$pL := q_h \cdot G \cdot C_{NL}$ $pL = -1.73 \cdot psf$

$PLvb := pL \cdot B_f \cdot \alpha$ $PLvb = -4.2 \cdot plf$

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Wind Load Analysis - Open Bldg, per Fig 27.3-4 & 27.3-5

Slope = $\theta := 0.0 \cdot deg$ $\Theta < 7.5$ deg Slope = $\theta := 24 \cdot deg$ $\Theta = 22.5$ deg

Wind Direction γ = 180 deg (Worst pressure coefficents applied)

Load Case A $C_{NW} := 1.2$ $C_{NL} := 0.3$

$pW := q_h \cdot G \cdot C_{NW}$ $pW = 20.8 \cdot psf$

$PWva180 := pW \cdot B_f \cdot \alpha$ $PWva180 = 50.1 \cdot plf$

$pL := q_h \cdot G \cdot C_{NL}$ $pL = 5.2 \cdot psf$

$PLva180 := pL \cdot B_f \cdot \alpha$ $PLva180 = 12.5 \cdot plf$

Load Case B $C_{NW} := -1.1$ $C_{NL} := -0.1$

$pW := q_h \cdot G \cdot C_{NW}$ $pW = -19.07 \cdot psf$

$PWvb180 := pW \cdot B_f \cdot \alpha$ $PWvb180 = -45.9 \cdot plf$

$pL := q_h \cdot G \cdot C_{NL}$ $pL = -1.73 \cdot psf$

$PLvb180 := pL \cdot B_f \cdot \alpha$ $PLvb180 = -4.2 \cdot plf$

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Wind load on arch canopy members - Other Structures/Equipment, per Sec. 29.4

Post

Diameter $D_1 := prop_{2,A}\,in = 6.625 \cdot in$

Height to Depth Ratio $\frac{h}{D_1} = 19.92$

Round Coefficient Factor $D_1 \cdot ft^{-1} \cdot \sqrt{q_h \cdot psf^{-1}} = 2.49$

Wind force coefficient (Figure 29.4-1) $C_f := 1.2$

Design wind load normal to surface (Eq. 29.4-1) $q_w := q_h \cdot G \cdot C_f \cdot D_1 = 11.5 \cdot plf$

6.0" Diameter Tube

Diameter $D_2 := 6.0in$

Height to Depth Ratio $\frac{h}{D_2} = 22$

Round Coefficient Factor $D_2 \cdot ft^{-1} \cdot \sqrt{q_h \cdot psf^{-1}} = 2.26$

Wind force coefficient (Figure 29.4-1) $C_f := 1.2$

Design wind load normal to surface (Eq. 29.4-1) $q_w := q_h \cdot G \cdot C_f \cdot D_2 = 10.4 \cdot plf$

Lateral Wind Reaction due to Aluminum Pipe $F_{wa} := q_w \cdot B = 130\,lb$

Mast / Support Arm

Diameter $D_3 := pprop_{2,B}\,in = 3.5 \cdot in$

Height to Depth Ratio $\frac{h}{D_3} = 37.71$

Round Coefficient Factor $D_3 \cdot ft^{-1} \cdot \sqrt{q_h \cdot psf^{-1}} = 1.32$

Wind force coefficient (Figure 29.4-1) $C_f := 1.2$

Design wind load normal to surface (Eq. 29.4-1) $q_w := q_h \cdot G \cdot C_f \cdot D_3 = 6.1 \cdot plf$

Separator

Projected Area $A_S = 2\,ft^2$

Wind force coefficient (Figure 29.4-1) $C_f := 1.2$

Design wind load normal to surface (Eq. 29.4-1) $q_w := q_h \cdot G \cdot C_f \cdot A_S = 42\,lb$

$M := q_w \cdot e = 52\,ft \cdot lb$

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Ice Weight $\rho_i := 56pcf$

Importance Factor $I_i := 0.8$

Topographic Factor $K_{zt} = 1.0$

Height Factor $f_z := \left(\frac{H_T \cdot ft^{-1}}{33}\right)^{0.10} = 0.9$ (EQ. 10.4-4)

Equivalent Radial Ice Thickness $t := 1.5in$ (Fig. 10.4-2)

Design Ice Thickness $t_d := t \cdot I_i \cdot f_z \cdot K_{zt}^{0.35} = 1.08 \cdot in$ (EQ. 10.4-5)

Ice Cross Sectional Geometry

Post $A_{i1} := \pi \cdot t_d \cdot (D_1 + t_d) = 0.18 ft^2$ (EQ. 10.4-1)

$d_{i1} := D_1 + 2 \cdot t_d = 0.73 ft$

Load per foot $D_{i1} := A_{i1} \cdot \rho_i = 10.11 \cdot plf$

6.0" Diameter Tube $A_{i2} := \pi \cdot t_d \cdot (D_2 + t_d) = 0.17 ft^2$ (EQ. 10.4-1)

$d_{i2} := D_2 + 2 \cdot t_d = 0.68 ft$

Load per foot $D_{i2} := A_{i2} \cdot \rho_i = 9.29 \cdot plf$

$P_{i2} := D_{i2} \cdot B = 116.17 lb$

Mast / Support Arm $A_{i3} := \pi \cdot t_d \cdot (D_3 + t_d) = 0.11 ft^2$ (EQ. 10.4-1)

$d_{i3} := D_3 + 2 \cdot t_d = 0.47 ft$

Load per foot $D_{i3} := A_{i3} \cdot \rho_i = 6.01 \cdot plf$

Separator $A_{Si} := \pi \cdot t_d \cdot (D_S + t_d) = 0.31 ft^2$

$D_{Si} := D_S + t_d = 13.08 \cdot in$

$V_i := A_{Si} \cdot L_S \cdot \rho_i = 34.35 lb$ (EQ 10.4-2)

$M_i := V_i \cdot e = 42.94 ft \cdot lb$

$P_{DLi} := V_i + P_{i2} = 150.52 lb$

$M_{DLi} := M_i + P_{i2} \cdot e = 188.15 ft \cdot lb$

Aluminum Cross Bar $A_{cbi} := \pi \cdot t_d \cdot (D_{cb} + t_d) = 0.07 \cdot ft^2$ (EQ. 10-1)

$D_{cbi} := D_{cb} + 2 \cdot t_d = 4.15 \cdot in$

$D_{icb} := A_{cbi} \cdot \rho_i = 4.04 \cdot plf$

Load per foot of canopy $W_{cbi} := D_{icb} \cdot L_{cb} \div S_{trellis} = 70.08 \cdot plf$

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Wind Loading (Atmospheric Ice) Directional Procedure per ASCE 7-16, Chapter 27

3 Second Gust Speed (Ultimate) $V := 40 \cdot mph$ <- Per Fig. 10.4-2

Velocity Pressure $q_h := 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \cdot K_e \cdot V_o^2 \cdot psf = 2.96 \cdot psf$

Percent Solid (w/ice) $\alpha_i := D_{cbi} \div S_{trellis} = 0.4$

Wind Load Analysis - Open Bldg, per Fig 27.3-4 & 27.3-5

Slope = $\theta := 0.0 \cdot deg$ $\Theta < 7.5$ deg Slope = $\theta := 24 \cdot deg$ $\Theta = 22.5$ deg

Wind Direction $\gamma = 0$ deg (Worst pressure coefficents applied)

Load Case A $C_{NW} := 1.2$ $C_{NL} := 0.3$

$pW := q_h \cdot G \cdot C_{NW}$ $pW = 3.02 \cdot psf$

$PWvai := pW \cdot B_f \cdot \alpha_i$ $PWvai = 15.1 \cdot plf$

$pL := q_h \cdot G \cdot C_{NL}$ $pL = 0.75 \cdot psf$

$PLvai := pL \cdot B_f \cdot \alpha_i$ $PLvai = 3.8 \cdot plf$

Wind Load Analysis - Open Bldg, per Fig 27.3-4 & 27.3-5

Slope = $\theta := 0.0 \cdot deg$ $\Theta < 7.5$ deg Slope = $\theta := 24 \cdot deg$ $\Theta = 22.5$ deg

Wind Direction $\gamma = 180$ deg (Worst pressure coefficents applied)

Load Case A $C_{NW} := 1.2$ $C_{NL} := 0.3$

$pW := q_h \cdot G \cdot C_{NW}$ $pW = 3.02 \cdot psf$

$PWva180i := pW \cdot B_f \cdot \alpha_i$ $PWva180i = 15.1 \cdot plf$

$pL := q_h \cdot G \cdot C_{NL}$ $pL = 0.75 \cdot psf$

$PLva180i := pL \cdot B_f \cdot \alpha_i$ $PLva180i = 3.8 \cdot plf$

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F rensic Engineers
3600 E. University Dr, Suite1400
Ph enix, AZ 85034
(602) 438-2500

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Wind load on arch canopy members (+ ice cross section) - Other Structures/Equipment, per Sec. 29.4

Post

Diameter $d_{i1} = 8.78 \cdot in$

Height to Depth Ratio $\frac{h}{d_{i1}} = 15.04$

Round Coefficient Factor $d_{i1} \cdot ft^{-1} \cdot \sqrt{q_h \cdot psf^{-1}} = 1.26$

Wind force coefficient (Figure 29.4-1) $C_f := 1.2$

Design wind load normal to surface (Eq. 29.4-1) $q_w := q_h \cdot G \cdot C_f \cdot d_{i1} = 2.2 \cdot plf$

6.0" Diameter Tube

Diameter $d_{i2} = 8.15 \cdot in$

Height to Depth Ratio $\frac{h}{d_{i2}} = 16.2$

Round Coefficient Factor $d_{i2} \cdot ft^{-1} \cdot \sqrt{q_h \cdot psf^{-1}} = 1.17$

Wind force coefficient (Figure 29.4-1) $C_f := 1.2$

Design wind load normal to surface (Eq. 29.4-1) $q_w := q_h \cdot G \cdot C_f \cdot d_{i2} = 2.1 \cdot plf$

Lateral Wind Reaction due to Aluminum Pipe $F_{wa} := q_w \cdot B = 25.6\,lb$

Mast Arm / Support Arm

Diameter $d_{i3} = 5.65 \cdot in$

Height to Depth Ratio $\frac{h}{d_{i3}} = 23.36$

Round Coefficient Factor $d_{i3} \cdot ft^{-1} \cdot \sqrt{q_h \cdot psf^{-1}} = 0.81$

Wind force coefficient (Figure 29.4-1) $C_f := 1.2$

Design wind load normal to surface (Eq. 29.4-1) $q_w := q_h \cdot G \cdot C_f \cdot d_{i3} = 1.4 \cdot plf$

Separator

Projected Area $A_{Si} := D_{Si} \cdot 2ft = 2.18\,ft^2$

Wind force coefficient (Figure 29.4-1) $C_f := 1.2$

Design wind load normal to surface (Eq. 29.4-1) $q_w := q_h \cdot G \cdot C_f \cdot A_{Si} = 7\,lb$

$M := q_w \cdot e = 8\,ft \cdot lb$

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3600 E. University Dr, Suite1400
Ph enix, AZ 85034
(602) 438-2500

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Snow Load $\theta_s := 70deg$

Ground Snow Load	$p_g := 25psf$	
Exposure Factor	$C_e := 1.0$	ASCE 7-16 Table 7.3-1
Thermal Factor	$C_t := 1.2$	ASCE 7-16 Table 7.3-2
Importance Factor	$I_s := 0.8$	ASCE 7-16 Table 1.5-2
Flat Roof Snow Load	$p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g$	ASCE 7.3-1
Roof Snow Load	$P_{SL} := p_f = 16.8 \cdot psf$	

Min Roof Snow Load
$$P_{SLmin} := \begin{cases} 0 & \text{if } p_g = 0 \\ (I_s \cdot p_g) & \text{if } p_g < 20psf \\ (20psf \cdot I_s) & \text{otherwise} \end{cases} = 16 \cdot psf$$

$$p_f := \max(P_{SL}, P_{SLmin}, 0psf) = 16.8 \cdot psf$$

Snow Density
$$\gamma_s := \min(0.13p_g \div ft + 14pcf, 30pcf) = 17.25 \cdot pcf$$

Snow width (trapezoid)
$$x_s := (p_f \div \gamma_s) \div \tan(\theta_s) = 4.25 \cdot in$$

6.0" Diameter Tube (per ASCE 7-16 7.13)
$$P_{SLi2} := \begin{cases} B \cdot \left[\left(1.37 d_{i2}^2 \div 2\right) \cdot \gamma_s\right] & \text{if } d_{i2} \le \dfrac{0.73 p_f}{\gamma_s} \\ \left[B \cdot \left[\dfrac{d_{i2} + (d_{i2} - 2 \cdot x_s)}{2} \cdot p_f\right]\right] & \text{otherwise} \end{cases} = 68.14 \cdot lb$$

$$M_{SLi2} := P_{SLi2} \cdot e = 85.17 \, ft \cdot lb$$

Mast / Support Arm (per ASCE 7-16 7.13)
$$W_{SLi3} := \begin{cases} \left[\left(1.37 d_{i3}^2 \div 2\right) \cdot \gamma_s\right] & \text{if } d_{i3} \le \dfrac{0.73 p_f}{\gamma_s} \\ \left[\dfrac{d_{i3} + (d_{i3} - 2 \cdot x_s)}{2} \cdot p_f\right] & \text{otherwise} \end{cases} = 2.62 \cdot plf$$

Separator
$$P_{SLiS} := \frac{\pi \cdot D_S^2}{4} \cdot p_f = 13.191 \quad M_{SLiS} := P_{SLiS} \cdot e = 16.49 \, ft \cdot lb$$

Cross Bar
$$W_{SLcb} := \begin{cases} \dfrac{L_{cb}}{S_{trellis}} \cdot \left[\left(1.37 D_{cbi}^2 \div 2\right) \cdot \gamma_s\right] & \text{if } D_{cbi} \le \dfrac{0.73 p_f}{\gamma_s} \\ \dfrac{D_{cbi} + (D_{cbi} - 2 \cdot x_s)}{2} \cdot p_f \cdot \dfrac{L_{cb}}{S_{trellis}} & \text{otherwise} \end{cases} = 24.52 \cdot plf$$

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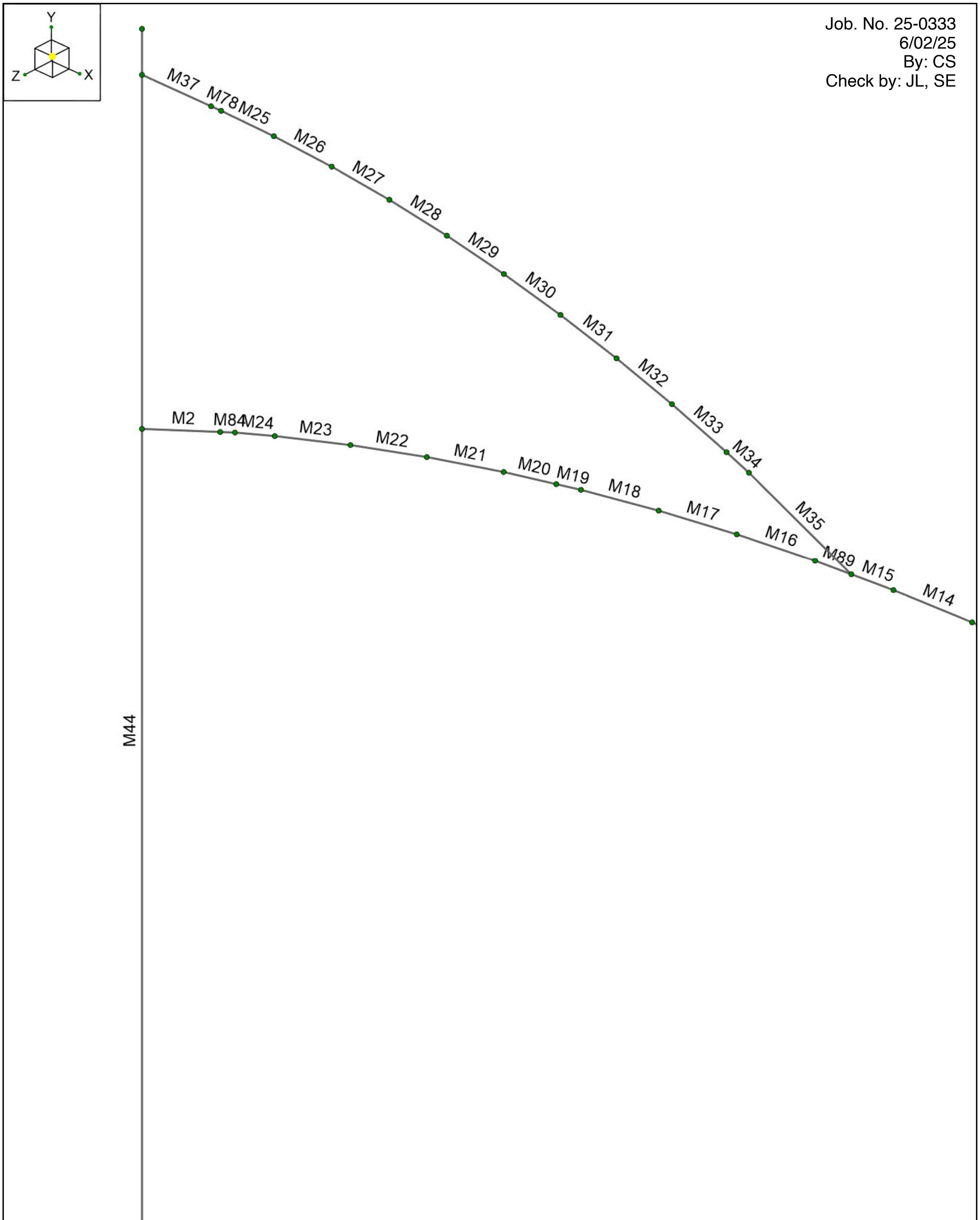
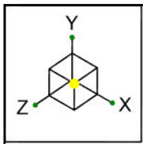


SML	Half Palm Arch	SK-1
C. Soare		Jun 02, 2025
25-0333		Half Palm - Trellis.r3d



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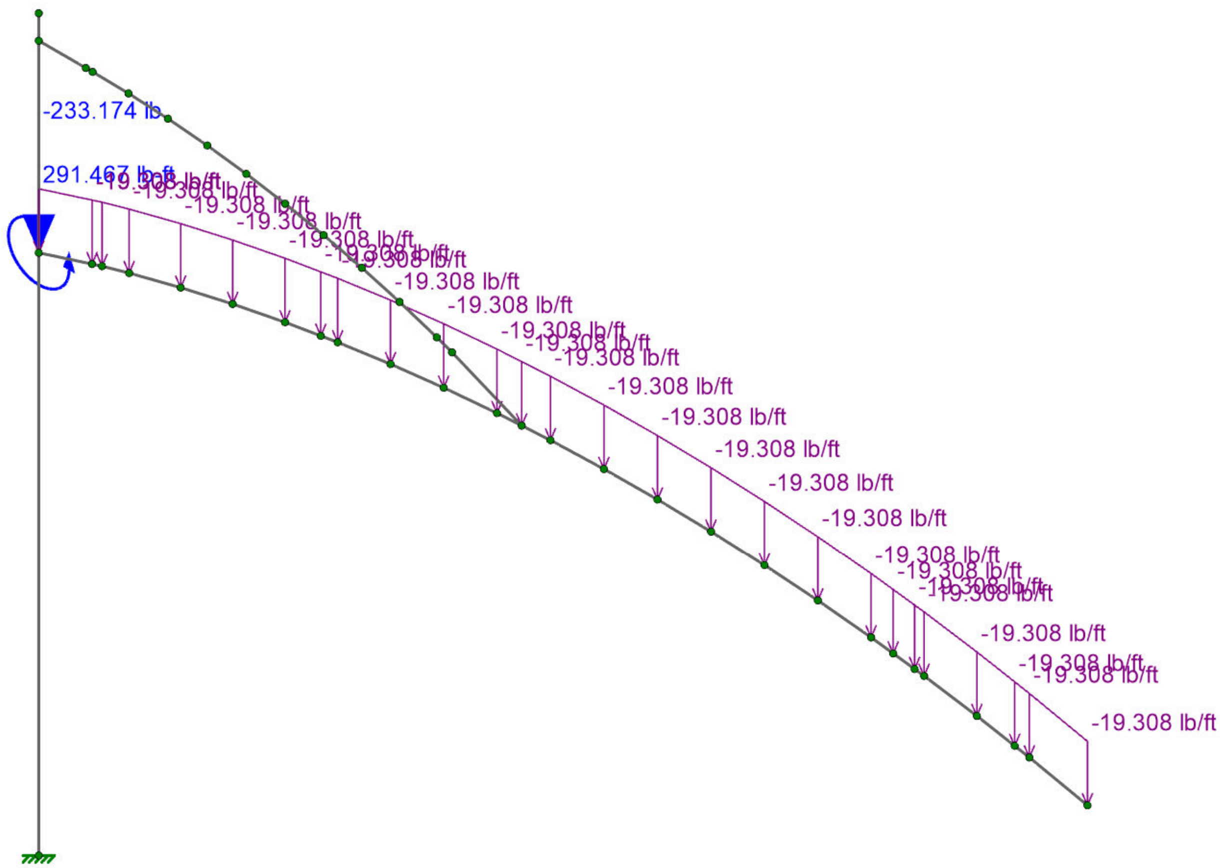

Loads: BLC 1, DL

SML	Half Palm Arch	SK-2
C. Soare		Jun 02, 2025
25-0333		Half Palm - Trellis.r3d

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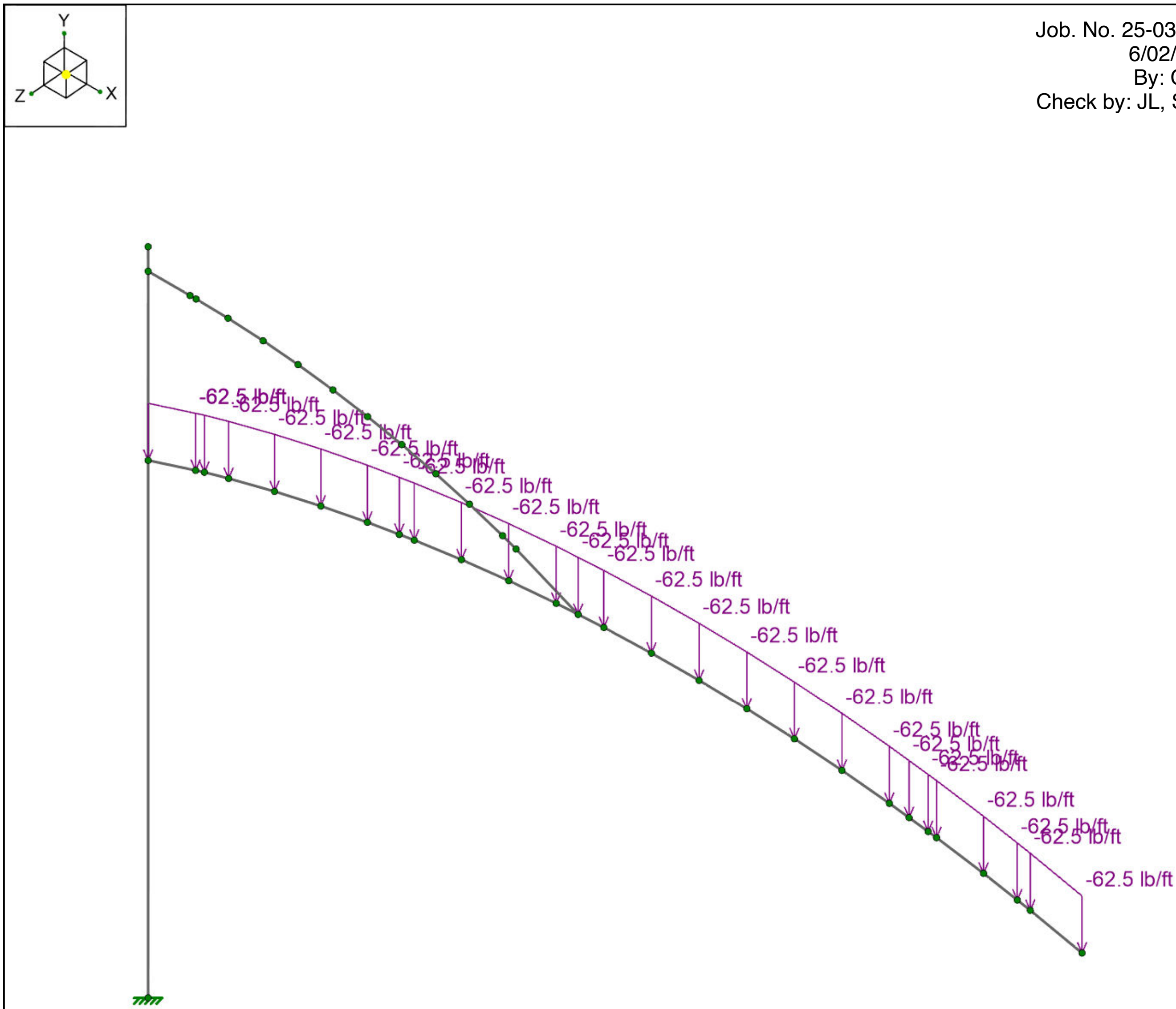

Loads: BLC 2, Lr

SML	Half Palm Arch	SK-3
C. Soare		Jun 02, 2025
25-0333		Half Palm - Trellis.r3d

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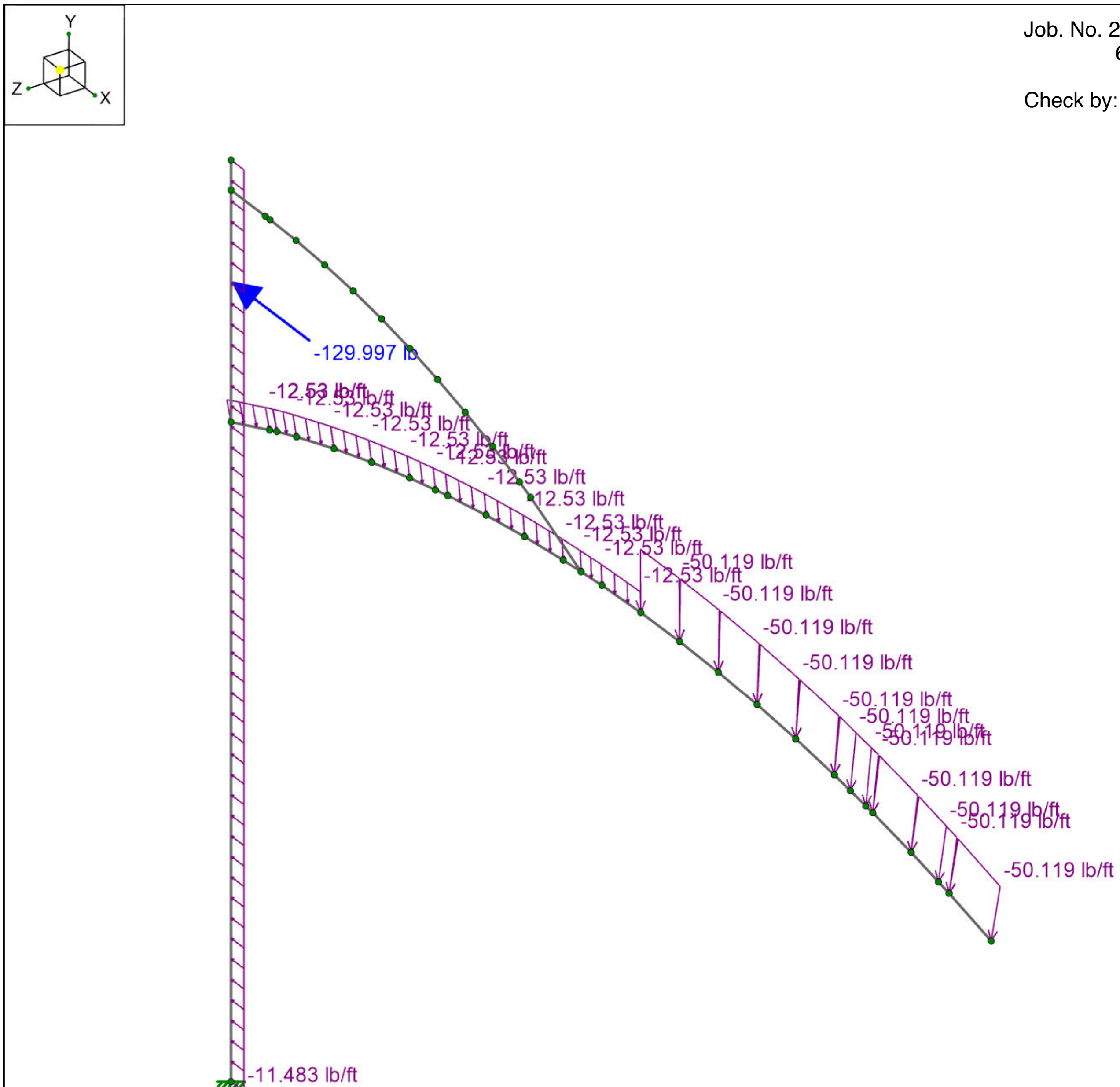

Loads: BLC 3, WL-A

SML	Half Palm Arch	SK-4
C. Soare		Jun 02, 2025
25-0333		Half Palm - Trellis.r3d

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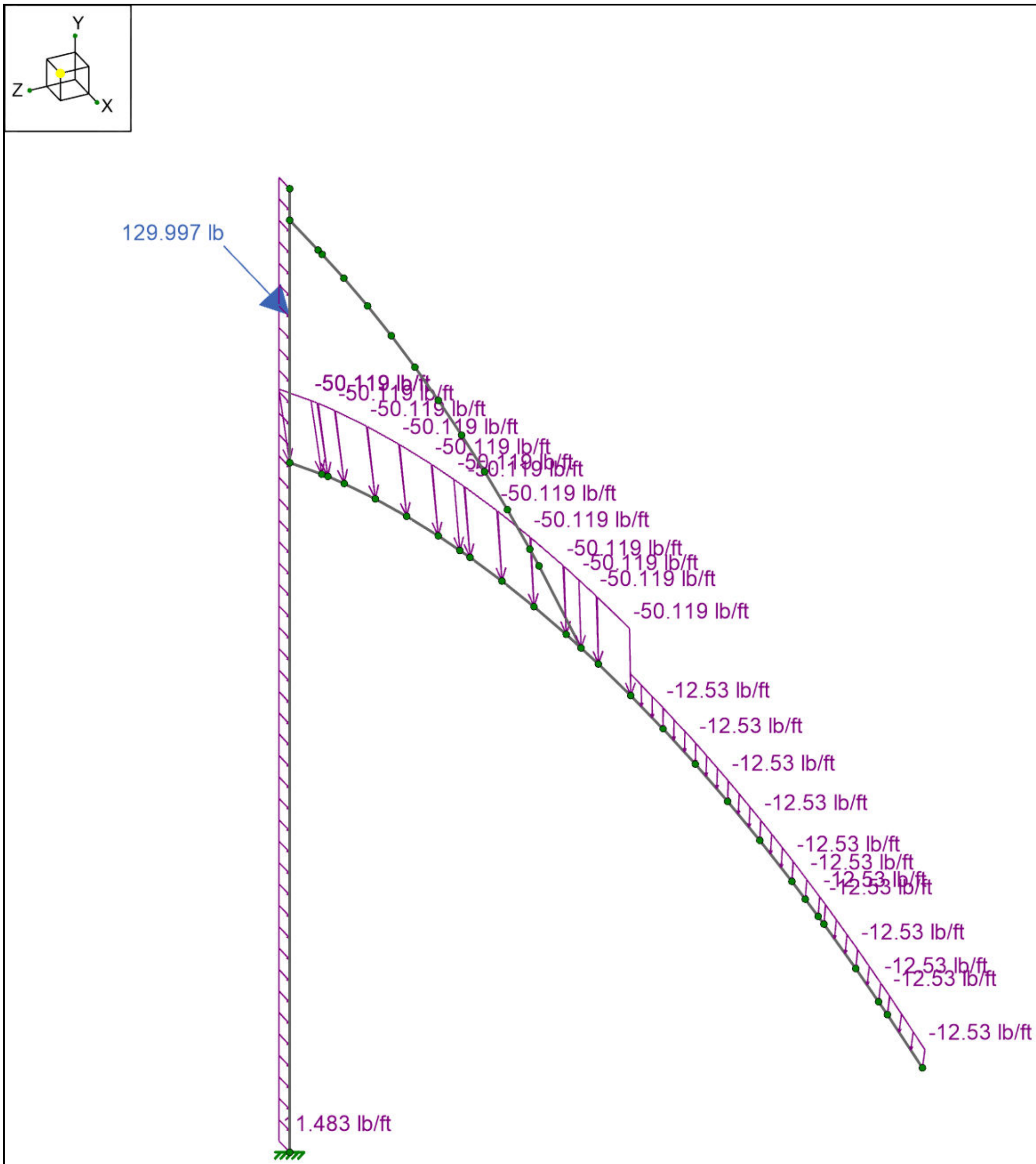
Check by: JL, SE



Loads: BLC 12, WA180

SML	Half Palm Arch	SK-13
C. Soare		Jun 02, 2025
25-0333		Half Palm - Trellis.r3d

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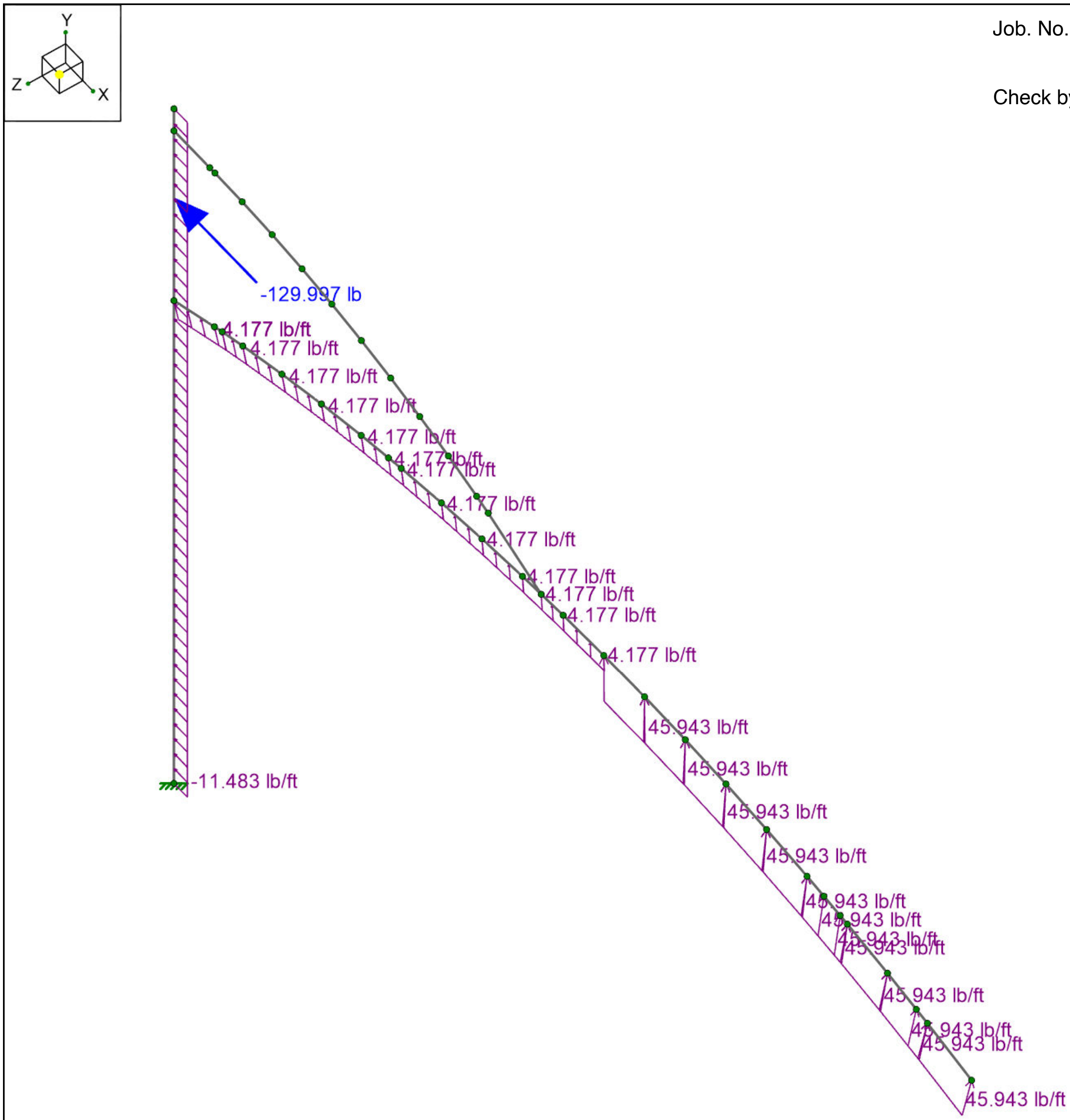
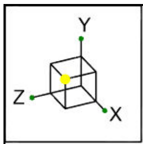


Loads: BLC 4, WL-B

SML	Half Palm Arch	SK-5
C. Soare		Jun 02, 2025
25-0333		Half Palm - Trellis.r3d



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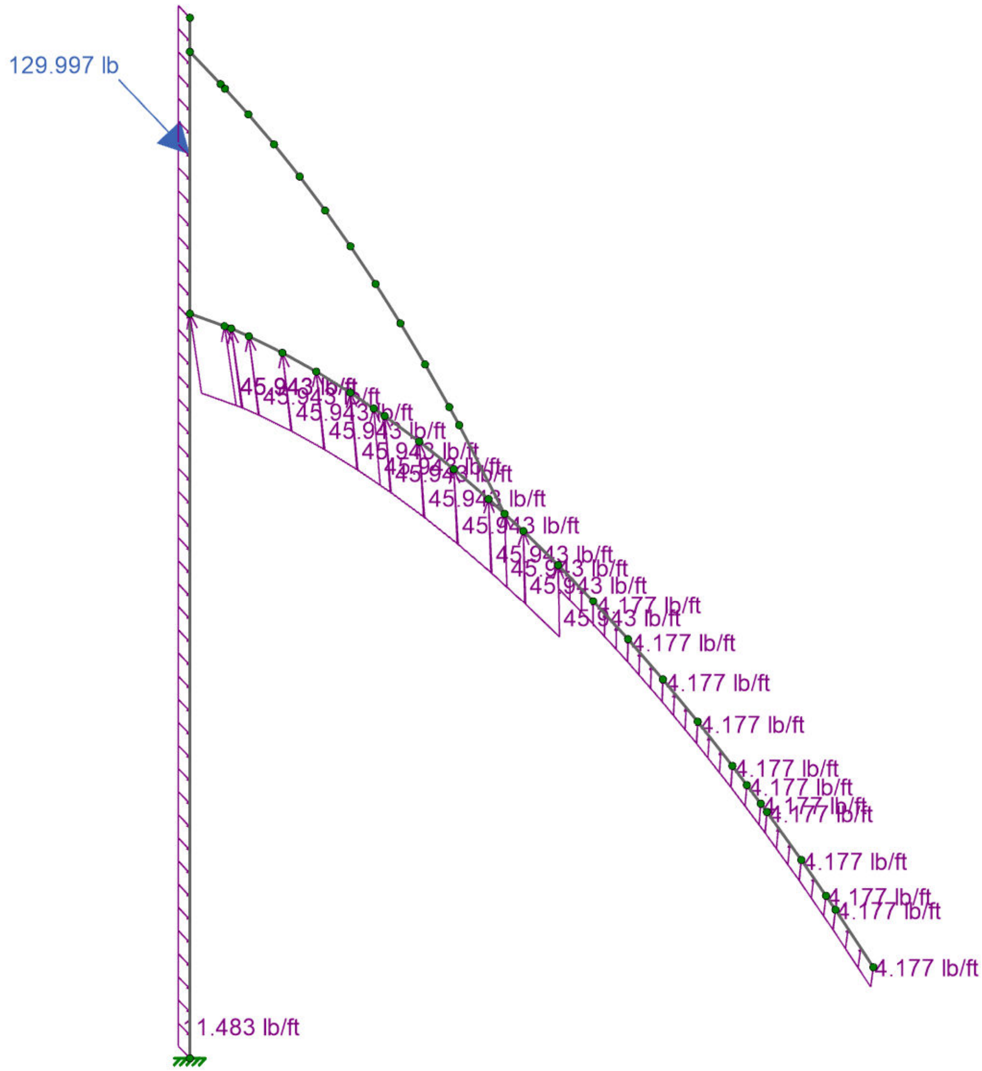

Loads: BLC 13, WB180

SML	Half Palm Arch	SK-14
C. Soare		Jun 02, 2025
25-0333		Half Palm - Trellis.r3d

Job. No. 25-0333
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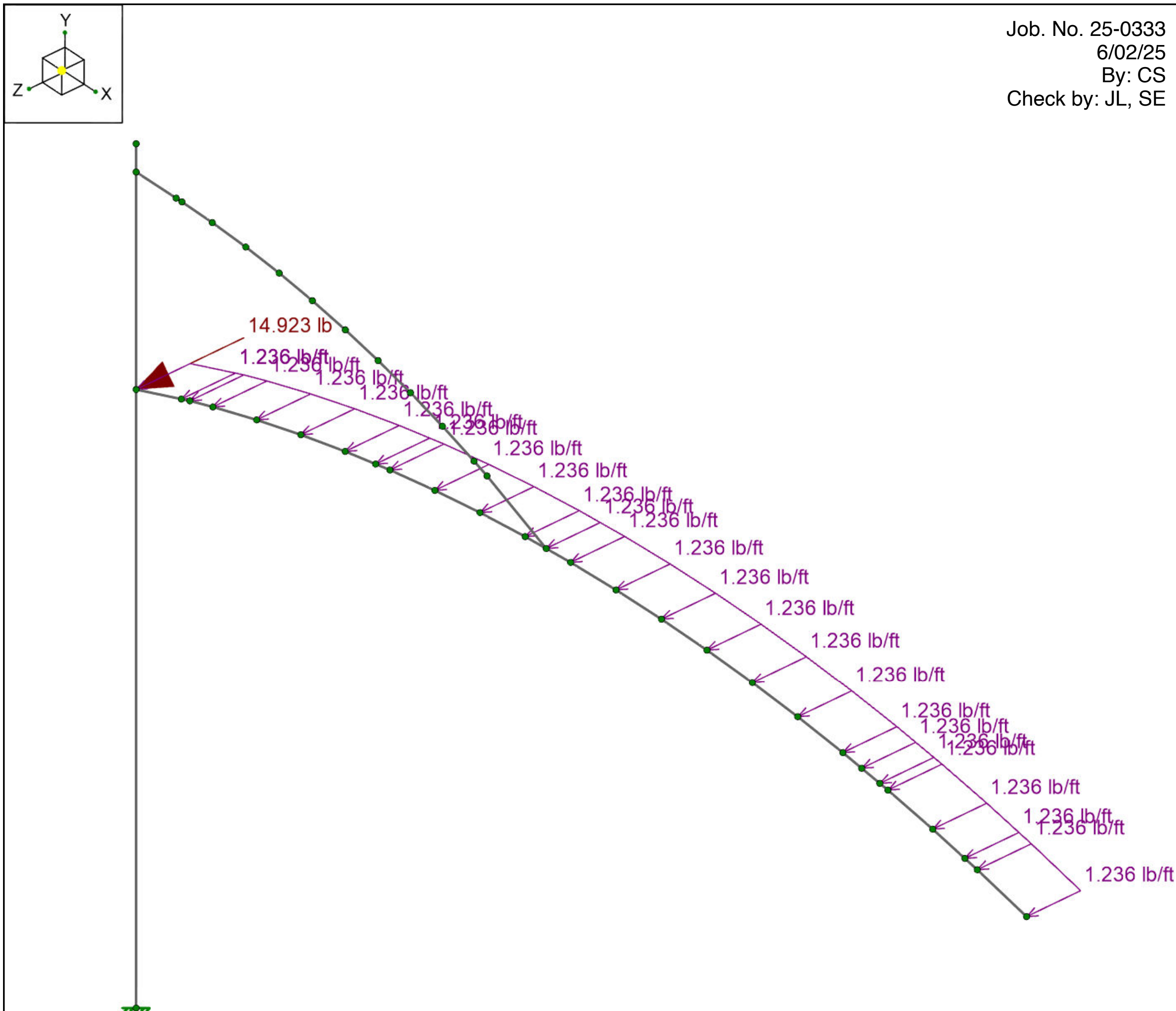

Loads: BLC 5, ELz

SML	Half Palm Arch	SK-6
C. Soare		Jun 02, 2025
25-0333		Half Palm - Trellis.r3d

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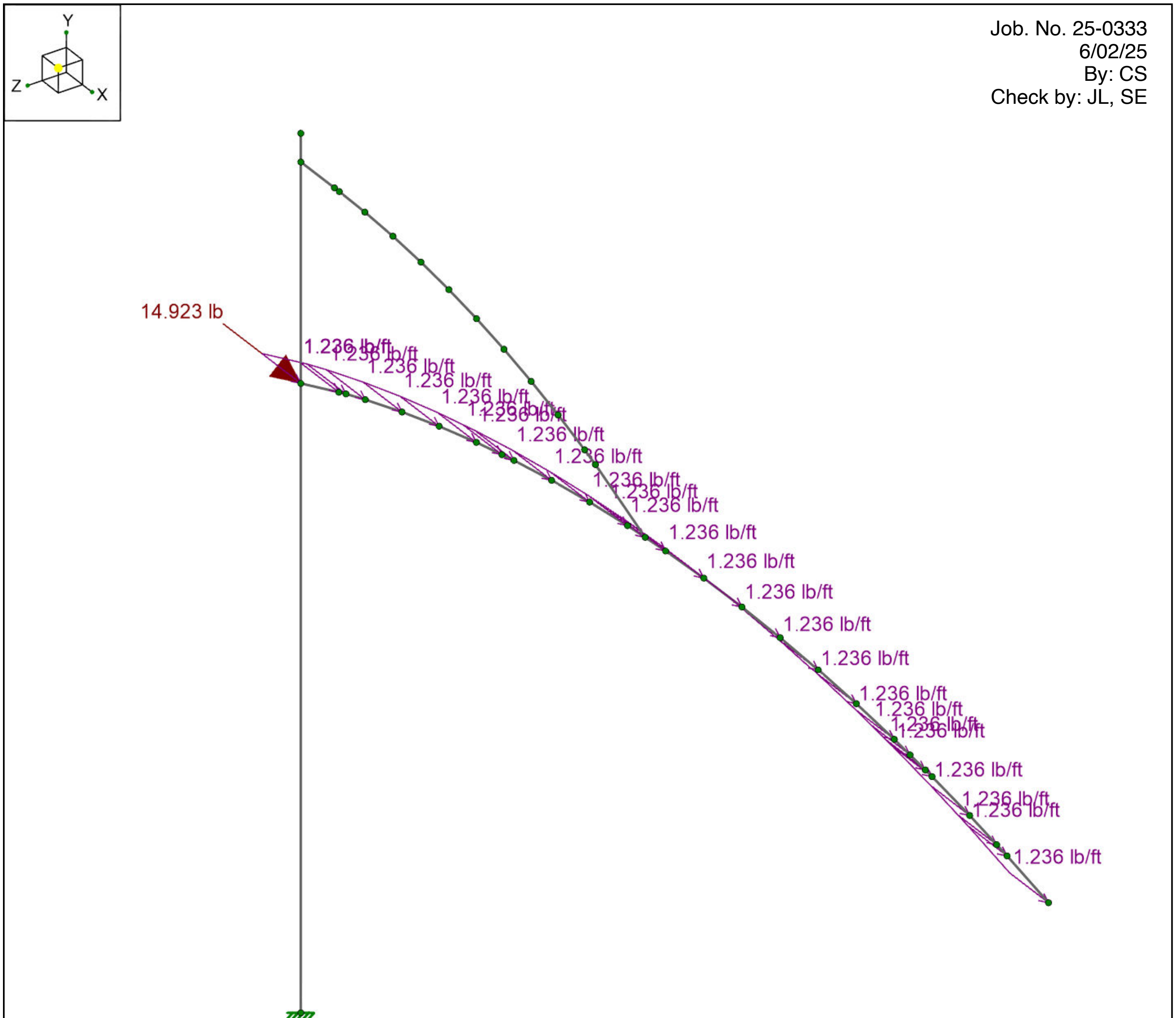
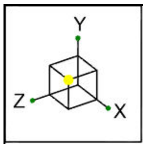


Loads: BLC 6, ELx

SML	Half Palm Arch	SK-7
C. Soare		Jun 02, 2025
25-0333		Half Palm - Trellis.r3d



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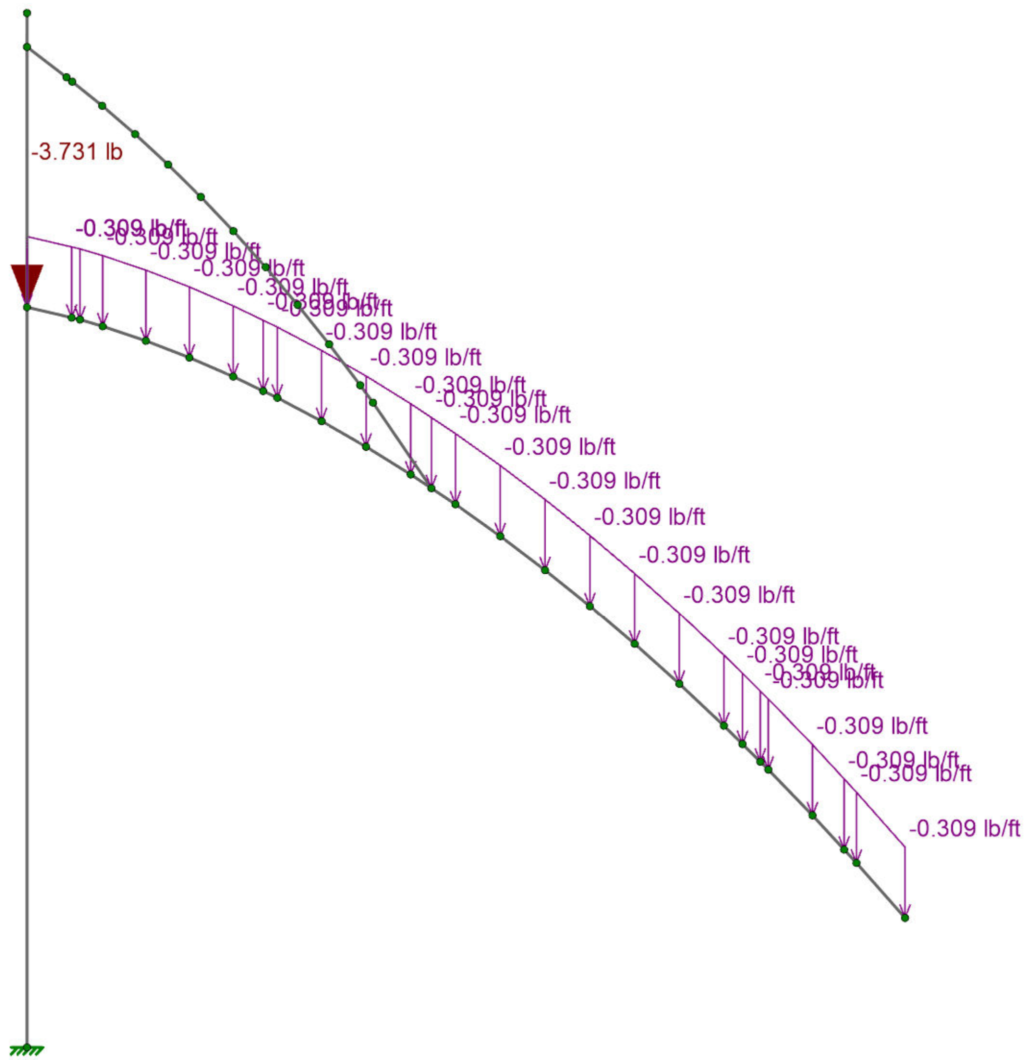
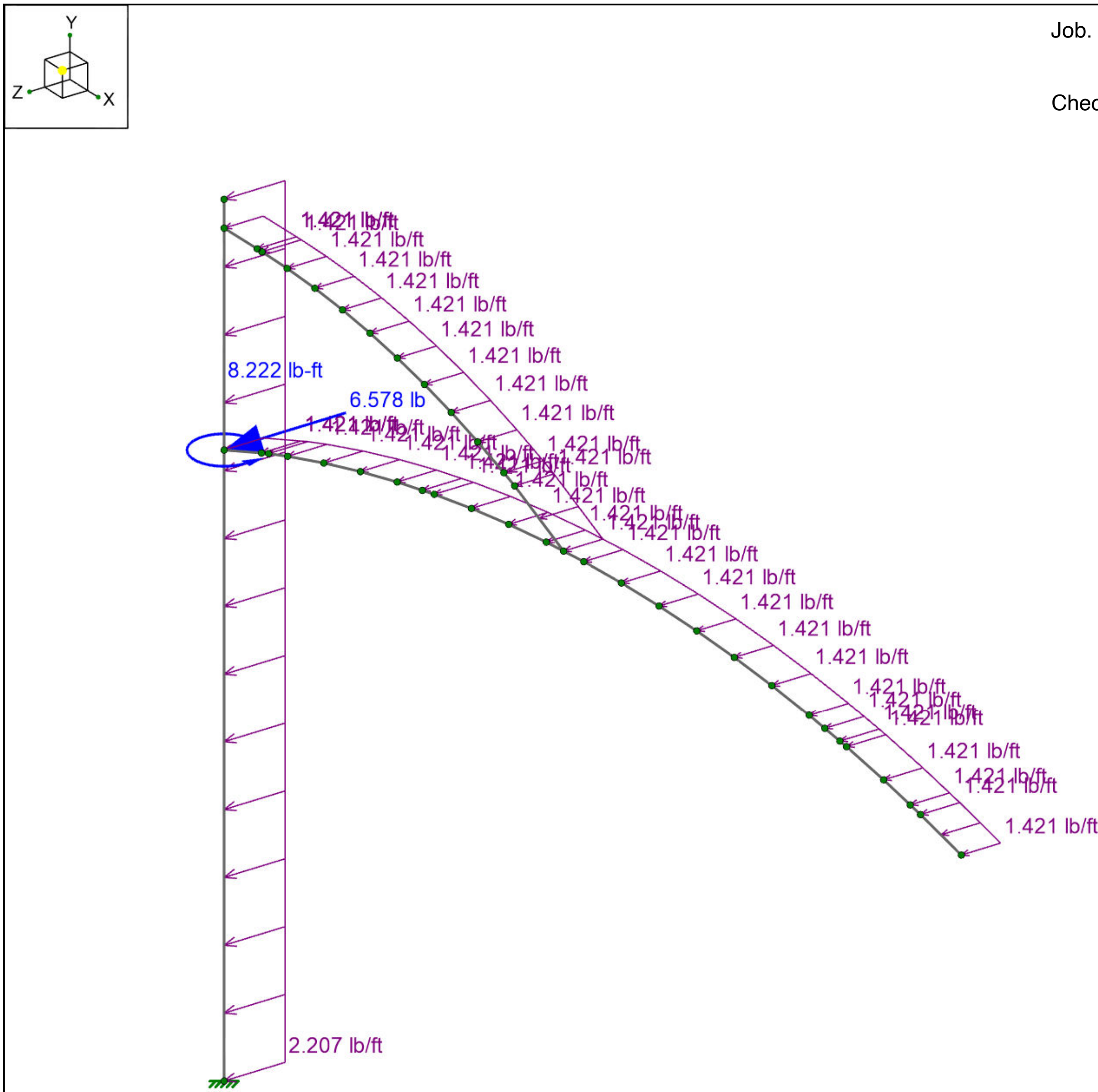


Loads: BLC 7, ELy

SML	Half Palm Arch	SK-8
C. Soare		Jun 02, 2025
25-0333		Half Palm - Trellis.r3d

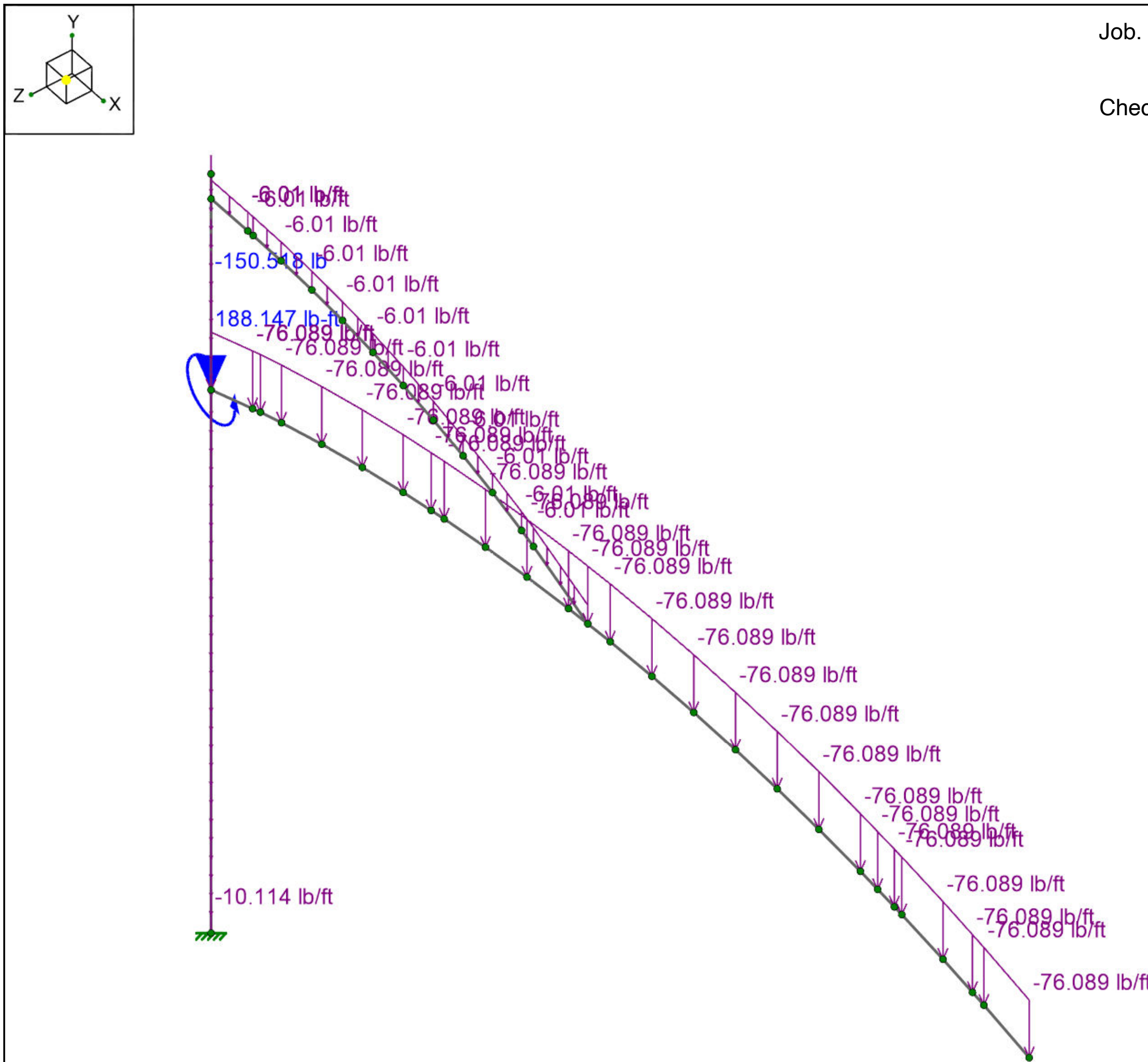
Job. No. 25-0333
6/02/25
By: CS
Check by: JL, SE



Loads: BLC 8, WL-Lat (w/ice)

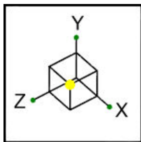
SML	Half Palm Arch	SK-9
C. Soare		Jun 02, 2025
25-0333		Half Palm - Trellis.r3d

Job. No. 25-0333
6/02/25
By: CS
Check by: JL, SE



Loads: BLC 9, DL-Ice

SML	Half Palm Arch	SK-10
C. Soare		Jun 02, 2025
25-0333		Half Palm - Trellis.r3d



Job. No. 25-0333
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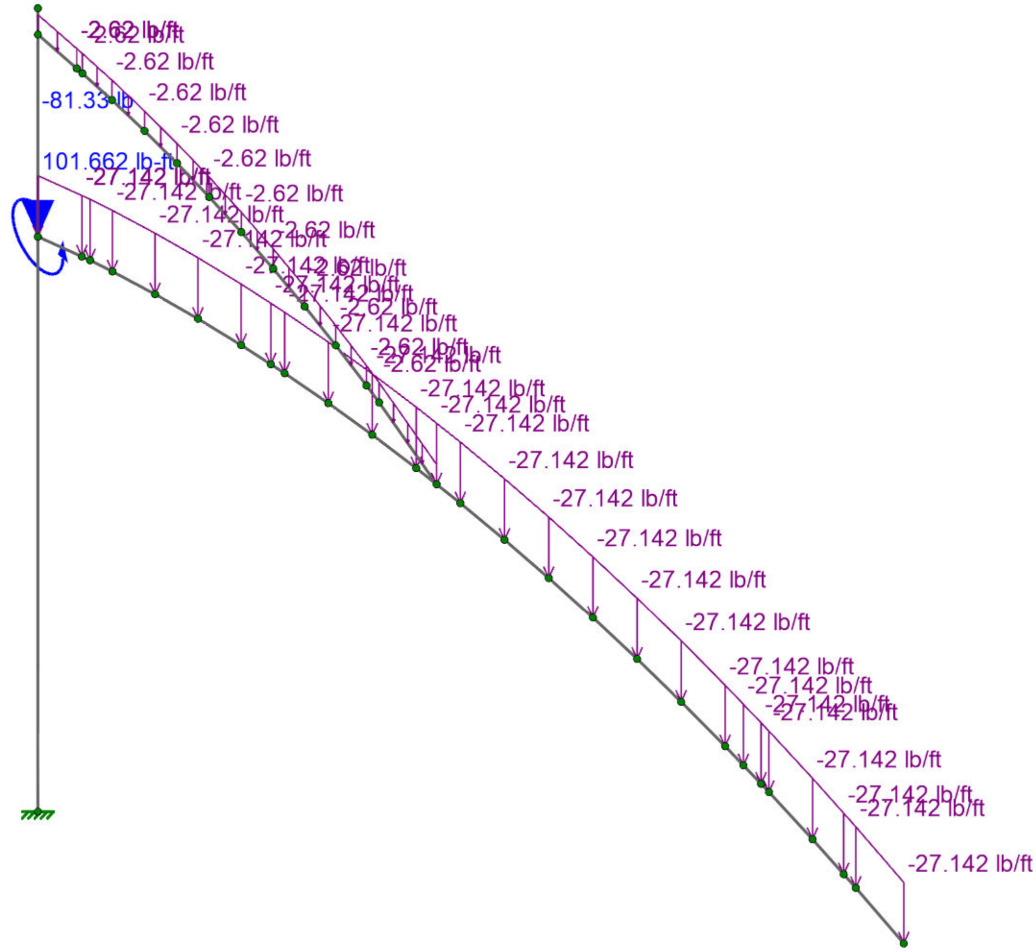

Loads: BLC 10, SL

SML	Half Palm Arch	SK-11
C. Soare		Jun 02, 2025
25-0333		Half Palm - Trellis.r3d

Job. No. 25-0333
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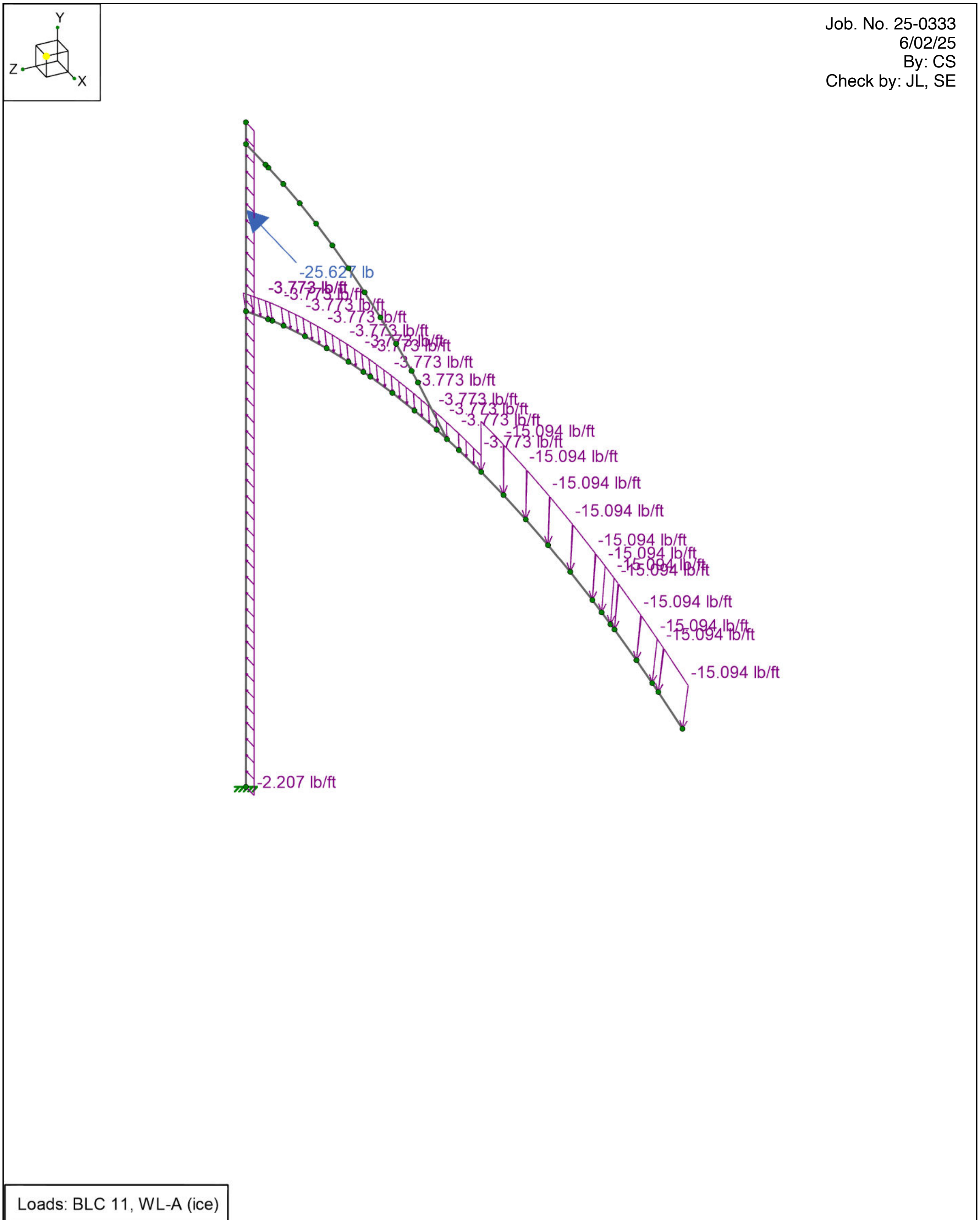

SML	Half Palm Arch	SK-12
C. Soare		Jun 02, 2025
25-0333		Half Palm - Trellis.r3d

Model Settings

Solution

Members

Number of Reported Sections	5
Number of Internal Sections	100
Member Area Load Mesh Size (in^2)	144
Consider Shear Deformation	Yes
Consider Torsional Warping	Yes

Wall Panels

Approximate Mesh Size (in)	24
Transfer Forces Between Intersecting Wood Walls	Yes
Increase Wood Wall Nailing Capacity for Wind Loads	Yes
Include P-Delta for Walls	Yes
Optimize Masonry and Wood Walls	Yes
Maximum Number of Iterations	3

Processor Core Utilization

Single	No
Multiple (Optimum)	Yes
Maximum	No

Axis

Vertical Global Axis

Global Axis corresponding to vertical direction	Y
Convert Existing Data	Yes

Default Member Orientation

Default Global Plane for z-axis	XZ

Plate Axis

Plate Local Axis Orientation	Global

Codes

Hot Rolled Steel	AISC 15th (360-16): ASD
Stiffness Adjustment	Yes (Iterative)
Notional Annex	None
Connections	AISC 14th (360-10): ASD
Cold Formed Steel	AISI S100-16: ASD
Stiffness Adjustment	Yes (Iterative)
Wood	AWC NDS-18: ASD
Temperature	< 100F
Concrete	ACI 318-19
Masonry	TMS 402-16: ASD
Aluminum	AA ADM1-15: ASD
Structure Type	Building
Stiffness Adjustment	Yes (Iterative)
Stainless	AISC 14th (360-10): ASD
Stiffness Adjustment	Yes (Iterative)

Concrete

Compression Stress Block	Rectangular Stress Block
Analyze using Cracked Sections	Yes
Leave room for horizontal rebar splices (2*d bar spacing)	Yes
List forces which were ignored for design in the Detail Report	Yes

Rebar

Column Min Steel	1
Column Max Steel	8
Rebar Material Spec	ASTM A615

Model Settings (Continued)

Warn if beam-column framing arrangement is not understood	No

Shear Reinforcement

Number of Shear Regions	4
Region 2 & 3 Spacing Increase Increment (in)	4

Seismic

RISA-3D Seismic Load Options

Code	ASCE 7-16
Risk Category	I or II
Drift Cat	Other
Base Elevation (ft)	
Include the weight of the structure in base shear calcs	Yes

Site Parameters

S_1 (g)	1
SD_1 (g)	1
SD_S (g)	1
T_L (sec)	5

Structure Characteristics

T Z (sec)	
T X (sec)	
C_tX	0.02
C_tExp. Z	0.75
C_tExp. X	0.75
R Z	3
R X	3
Ω_0Z	1
Ω_0X	1
C_dZ	4
C_dX	4
ρ Z	1
ρ X	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N2	0.709561	7.867119	0	
2	N3	13.964911	8.2789	0	
3	N4	13.191617	8.460171	0	
4	N5	12.996477	8.499721	0	
5	N6	12.492612	8.601843	0	
6	N7	11.789896	8.722772	0	
7	N8	11.083895	8.822891	0	
8	N9	10.375142	8.902121	0	
9	N10	9.664405	8.960372	0	
10	N11	8.952411	8.997593	0	
11	N12	8.239454	9.01377	0	
12	N13	7.52631	9.008875	0	
13	N14	6.813757	8.982918	0	
14	N15	6.102226	8.935918	0	
15	N16	5.392305	8.86791	0	
16	N17	4.684768	8.778965	0	
17	N18	3.980283	8.669175	0	
18	N19	3.756128	8.627424	0	
19	N20	3.279194	8.538592	0	
20	N21	2.582262	8.387352	0	
21	N22	1.890223	8.215617	0	
22	N23	1.203913	8.023613	0	
23	N24	0.842727	7.913189	0	
24	N25	0.717749	10.299381	0	
25	N26	1.195249	10.2886	0	
26	N27	1.720028	10.257073	0	
27	N28	2.243279	10.204501	0	
28	N29	2.763961	10.130983	0	
29	N30	3.281316	10.036627	0	
30	N31	3.794415	9.921602	0	
31	N32	4.302541	9.78607	0	
32	N33	4.804756	9.63028	0	
33	N34	5.299743	9.45467	0	
34	N40	5.502786	9.376363	0	
35	N41	6.430773	8.95762	0	
36	N44	0	10.647485	0	
37	N45	0	0	0	
38	N46	0.626983	10.299406	0	
39	N47	0	10.299406	0	
40	N48	11.663294	8.740725	0	
41	N49	11.378549	8.781106	0	
42	N51	0	7.621065	0	

Node Boundary Conditions

	Node 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	N45	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction

Hot Rolled Steel Properties

	Label	E [psi]	G [psi]	Nu	Therm. Coeff. [1e⁵°F⁻¹]	Density [lb/ft³]	Yield [psi]	Ry	Fu [psi]	Rt
1	A992	2.9e+07	1.115e+07	0.3	0.65	490	49999.999	1.1	64999.999	1.1
2	A36 Gr.36	2.9e+07	1.115e+07	0.3	0.65	490	36000	1.5	58000	1.2
3	A572 Gr.50	2.9e+07	1.115e+07	0.3	0.65	490	49999.999	1.1	64999.999	1.1
4	A500 Gr.B RND	2.9e+07	1.115e+07	0.3	0.65	527	42000	1.4	58000	1.3
5	A500 Gr.B RECT	2.9e+07	1.115e+07	0.3	0.65	527	46000	1.4	58000	1.3
6	A500 Gr.C RND	2.9e+07	1.115e+07	0.3	0.65	527	46000	1.4	62000	1.3
7	A500 Gr.C RECT	2.9e+07	1.115e+07	0.3	0.65	527	50000	1.4	62000	1.3
8	A53 Gr.B	2.9e+07	1.115e+07	0.3	0.65	490	35000	1.6	60000	1.2
9	A1085	2.9e+07	1.115e+07	0.3	0.65	490	50000	1.4	65000	1.3
10	A913 Gr.65	2.9e+07	1.115e+07	0.3	0.65	490	65000	1.1	80000	1.1
11	A500 Gr.42	2.9e+07	1.115e+07	0.3	0.65	490	42000.001	1.4	58000	1.3

Hot Rolled Steel Properties (Continued)

	Label	E [psi]	G [psi]	Nu	Therm. Coeff. [1e⁵°F⁻¹]	Density [lb/ft³]	Yield [psi]	Ry	Fu [psi]	Rt
12	A500 Gr.46	2.9e+07	1.115e+07	0.3	0.65	490	46000.001	1.4	58000	1.3
13	A53 Gr. B	2.9e+07	1.115e+07	0.3	0.65	490	35000.001	1.5	60000	1.2
14	A500 Gr. 50	2.9e+07	1.115e+07	0.3	0.65	490	49999.999	1.5	58000	1.2

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in²]	Iyy [in⁴]	Izz [in⁴]	J [in⁴]
1	HR1	W10X33	Beam	Wide Flange	A992	Typical	9.71	36.6	171	0.583

Hot Rolled Steel Design Parameters

	Label	Shape	Length [ft]	Lb y-y [ft]	Lb z-z [ft]	Lcomp top [ft]	Lcomp bot [ft]	L-Torque [ft]	Function
1	M2	HSS3.500X0.216	0.751	0	0	0	0	0	Lateral
2	M3	HSS3.500X0.216	0.794	0	0	0	0	0	Lateral
3	M4	HSS3.500X0.216	0.199	0	0	0	0	0	Lateral
4	M5	HSS3.500X0.216	0.514	0	0	0	0	0	Lateral
5	M6	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
6	M7	HSS3.500X0.216	0.128	0	0	0	0	0	Lateral
7	M8	HSS3.500X0.216	0.298	0	0	0	0	0	Lateral
8	M9	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
9	M10	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
10	M11	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
11	M12	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
12	M13	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
13	M14	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
14	M15	HSS3.500X0.216	0.384	0	0	0	0	0	Lateral
15	M16	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
16	M17	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
17	M18	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
18	M19	HSS3.500X0.216	0.228	0	0	0	0	0	Lateral
19	M20	HSS3.500X0.216	0.485	0	0	0	0	0	Lateral
20	M21	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
21	M22	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
22	M23	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
23	M24	HSS3.500X0.216	0.378	0	0	0	0	0	Lateral
24	M25	HSS3.500X0.216	0.478	0	0	0	0	0	Lateral
25	M26	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
26	M27	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
27	M28	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
28	M29	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
29	M30	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
30	M31	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
31	M32	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
32	M33	HSS3.500X0.216	0.525	0	0	0	0	0	Lateral
33	M34	HSS3.500X0.216	0.218	0	0	0	0	0	Lateral
34	M35	HSS3.500X0.216	1.018	0	0	0	0	0	Lateral
35	M37	HSS3.500X0.216	0.627	0	0	0	0	0	Lateral
36	M38	HSS3.500X0.216	0.288	0	0	0	0	0	Lateral
37	M78	HSS3.500X0.216	0.091	0	0	0	0	0	Lateral
38	M84	HSS3.500X0.216	0.141	0	0	0	0	0	Lateral
39	M89	HSS3.500X0.216	0.329	0	0	0	0	0	Lateral
40	M44	HSS6.625X0.280	10.647	0	0	0	0	0	Lateral

Node Loads and Enforced Displacements (BLC 1 : DL)

	Node Label	L, D, M	Direction	Magnitude [(lb, lb-ft), (in, rad), (lb*s²/ft, lb*s²*ft)]
1	N51	L	Y	-233.174
2	N51	L	MZ	291.467

Node Loads and Enforced Displacements (BLC 5 : ELz)

	Node Label	L, D, M	Direction	Magnitude [(lb, lb-ft), (in, rad), (lb*s²/ft, lb*s²*ft)]
1	N51	L	Z	14.923

Node Loads and Enforced Displacements (BLC 6 : ELx)

	Node Label	L, D, M	Direction	Magnitude [(lb, lb-ft), (in, rad), (lb*s²/ft, lb*s²*ft)]
1	N51	L	X	14.923

Node Loads and Enforced Displacements (BLC 7 : ELy)

	Node Label	L, D, M	Direction	Magnitude [(lb, lb-ft), (in, rad), (lb*s²/ft, lb*s²*ft)]
1	N51	L	Y	-3.731

Node Loads and Enforced Displacements (BLC 8 : WL-Lat (w/ice))

	Node Label	L, D, M	Direction	Magnitude [(lb, lb-ft), (in, rad), (lb*s²/ft, lb*s²*ft)]
1	N51	L	Z	6.578
2	N51	L	MY	8.222

Node Loads and Enforced Displacements (BLC 9 : DL-Ice)

	Node Label	L, D, M	Direction	Magnitude [(lb, lb-ft), (in, rad), (lb*s²/ft, lb*s²*ft)]
1	N51	L	Y	-150.518
2	N51	L	MZ	188.147

Node Loads and Enforced Displacements (BLC 10 : SL)

	Node Label	L, D, M	Direction	Magnitude [(lb, lb-ft), (in, rad), (lb*s²/ft, lb*s²*ft)]
1	N51	L	Y	-81.33
2	N51	L	MZ	101.662

Member Point Loads (BLC 3 : WL-A)

	Member Label	Direction	Magnitude [lb, lb-ft]	Location [(ft, %)]
1	M44	X	-129.997	9.25

Member Point Loads (BLC 4 : WL-B)

	Member Label	Direction	Magnitude [lb, lb-ft]	Location [(ft, %)]
1	M44	X	-129.997	9.25

Member Point Loads (BLC 11 : WL-A (ice))

	Member Label	Direction	Magnitude [lb, lb-ft]	Location [(ft, %)]
1	M44	X	-25.627	9.25

Member Point Loads (BLC 12 : WA180)

	Member Label	Direction	Magnitude [lb, lb-ft]	Location [(ft, %)]
1	M44	X	129.997	9.25

Member Point Loads (BLC 13 : WB180)

	Member Label	Direction	Magnitude [lb, lb-ft]	Location [(ft, %)]
1	M44	X	129.997	9.25

Member Distributed Loads (BLC 1 : DL)

	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	M2	Y	-19.308	-19.308	0	0.751
2	M3	Y	-19.308	-19.308	0	0.794
3	M4	Y	-19.308	-19.308	0	0.199
4	M5	Y	-19.308	-19.308	0	0.514
5	M6	Y	-19.308	-19.308	0	0.713
6	M7	Y	-19.308	-19.308	0	0.128
7	M8	Y	-19.308	-19.308	0	0.298
8	M9	Y	-19.308	-19.308	0	0.713
9	M10	Y	-19.308	-19.308	0	0.713

Member Distributed Loads (BLC 1 : DL) (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, %)]
10	M11	Y	-19.308	-19.308	0	0.713
11	M12	Y	-19.308	-19.308	0	0.713
12	M13	Y	-19.308	-19.308	0	0.713
13	M14	Y	-19.308	-19.308	0	0.713
14	M15	Y	-19.308	-19.308	0	0.384
15	M16	Y	-19.308	-19.308	0	0.713
16	M17	Y	-19.308	-19.308	0	0.713
17	M18	Y	-19.308	-19.308	0	0.713
18	M19	Y	-19.308	-19.308	0	0.228
19	M20	Y	-19.308	-19.308	0	0.485
20	M21	Y	-19.308	-19.308	0	0.713
21	M22	Y	-19.308	-19.308	0	0.713
22	M23	Y	-19.308	-19.308	0	0.713
23	M24	Y	-19.308	-19.308	0	0.378
24	M38	Y	-19.308	-19.308	0	0.288
25	M84	Y	-19.308	-19.308	0	0.141
26	M89	Y	-19.308	-19.308	0	0.329

Member Distributed Loads (BLC 2 : Lr)

	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	M2	Y	-62.5	-62.5	0	0.751
2	M3	Y	-62.5	-62.5	0	0.794
3	M4	Y	-62.5	-62.5	0	0.199
4	M5	Y	-62.5	-62.5	0	0.514
5	M6	Y	-62.5	-62.5	0	0.713
6	M7	Y	-62.5	-62.5	0	0.128
7	M8	Y	-62.5	-62.5	0	0.298
8	M9	Y	-62.5	-62.5	0	0.713
9	M10	Y	-62.5	-62.5	0	0.713
10	M11	Y	-62.5	-62.5	0	0.713
11	M12	Y	-62.5	-62.5	0	0.713
12	M13	Y	-62.5	-62.5	0	0.713
13	M14	Y	-62.5	-62.5	0	0.713
14	M15	Y	-62.5	-62.5	0	0.384
15	M16	Y	-62.5	-62.5	0	0.713
16	M17	Y	-62.5	-62.5	0	0.713
17	M18	Y	-62.5	-62.5	0	0.713
18	M19	Y	-62.5	-62.5	0	0.228
19	M20	Y	-62.5	-62.5	0	0.485
20	M21	Y	-62.5	-62.5	0	0.713
21	M22	Y	-62.5	-62.5	0	0.713
22	M23	Y	-62.5	-62.5	0	0.713
23	M24	Y	-62.5	-62.5	0	0.378
24	M38	Y	-62.5	-62.5	0	0.288
25	M84	Y	-62.5	-62.5	0	0.141
26	M89	Y	-62.5	-62.5	0	0.329

Member Distributed Loads (BLC 3 : WL-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	M2	y	-12.53	-12.53	0	0.751
2	M84	y	-12.53	-12.53	0	0.141
3	M24	y	-12.53	-12.53	0	0.378
4	M23	y	-12.53	-12.53	0	0.713
5	M22	y	-12.53	-12.53	0	0.713
6	M21	y	-12.53	-12.53	0	0.713
7	M20	y	-12.53	-12.53	0	0.485
8	M19	y	-12.53	-12.53	0	0.228
9	M18	y	-12.53	-12.53	0	0.713
10	M17	y	-12.53	-12.53	0	0.713
11	M16	y	-12.53	-12.53	0	0.713

Member Distributed Loads (BLC 3 : WL-A) (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, %)]
12	M89	y	-12.53	-12.53	0	0.329
13	M15	y	-12.53	-12.53	0	0.384
14	M14	y	-12.53	-12.53	0	0.713
15	M13	y	-50.119	-50.119	0	0.713
16	M12	y	-50.119	-50.119	0	0.713
17	M11	y	-50.119	-50.119	0	0.713
18	M10	y	-50.119	-50.119	0	0.713
19	M9	y	-50.119	-50.119	0	0.713
20	M8	y	-50.119	-50.119	0	0.298
21	M38	y	-50.119	-50.119	0	0.288
22	M7	y	-50.119	-50.119	0	0.128
23	M6	y	-50.119	-50.119	0	0.713
24	M5	y	-50.119	-50.119	0	0.514
25	M4	y	-50.119	-50.119	0	0.199
26	M3	y	-50.119	-50.119	0	0.794
27	M44	X	-11.483	-11.483	0	10.647

Member Distributed Loads (BLC 4 : WL-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	M2	y	4.177	4.177	0	0.751
2	M84	y	4.177	4.177	0	0.141
3	M24	y	4.177	4.177	0	0.378
4	M23	y	4.177	4.177	0	0.713
5	M22	y	4.177	4.177	0	0.713
6	M21	y	4.177	4.177	0	0.713
7	M20	y	4.177	4.177	0	0.485
8	M19	y	4.177	4.177	0	0.228
9	M18	y	4.177	4.177	0	0.713
10	M17	y	4.177	4.177	0	0.713
11	M16	y	4.177	4.177	0	0.713
12	M89	y	4.177	4.177	0	0.329
13	M15	y	4.177	4.177	0	0.384
14	M14	y	4.177	4.177	0	0.713
15	M13	y	45.943	45.943	0	0.713
16	M12	y	45.943	45.943	0	0.713
17	M11	y	45.943	45.943	0	0.713
18	M10	y	45.943	45.943	0	0.713
19	M9	y	45.943	45.943	0	0.713
20	M8	y	45.943	45.943	0	0.298
21	M38	y	45.943	45.943	0	0.288
22	M7	y	45.943	45.943	0	0.128
23	M6	y	45.943	45.943	0	0.713
24	M5	y	45.943	45.943	0	0.514
25	M4	y	45.943	45.943	0	0.199
26	M3	y	45.943	45.943	0	0.794
27	M44	X	-11.483	-11.483	0	10.647

Member Distributed Loads (BLC 5 : ELz)

	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	M2	Z	1.236	1.236	0	0.751
2	M3	Z	1.236	1.236	0	0.794
3	M24	Z	1.236	1.236	0	0.378
4	M84	Z	1.236	1.236	0	0.141
5	M23	Z	1.236	1.236	0	0.713
6	M22	Z	1.236	1.236	0	0.713
7	M21	Z	1.236	1.236	0	0.713
8	M20	Z	1.236	1.236	0	0.485
9	M19	Z	1.236	1.236	0	0.228
10	M18	Z	1.236	1.236	0	0.713
11	M17	Z	1.236	1.236	0	0.713

Member Distributed Loads (BLC 5 : ELz) (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, %)]
12	M16	Z	1.236	1.236	0	0.713
13	M89	Z	1.236	1.236	0	0.329
14	M15	Z	1.236	1.236	0	0.384
15	M14	Z	1.236	1.236	0	0.713
16	M13	Z	1.236	1.236	0	0.713
17	M12	Z	1.236	1.236	0	0.713
18	M11	Z	1.236	1.236	0	0.713
19	M10	Z	1.236	1.236	0	0.713
20	M9	Z	1.236	1.236	0	0.713
21	M8	Z	1.236	1.236	0	0.298
22	M38	Z	1.236	1.236	0	0.288
23	M7	Z	1.236	1.236	0	0.128
24	M6	Z	1.236	1.236	0	0.713
25	M5	Z	1.236	1.236	0	0.514
26	M4	Z	1.236	1.236	0	0.199

Member Distributed Loads (BLC 6 : ELx)

	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	M2	X	1.236	1.236	0	0.751
2	M3	X	1.236	1.236	0	0.794
3	M24	X	1.236	1.236	0	0.378
4	M84	X	1.236	1.236	0	0.141
5	M23	X	1.236	1.236	0	0.713
6	M22	X	1.236	1.236	0	0.713
7	M21	X	1.236	1.236	0	0.713
8	M20	X	1.236	1.236	0	0.485
9	M19	X	1.236	1.236	0	0.228
10	M18	X	1.236	1.236	0	0.713
11	M17	X	1.236	1.236	0	0.713
12	M16	X	1.236	1.236	0	0.713
13	M89	X	1.236	1.236	0	0.329
14	M15	X	1.236	1.236	0	0.384
15	M14	X	1.236	1.236	0	0.713
16	M13	X	1.236	1.236	0	0.713
17	M12	X	1.236	1.236	0	0.713
18	M11	X	1.236	1.236	0	0.713
19	M10	X	1.236	1.236	0	0.713
20	M9	X	1.236	1.236	0	0.713
21	M8	X	1.236	1.236	0	0.298
22	M38	X	1.236	1.236	0	0.288
23	M7	X	1.236	1.236	0	0.128
24	M6	X	1.236	1.236	0	0.713
25	M5	X	1.236	1.236	0	0.514
26	M4	X	1.236	1.236	0	0.199

Member Distributed Loads (BLC 7 : ELy)

	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	M2	Y	-0.309	-0.309	0	0.751
2	M3	Y	-0.309	-0.309	0	0.794
3	M24	Y	-0.309	-0.309	0	0.378
4	M84	Y	-0.309	-0.309	0	0.141
5	M23	Y	-0.309	-0.309	0	0.713
6	M22	Y	-0.309	-0.309	0	0.713
7	M21	Y	-0.309	-0.309	0	0.713
8	M20	Y	-0.309	-0.309	0	0.485
9	M19	Y	-0.309	-0.309	0	0.228
10	M18	Y	-0.309	-0.309	0	0.713
11	M17	Y	-0.309	-0.309	0	0.713
12	M16	Y	-0.309	-0.309	0	0.713
13	M89	Y	-0.309	-0.309	0	0.329

Member Distributed Loads (BLC 7 : ELy) (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, %)]
14	M15	Y	-0.309	-0.309	0	0.384
15	M14	Y	-0.309	-0.309	0	0.713
16	M13	Y	-0.309	-0.309	0	0.713
17	M12	Y	-0.309	-0.309	0	0.713
18	M11	Y	-0.309	-0.309	0	0.713
19	M10	Y	-0.309	-0.309	0	0.713
20	M9	Y	-0.309	-0.309	0	0.713
21	M8	Y	-0.309	-0.309	0	0.298
22	M38	Y	-0.309	-0.309	0	0.288
23	M7	Y	-0.309	-0.309	0	0.128
24	M6	Y	-0.309	-0.309	0	0.713
25	M5	Y	-0.309	-0.309	0	0.514
26	M4	Y	-0.309	-0.309	0	0.199

Member Distributed Loads (BLC 8 : WL-Lat (w/ice))

	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	M44	Z	2.207	2.207	0	10.647
2	M22	Z	1.421	1.421	0	0.713
3	M2	Z	1.421	1.421	0	0.751
4	M23	Z	1.421	1.421	0	0.713
5	M24	Z	1.421	1.421	0	0.378
6	M21	Z	1.421	1.421	0	0.713
7	M20	Z	1.421	1.421	0	0.485
8	M19	Z	1.421	1.421	0	0.228
9	M18	Z	1.421	1.421	0	0.713
10	M17	Z	1.421	1.421	0	0.713
11	M16	Z	1.421	1.421	0	0.713
12	M89	Z	1.421	1.421	0	0.329
13	M15	Z	1.421	1.421	0	0.384
14	M14	Z	1.421	1.421	0	0.713
15	M13	Z	1.421	1.421	0	0.713
16	M12	Z	1.421	1.421	0	0.713
17	M11	Z	1.421	1.421	0	0.713
18	M10	Z	1.421	1.421	0	0.713
19	M9	Z	1.421	1.421	0	0.713
20	M8	Z	1.421	1.421	0	0.298
21	M38	Z	1.421	1.421	0	0.288
22	M7	Z	1.421	1.421	0	0.128
23	M6	Z	1.421	1.421	0	0.713
24	M5	Z	1.421	1.421	0	0.514
25	M4	Z	1.421	1.421	0	0.199
26	M3	Z	1.421	1.421	0	0.794
27	M35	Z	1.421	1.421	0	1.018
28	M34	Z	1.421	1.421	0	0.218
29	M33	Z	1.421	1.421	0	0.525
30	M32	Z	1.421	1.421	0	0.526
31	M31	Z	1.421	1.421	0	0.526
32	M30	Z	1.421	1.421	0	0.526
33	M37	Z	1.421	1.421	0	0.627
34	M78	Z	1.421	1.421	0	0.091
35	M25	Z	1.421	1.421	0	0.478
36	M26	Z	1.421	1.421	0	0.526
37	M27	Z	1.421	1.421	0	0.526
38	M28	Z	1.421	1.421	0	0.526
39	M29	Z	1.421	1.421	0	0.526
40	M84	Z	1.421	1.421	0	0.141

Member Distributed Loads (BLC 9 : DL-Ice)

	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	M2	Y	-76.089	-76.089	0	0.751
2	M3	Y	-76.089	-76.089	0	0.794
3	M4	Y	-76.089	-76.089	0	0.199
4	M5	Y	-76.089	-76.089	0	0.514
5	M6	Y	-76.089	-76.089	0	0.713
6	M7	Y	-76.089	-76.089	0	0.128
7	M8	Y	-76.089	-76.089	0	0.298
8	M9	Y	-76.089	-76.089	0	0.713
9	M10	Y	-76.089	-76.089	0	0.713
10	M11	Y	-76.089	-76.089	0	0.713
11	M12	Y	-76.089	-76.089	0	0.713
12	M13	Y	-76.089	-76.089	0	0.713
13	M14	Y	-76.089	-76.089	0	0.713
14	M15	Y	-76.089	-76.089	0	0.384
15	M16	Y	-76.089	-76.089	0	0.713
16	M17	Y	-76.089	-76.089	0	0.713
17	M18	Y	-76.089	-76.089	0	0.713
18	M19	Y	-76.089	-76.089	0	0.228
19	M20	Y	-76.089	-76.089	0	0.485
20	M21	Y	-76.089	-76.089	0	0.713
21	M22	Y	-76.089	-76.089	0	0.713
22	M23	Y	-76.089	-76.089	0	0.713
23	M24	Y	-76.089	-76.089	0	0.378
24	M38	Y	-76.089	-76.089	0	0.288
25	M84	Y	-76.089	-76.089	0	0.141
26	M89	Y	-76.089	-76.089	0	0.329
27	M44	Y	-10.114	-10.114	0	10.647
28	M37	Y	-6.01	-6.01	0	0.627
29	M78	Y	-6.01	-6.01	0	0.091
30	M25	Y	-6.01	-6.01	0	0.478
31	M26	Y	-6.01	-6.01	0	0.526
32	M27	Y	-6.01	-6.01	0	0.526
33	M28	Y	-6.01	-6.01	0	0.526
34	M29	Y	-6.01	-6.01	0	0.526
35	M30	Y	-6.01	-6.01	0	0.526
36	M31	Y	-6.01	-6.01	0	0.526
37	M32	Y	-6.01	-6.01	0	0.526
38	M33	Y	-6.01	-6.01	0	0.525
39	M34	Y	-6.01	-6.01	0	0.218
40	M35	Y	-6.01	-6.01	0	1.018

Member Distributed Loads (BLC 10 : SL)

	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	M25	Y	-2.62	-2.62	0	0.478
2	M26	Y	-2.62	-2.62	0	0.526
3	M27	Y	-2.62	-2.62	0	0.526
4	M28	Y	-2.62	-2.62	0	0.526
5	M29	Y	-2.62	-2.62	0	0.526
6	M30	Y	-2.62	-2.62	0	0.526
7	M31	Y	-2.62	-2.62	0	0.526
8	M32	Y	-2.62	-2.62	0	0.526
9	M33	Y	-2.62	-2.62	0	0.525
10	M34	Y	-2.62	-2.62	0	0.218
11	M35	Y	-2.62	-2.62	0	1.018
12	M37	Y	-2.62	-2.62	0	0.627
13	M78	Y	-2.62	-2.62	0	0.091
14	M2	Y	-27.142	-27.142	0	0.751
15	M3	Y	-27.142	-27.142	0	0.794
16	M4	Y	-27.142	-27.142	0	0.199
17	M5	Y	-27.142	-27.142	0	0.514
18	M6	Y	-27.142	-27.142	0	0.713

Member Distributed Loads (BLC 10 : SL) (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, %)]
19	M7	Y	-27.142	-27.142	0	0.128
20	M8	Y	-27.142	-27.142	0	0.298
21	M9	Y	-27.142	-27.142	0	0.713
22	M10	Y	-27.142	-27.142	0	0.713
23	M11	Y	-27.142	-27.142	0	0.713
24	M12	Y	-27.142	-27.142	0	0.713
25	M13	Y	-27.142	-27.142	0	0.713
26	M14	Y	-27.142	-27.142	0	0.713
27	M15	Y	-27.142	-27.142	0	0.384
28	M16	Y	-27.142	-27.142	0	0.713
29	M17	Y	-27.142	-27.142	0	0.713
30	M18	Y	-27.142	-27.142	0	0.713
31	M19	Y	-27.142	-27.142	0	0.228
32	M20	Y	-27.142	-27.142	0	0.485
33	M21	Y	-27.142	-27.142	0	0.713
34	M22	Y	-27.142	-27.142	0	0.713
35	M23	Y	-27.142	-27.142	0	0.713
36	M24	Y	-27.142	-27.142	0	0.378
37	M38	Y	-27.142	-27.142	0	0.288
38	M84	Y	-27.142	-27.142	0	0.141
39	M89	Y	-27.142	-27.142	0	0.329

Member Distributed Loads (BLC 11 : WL-A (ice))

	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	M2	y	-3.773	-3.773	0	0.751
2	M84	y	-3.773	-3.773	0	0.141
3	M24	y	-3.773	-3.773	0	0.378
4	M23	y	-3.773	-3.773	0	0.713
5	M22	y	-3.773	-3.773	0	0.713
6	M21	y	-3.773	-3.773	0	0.713
7	M20	y	-3.773	-3.773	0	0.485
8	M19	y	-3.773	-3.773	0	0.228
9	M18	y	-3.773	-3.773	0	0.713
10	M17	y	-3.773	-3.773	0	0.713
11	M16	y	-3.773	-3.773	0	0.713
12	M89	y	-3.773	-3.773	0	0.329
13	M15	y	-3.773	-3.773	0	0.384
14	M14	y	-3.773	-3.773	0	0.713
15	M13	y	-15.094	-15.094	0	0.713
16	M12	y	-15.094	-15.094	0	0.713
17	M11	y	-15.094	-15.094	0	0.713
18	M10	y	-15.094	-15.094	0	0.713
19	M9	y	-15.094	-15.094	0	0.713
20	M8	y	-15.094	-15.094	0	0.298
21	M38	y	-15.094	-15.094	0	0.288
22	M7	y	-15.094	-15.094	0	0.128
23	M6	y	-15.094	-15.094	0	0.713
24	M5	y	-15.094	-15.094	0	0.514
25	M4	y	-15.094	-15.094	0	0.199
26	M3	y	-15.094	-15.094	0	0.794
27	M44	X	-2.207	-2.207	0	10.647

Member Distributed Loads (BLC 12 : WA180)

	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	M2	y	-50.119	-50.119	0	0.751
2	M84	y	-50.119	-50.119	0	0.141
3	M24	y	-50.119	-50.119	0	0.378
4	M23	y	-50.119	-50.119	0	0.713
5	M22	y	-50.119	-50.119	0	0.713
6	M21	y	-50.119	-50.119	0	0.713

Member Distributed Loads (BLC 12 : WA180) (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, %)]
7	M20	y	-50.119	-50.119	0	0.485
8	M19	y	-50.119	-50.119	0	0.228
9	M18	y	-50.119	-50.119	0	0.713
10	M17	y	-50.119	-50.119	0	0.713
11	M16	y	-50.119	-50.119	0	0.713
12	M89	y	-50.119	-50.119	0	0.329
13	M15	y	-50.119	-50.119	0	0.384
14	M14	y	-50.119	-50.119	0	0.713
15	M13	y	-12.53	-12.53	0	0.713
16	M12	y	-12.53	-12.53	0	0.713
17	M11	y	-12.53	-12.53	0	0.713
18	M10	y	-12.53	-12.53	0	0.713
19	M9	y	-12.53	-12.53	0	0.713
20	M8	y	-12.53	-12.53	0	0.298
21	M38	y	-12.53	-12.53	0	0.288
22	M7	y	-12.53	-12.53	0	0.128
23	M6	y	-12.53	-12.53	0	0.713
24	M5	y	-12.53	-12.53	0	0.514
25	M4	y	-12.53	-12.53	0	0.199
26	M3	y	-12.53	-12.53	0	0.794
27	M44	X	11.483	11.483	0	10.647

Member Distributed Loads (BLC 13 : WB180)

	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	M2	y	45.943	45.943	0	0.751
2	M84	y	45.943	45.943	0	0.141
3	M24	y	45.943	45.943	0	0.378
4	M23	y	45.943	45.943	0	0.713
5	M22	y	45.943	45.943	0	0.713
6	M21	y	45.943	45.943	0	0.713
7	M20	y	45.943	45.943	0	0.485
8	M19	y	45.943	45.943	0	0.228
9	M18	y	45.943	45.943	0	0.713
10	M17	y	45.943	45.943	0	0.713
11	M16	y	45.943	45.943	0	0.713
12	M89	y	45.943	45.943	0	0.329
13	M15	y	45.943	45.943	0	0.384
14	M14	y	45.943	45.943	0	0.713
15	M13	y	4.177	4.177	0	0.713
16	M12	y	4.177	4.177	0	0.713
17	M11	y	4.177	4.177	0	0.713
18	M10	y	4.177	4.177	0	0.713
19	M9	y	4.177	4.177	0	0.713
20	M8	y	4.177	4.177	0	0.298
21	M38	y	4.177	4.177	0	0.288
22	M7	y	4.177	4.177	0	0.128
23	M6	y	4.177	4.177	0	0.713
24	M5	y	4.177	4.177	0	0.514
25	M4	y	4.177	4.177	0	0.199
26	M3	y	4.177	4.177	0	0.794
27	M44	X	11.483	11.483	0	10.647

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Nodal	Point	Distributed
1	DL	None		-1		2		26
2	Lr	LL						26
3	WL-A	None					1	27
4	WL-B	None					1	27
5	ELz	None			0.06	1		26
6	ELx	None	0.06			1		26

Basic Load Cases (Continued)

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Nodal	Point	Distributed
7	ELy	None		-0.02		1		26
8	WL-Lat (w/ice)	None				2		40
9	DL-Ice	None				2		40
10	SL	None				2		39
11	WL-A (ice)	None					1	27
12	WA180	None					1	27
13	WB180	None					1	27

Load Combinations

	Description	Solve	PDelta	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	D	Yes	C	1	1						
2	D+Lr	Yes	C	1	1	2	1				
3	D + S	Yes	C	1	1	10	1				
4	D+0.6*WA	Yes	C	1	1	3	0.6				
5	D + 0.6WA180	Yes	C	1	1	12	0.6				
6	0.6*D+0.6*WB	Yes	C	1	0.6	4	0.6				
7	0.6D + 0.6WB180	Yes	C	1	0.6	13	0.6				
8	D+0.45*WA+0.75*Lr	Yes	C	1	1	3	0.45	2	0.75		
9	D+0.45*WA+0.75*S	Yes	C	1	1	3	0.45	10	0.75		
10	D+0.45WA180+0.75Lr	Yes	C	1	1	12	0.45	2	0.75		
11	D+0.45WA180+0.75S	Yes	C	1	1	12	0.45	10	0.75		
12	D +0.7ELx + 0.7ELy	Yes	C	1	1	6	0.7	7	0.7		
13	D+0.7ELz+0.7ELy	Yes	C	1	1	5	0.7	7	0.7		
14	0.6D-0.7ELx-0.7ELy	Yes	C	1	0.6	6	-0.7	7	-0.7		
15	0.6D-0.7ELz-0.7ELy	Yes	C	1	0.6	5	-0.7	7	-0.7		
16	D+0.7Di+0.7WL-Lat+S	Yes	C	1	1	9	0.7	8	0.7	10	1
17	D+0.7Di+0.7WA(ice)+S	Yes	C	1	1	9	0.7	11	0.7	10	1
18	1.4*D	Yes	C	1	1.4						
19	1.2D+1.6Lr+0.5WA	Yes	C	1	1.2	2	1.6	3	0.5		
20	1.2D+1.6S+0.5WA	Yes	C	1	1.2	10	1.6	3	0.5		
21	1.2*D+0.5Lr+WA	Yes	C	1	1.2	2	0.5	3	1		
22	1.2D+0.5S+WA	Yes	C	1	1.2	10	0.5	3	1		
23	0.9*D+WB	Yes	C	1	0.9	4	1				
24	1.2D+ELx+ELy	Yes	C	1	1.2	6	1	7	1		
25	1.2D+ELz+ELy	Yes	C	1	1.2	5	1	7	1		
26	0.9D-ELx-ELy	Yes	C	1	0.9	6	-1	7	-1		
27	0.9D-ELz-ELy	Yes	C	1	0.9	5	-1	7	-1		
28	1.2D+Di+WL-Lat+0.5S	Yes	C	1	1.2	9	1	8	1	10	0.5
29	1.2D+Di+WA(ice)+0.5S	Yes	C	1	1.2	9	1	11	1	10	0.5

Load Combination Design

	Description	Service	Hot Rolled	Cold Formed	Wood	Concrete	Masonry	Aluminum	Stainless	Connection
1	D		Yes							
2	D+Lr		Yes							
3	D + S		Yes							
4	D+0.6*WA		Yes							
5	D + 0.6WA180		Yes							
6	0.6*D+0.6*WB		Yes							
7	0.6D + 0.6WB180		Yes							
8	D+0.45*WA+0.75*Lr		Yes							
9	D+0.45*WA+0.75*S		Yes							
10	D+0.45WA180+0.75Lr		Yes							
11	D+0.45WA180+0.75S		Yes							
12	D +0.7ELx + 0.7ELy		Yes							
13	D+0.7ELz+0.7ELy		Yes							
14	0.6D-0.7ELx-0.7ELy		Yes							
15	0.6D-0.7ELz-0.7ELy		Yes							
16	D+0.7Di+0.7WL-Lat+S		Yes							
17	D+0.7Di+0.7WA(ice)+S		Yes							
18	1.4*D									

Load Combination Design (Continued)

	Description	Service	Hot Rolled	Cold Formed	Wood	Concrete	Masonry	Aluminum	Stainless	Connection
19	1.2D+1.6Lr+0.5WA									
20	1.2D+1.6S+0.5WA									
21	1.2*D+0.5Lr+WA									
22	1.2D+0.5S+WA									
23	0.9*D+WB									
24	1.2D+ELx+ELy									
25	1.2D+ELz+ELy									
26	0.9D-ELx-ELy									
27	0.9D-ELz-ELy									
28	1.2D+Di+WL-Lat+0.5S									
29	1.2D+Di+WA(ice)+0.5S									

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	M2	max	4742.631	0.751	17	454.683	0	17	11.747	0.751	15	17.776	0.751	16	66.774	0.751	15	271.295	0	16
2		min	-186.245	0	6	-102.635	0.751	6	-11.984	0.751	16	-15.565	0	15	-78.818	0.751	16	-126.668	0.751	4
3	M3	max	0	0	17	9.652	0.794	6	0.923	0.794	15	0	0.794	17	0.367	0.794	15	36.128	0.794	17
4		min	-19.358	0.794	16	-90.972	0.794	17	-0.923	0.794	13	0	0	1	-0.367	0.794	13	-3.833	0.794	6
5	M4	max	-1.543	0	14	11.96	0.199	6	1.155	0.199	15	0.011	0.199	13	0.573	0.199	15	56.633	0.199	17
6		min	-21.072	0.199	16	-114.459	0.199	17	-1.155	0.199	13	-0.011	0	15	-0.573	0.199	13	-5.975	0.199	6
7	M5	max	-1.93	0	14	18.155	0.514	6	1.752	0.514	15	0.011	0.514	13	1.321	0.514	15	130.706	0.514	17
8		min	-31.977	0.514	16	-173.699	0.514	17	-1.752	0.514	13	-0.011	0	15	-1.321	0.514	13	-13.717	0.514	6
9	M6	max	-2.24	0	14	26.518	0.713	6	2.581	0.713	15	0.05	0.713	13	2.865	0.713	15	284.616	0.713	17
10		min	-40.216	0.713	16	-257.137	0.713	17	-2.581	0.713	13	-0.05	0	15	-2.865	0.713	13	-29.584	0.713	6
11	M7	max	-2.282	0	14	27.795	0.128	6	2.73	0.128	15	0.135	0.128	13	3.202	0.128	15	318.581	0.128	17
12		min	-35.212	0.128	16	-273.063	0.128	17	-2.73	0.128	13	-0.135	0	15	-3.202	0.128	13	-33.04	0.128	6
13	M8	max	-2.709	0	14	34.753	0.298	6	3.41	0.298	15	0.135	0.298	13	4.998	0.298	15	498.29	0.298	17
14		min	-43.986	0.298	16	-341.12	0.298	17	-3.41	0.298	13	-0.135	0	15	-4.998	0.298	13	-51.342	0.298	6
15	M9	max	-1.668	0	14	42.875	0.713	6	4.239	0.713	15	0.282	0.713	13	7.72	0.713	15	772.033	0.713	17
16		min	-43.265	0.713	16	-425.452	0.713	17	-4.239	0.713	13	-0.282	0	15	-7.72	0.713	13	-78.91	0.713	6
17	M10	max	2.001	0	4	50.893	0.713	6	5.068	0.713	15	0.51	0.713	13	11.027	0.713	15	1105.91	0.713	17
18		min	-38.032	0.713	16	-509.91	0.713	17	-5.068	0.713	13	-0.51	0	15	-11.027	0.713	13	-112.205	0.713	6
19	M11	max	7.708	0	4	58.818	0.713	6	5.897	0.713	15	0.836	0.713	13	14.916	0.713	15	1499.817	0.713	17
20		min	-28.282	0.713	16	-594.275	0.713	17	-5.897	0.713	13	-0.836	0	15	-14.916	0.713	13	-151.153	0.713	6
21	M12	max	15.151	0	4	66.669	0.713	6	6.726	0.713	15	1.276	0.713	13	19.385	0.713	15	1953.763	0.713	17
22		min	-18.75	0.713	6	-678.38	0.713	17	-6.726	0.713	13	-1.276	0	15	-19.385	0.713	13	-195.712	0.713	6
23	M13	max	24.457	0.713	4	74.454	0.713	6	7.556	0.713	15	1.848	0.713	13	24.432	0.713	15	2467.932	0.713	17
24		min	-20.711	0	6	-762.818	0.713	17	-7.557	0.713	13	-1.848	0	15	-24.433	0.713	13	-245.826	0.713	6
25	M14	max	40.974	0.713	8	73.812	0	6	8.389	0.713	15	2.569	0.713	13	30.053	0.713	15	3040.077	0.713	17
26		min	-22.825	0	6	-841.407	0.713	17	-8.393	0.713	13	-2.569	0	15	-30.057	0.713	13	-295.071	0.713	6
27	M15	max	65.7	0.384	17	63.628	0	6	8.84	0.384	15	3.456	0.384	13	33.272	0.384	15	3370.97	0.384	17
28		min	-24.304	0	6	-883.062	0.384	17	-8.847	0.384	13	-3.456	0	15	-33.278	0.384	13	-318.514	0.384	6
29	M16	max	4682.708	0.713	17	26.436	0	6	5.685	0.713	15	6.922	0.713	16	20.737	0.713	15	765.657	0.713	17
30		min	-212.696	0	6	-212.867	0.713	17	-9.815	0.713	16	-6.363	0	15	-20.968	0.713	13	-121.485	0.713	6
31	M17	max	4689.735	0.713	17	10.724	0	6	6.491	0.713	15	7.51	0.713	16	24.873	0.713	15	840.328	0.713	17
32		min	-212.029	0	6	-143.433	0.713	17	-10.366	0.713	16	-6.973	0	15	-26.934	0.713	16	-125.776	0.713	6
33	M18	max	4697.186	0.713	17	20.828	0	10	7.29	0.713	15	8.303	0.713	16	29.558	0.713	15	864.638	0.713	17
34		min	-210.568	0	6	-72.654	0.713	17	-10.839	0.713	16	-7.704	0	15	-34.176	0.713	16	-125.776	0	6
35	M19	max	4695.554	0.228	17	75.927	0	8	7.533	0.228	15	9.309	0.228	16	31.005	0.228	15	864.638	0	17
36		min	-208.317	0	6	-23.419	0.228	6	-10.881	0.228	16	-8.574	0	15	-36.371	0.228	16	-118.934	0	6
37	M20	max	4705.04	0.485	17	61.168	0	8	8.075	0.485	15	9.309	0.485	16	34.785	0.485	15	850.889	0	17
38		min	-207.656	0	6	-29.753	0.485	6	-11.173	0.485	16	-8.574	0	15	-41.674	0.485	16	-113.934	0	6
39	M21	max	4713.267	0.713	17	147.232	0	17	8.866	0.713	15	10.536	0.713	16	40.544	0.713	15	838.013	0	17
40		min	-205.28	0	6	-45.08	0.713	6	-11.545	0.713	16	-9.598	0	15	-49.361	0.713	16	-101.036	0	6
41	M22	max	4721.828	0.713	17	218.507	0	17	9.641	0.713	15	11.989	0.713	16	46.821	0.713	15	760.224	0	17
42		min	-201.466	0	6	-60.223	0.713	6	-11.773	0.713	16	-10.792	0	15	-57.17	0.713	16	-72.184	0	6
43	M23	max	4730.68	0.713	17	289.026	0	17	10.406	0.713	15	13.673	0.713	16	53.603	0.713	15	631.441	0	17
44		min	-196.881	0	6	-75.148	0.713	6	-11.914	0.713	16	-12.17	0	15	-65.029	0.713	16	-32.512	0	6
45	M24	max	4731.823	0.378	17	330.914	0	17	10.79	0.378	15	15.224	0.378	16	57.289	0.378	15	452.249	0	17
46		min	-191.989	0	6	-84.532	0.378	6	-11.802	0.378	16	-13.448	0	15	-69.07	0.378	16	-27.617	0.378	7
47	M25	max	188.9	0.478	6	541.079	0	17	6.853	0	15	3.299	0.478	16	63.983	0	16	48.248	0	6

Envelope Maximum Member Section Forces (Continued)

	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
48		min	-4668.81	0	17	17.822	0.478	6	-10.967	0	16	-2.906	0	15	-51.749	0	15	-226.445	0.478	17
49	M26	max	188.213	0.526	6	359.355	0	17	6.711	0	15	1.129	0.526	13	58.941	0	16	39.252	0	6
50		min	-4685.389	0	17	4.593	0.526	7	-10.492	0	16	-1.089	0	15	-48.584	0	15	-413.449	0.526	17
51	M27	max	187.353	0.526	6	163.81	0	17	6.555	0	15	0.722	0.526	15	53.563	0	16	26.751	0	6
52		min	-4695.304	0	17	-9.766	0.526	7	-9.969	0	16	-1.056	0	16	-45.105	0	15	-497.681	0.526	17
53	M28	max	186.37	0.526	6	35.487	0	6	6.398	0	15	2.394	0.526	15	48.377	0	16	11.449	0	6
54		min	-4697.073	0	17	-50.941	0.526	8	-9.446	0	16	-2.999	0	16	-41.636	0	15	-497.681	0	17
55	M29	max	185.264	0.526	6	40.727	0	6	6.242	0	15	3.929	0.526	15	43.392	0	16	-2.182	0.526	7
56		min	-4690.698	0	17	-234.753	0.526	17	-8.923	0	16	-4.744	0	16	-38.186	0	15	-478.981	0	17
57	M30	max	184.036	0.526	6	45.926	0	6	6.086	0	15	5.328	0.526	15	38.615	0	16	24.862	0.526	7
58		min	-4676.192	0	17	-429.839	0.526	17	-8.4	0	16	-6.298	0	16	-34.759	0	15	-357.419	0	17
59	M31	max	182.687	0.526	6	51.082	0	6	5.929	0	15	6.591	0.526	15	34.056	0	16	194.382	0.526	8
60		min	-4653.583	0	17	-624.103	0.526	17	-7.877	0	16	-7.671	0	16	-31.36	0	15	-134.911	0	16
61	M32	max	181.216	0.526	6	56.192	0	6	5.773	0	15	7.721	0.526	15	29.719	0	16	620.955	0.526	17
62		min	-4622.914	0	17	-817.211	0.526	17	-7.354	0	16	-8.87	0	16	-27.996	0	15	-106.33	0.526	6
63	M33	max	179.624	0.525	6	61.256	0	6	5.617	0	15	8.718	0.525	15	25.613	0	16	1148.994	0.525	17
64		min	-4584.242	0	17	-1008.819	0.525	17	-6.831	0	16	-9.906	0	16	-24.672	0	15	-137.95	0.525	6
65	M34	max	178.267	0.218	6	63.985	0	6	5.461	0	15	9.306	0.218	15	21.885	0	16	1395.848	0.218	17
66		min	-4552.701	0	17	-1135.747	0.218	17	-6.308	0	16	-10.504	0	16	-21.518	0	15	-151.781	0.218	6
67	M35	max	176.213	1.018	6	72.909	0	6	5.396	0	15	10.425	1.018	15	20.059	0	13	2815.296	1.018	17
68		min	-4481.202	0	17	-1400.68	1.018	17	-6.092	0	16	-11.633	0	16	-19.786	0	15	-224.002	1.018	6
69	M37	max	189.267	0.627	6	-15.945	0	6	7.066	0.627	15	4.742	0.627	16	56.665	0.627	15	497.881	0.627	17
70		min	-4655.407	0	17	-656.306	0.627	17	-11.681	0.627	16	-4.073	0	15	-72.02	0.627	16	-23.797	0	7
71	M38	max	-2.413	0	14	31.215	0.288	6	3.064	0.288	15	0.135	0.288	13	4.035	0.288	15	401.922	0.288	17
72		min	-39.524	0.288	16	-306.509	0.288	17	-3.064	0.288	13	-0.135	0	15	-4.035	0.288	13	-41.526	0.288	6
73	M78	max	189.267	0.091	6	647.588	0	17	6.88	0	15	4.742	0.091	16	64.892	0	16	92.877	0	16
74		min	-4655.407	0	17	15.572	0.091	6	-11.057	0	16	-4.073	0	15	-52.293	0	15	-26.263	0.091	7
75	M84	max	4716.804	0	17	93.149	0	6	10.929	0	15	17.725	0.141	16	70.112	0	16	334.739	0.141	17
76		min	-187.041	0.141	6	-465.108	0.141	17	-11.714	0	16	-15.523	0	15	-58.291	0	15	-41.732	0	7
77	M89	max	4676.127	0.329	17	37.084	0	6	4.868	0.329	15	6.527	0.329	16	17.159	0.329	15	641.552	0.329	17
78		min	-212.166	0	6	-278.798	0.329	17	-9.166	0.329	16	-5.858	0	15	-17.134	0.329	13	-106.002	0.329	6
79	M44	max	2378.781	0	17	4682.75	10.204	17	36.951	0	15	146.557	7.542	16	322.347	0	16	12857.203	7.653	17
80		min	0	10.647	1	-288.013	7.653	6	-42.469	0	16	-124.853	0	15	-285.58	0	15	-1474.814	0	6

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	M2	HSS3.500X0.216	0.087	0	17	0.025	0	16	62275.448	62275.448	5464.072	5464.072	1.925	H1-1b
2	M3	HSS3.500X0.216	0.007	0.794	17	0.005	0.794	17	62275.448	62275.448	5464.072	5464.072	2.326	H1-1b
3	M4	HSS3.500X0.216	0.011	0.199	17	0.006	0.199	17	62275.448	62275.448	5464.072	5464.072	1.179	H1-1b
4	M5	HSS3.500X0.216	0.024	0.514	17	0.009	0.514	17	62275.448	62275.448	5464.072	5464.072	1.327	H1-1b
5	M6	HSS3.500X0.216	0.052	0.713	17	0.014	0.713	17	62275.448	62275.448	5464.072	5464.072	1.305	H1-1b
6	M7	HSS3.500X0.216	0.059	0.128	17	0.015	0.128	17	62275.448	62275.448	5464.072	5464.072	1.045	H1-1b
7	M8	HSS3.500X0.216	0.092	0.298	17	0.018	0.298	17	62275.448	62275.448	5464.072	5464.072	1.086	H1-1b
8	M9	HSS3.500X0.216	0.142	0.713	17	0.023	0.713	17	62275.448	62275.448	5464.072	5464.072	1.174	H1-1b
9	M10	HSS3.500X0.216	0.203	0.713	17	0.027	0.713	17	62275.448	62275.448	5464.072	5464.072	1.143	H1-1b
10	M11	HSS3.500X0.216	0.275	0.713	17	0.032	0.713	17	62275.448	62275.448	5464.072	5464.072	1.122	H1-1b
11	M12	HSS3.500X0.216	0.358	0.713	17	0.036	0.713	17	62275.448	62275.448	5464.072	5464.072	1.106	H1-1b
12	M13	HSS3.500X0.216	0.452	0.713	17	0.041	0.713	17	62275.448	62275.448	5464.072	5464.072	1.093	H1-1b
13	M14	HSS3.500X0.216	0.557	0.713	17	0.045	0.713	17	62275.448	62275.448	5464.072	5464.072	1.083	H1-1b
14	M15	HSS3.500X0.216	0.617	0.384	17	0.047	0.384	17	62275.448	62275.448	5464.072	5464.072	1.041	H1-1b
15	M16	HSS3.500X0.216	0.178	0.713	17	0.011	0.713	17	62275.448	62275.448	5464.072	5464.072	1.076	H1-1b
16	M17	HSS3.500X0.216	0.191	0.713	17	0.008	0.713	16	62275.448	62275.448	5464.072	5464.072	1.043	H1-1b
17	M18	HSS3.500X0.216	0.196	0.713	17	0.005	0.713	16	62275.448	62275.448	5464.072	5464.072	1.017	H1-1b
18	M19	HSS3.500X0.216	0.196	0	17	0.005	0	16	62275.448	62275.448	5464.072	5464.072	1.007	H1-1b
19	M20	HSS3.500X0.216	0.193	0	17	0.004	0	16	62275.448	62275.448	5464.072	5464.072	1.009	H1-1b
20	M21	HSS3.500X0.216	0.191	0	17	0.009	0	16	62275.448	62275.448	5464.072	5464.072	1.045	H1-1b
21	M22	HSS3.500X0.216	0.177	0	17	0.013	0	16	62275.448	62275.448	5464.072	5464.072	1.08	H1-1b
22	M23	HSS3.500X0.216	0.153	0	17	0.016	0	16	62275.448	62275.448	5464.072	5464.072	1.137	H1-1b
23	M24	HSS3.500X0.216	0.121	0	17	0.018	0	16	62275.448	62275.448	5464.072	5464.072	1.119	H1-1b
24	M25	HSS3.500X0.216	0.079	0.478	17	0.029	0	17	62275.448	62275.448	5464.072	5464.072	1.827	H1-1b
25	M26	HSS3.500X0.216	0.113	0.526	17	0.019	0	17	62275.448	62275.448	5464.072	5464.072	1.22	H1-1b

Job. No. 25-0333
6/02/25
By: CS
Check by: JL, SE

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

	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
26	M27	HSS3.500X0.216	0.129	0.526	17	0.009	0	17	62275.448	62275.448	5464.072	5464.072	1.072	H1-1b
27	M28	HSS3.500X0.216	0.129	0	17	0.003	0.526	8	62275.448	62275.448	5464.072	5464.072	1.015	H1-1b
28	M29	HSS3.500X0.216	0.125	0	17	0.013	0.526	17	62275.448	62275.448	5464.072	5464.072	1.112	H1-1b
29	M30	HSS3.500X0.216	0.103	0	17	0.023	0.526	17	62275.448	62275.448	5464.072	5464.072	1.333	H1-1b
30	M31	HSS3.500X0.216	0.073	0.526	17	0.033	0.526	17	62275.448	62275.448	5464.072	5464.072	2.214	H1-1b
31	M32	HSS3.500X0.216	0.151	0.526	17	0.044	0.526	17	62275.448	62275.448	5464.072	5464.072	1.381	H1-1b
32	M33	HSS3.500X0.216	0.247	0.525	17	0.054	0.525	17	62275.448	62275.448	5464.072	5464.072	1.226	H1-1b
33	M34	HSS3.500X0.216	0.292	0.218	17	0.061	0.218	17	62275.448	62275.448	5464.072	5464.072	1.076	H1-1b
34	M35	HSS3.500X0.216	0.551	1.018	17	0.075	1.018	17	62275.448	62275.448	5464.072	5464.072	1.253	H1-1b
35	M37	HSS3.500X0.216	0.128	0.627	17	0.035	0.627	17	62275.448	62275.448	5464.072	5464.072	1.491	H1-1b
36	M38	HSS3.500X0.216	0.074	0.288	17	0.016	0.288	17	62275.448	62275.448	5464.072	5464.072	1.093	H1-1b
37	M78	HSS3.500X0.216	0.055	0	16	0.035	0	17	62275.448	62275.448	5464.072	5464.072	1.309	H1-1b
38	M84	HSS3.500X0.216	0.099	0.141	17	0.025	0.141	16	62275.448	62275.448	5464.072	5464.072	1.084	H1-1b
39	M89	HSS3.500X0.216	0.155	0.329	17	0.015	0.329	17	62275.448	62275.448	5464.072	5464.072	1.058	H1-1b
40	M44	HSS6.625X0.280	0.493	7.653	17	0.1	10.204	17	155688.62	155688.62	26197.604	26197.604	1.048	H1-1b

Node Reactions

	LC	Node Label	X [lb]	Y [lb]	Z [lb]	MX [lb-ft]	MY [lb-ft]	MZ [lb-ft]
1	1	N45	0	842.863	0	0	0	2546.684
2	1	Totals:	0	842.863	0			
3	1	COG (ft):	X: 3.268	Y: 7.687	Z: 0			
4	2	N45	0	1729.495	0	0	0	9573.401
5	2	Totals:	0	1729.495	0			
6	2	COG (ft):	X: 5.155	Y: 8.176	Z: 0			
7	3	N45	0	1326.622	0	0	0	5434.284
8	3	Totals:	0	1326.622	0			
9	3	COG (ft):	X: 4.136	Y: 7.989	Z: 0			
10	4	N45	162.875	1093.064	0	0	0	3794.979
11	4	Totals:	162.875	1093.064	0			
12	4	COG (ft):	X: 4.618	Y: 7.926	Z: 0			
13	5	N45	-187.603	1117.595	0	0	0	5470.64
14	5	Totals:	-187.603	1117.595	0			
15	5	COG (ft):	X: 3.692	Y: 7.905	Z: 0			
16	6	N45	134.713	309.37	0	0	0	-1474.814
17	6	Totals:	134.713	309.37	0			
18	6	COG (ft):	X: -1.052	Y: 7.004	Z: 0			
19	7	N45	-114.931	282.113	0	0	0	1343.467
20	7	Totals:	-114.931	282.113	0			
21	7	COG (ft):	X: 2.477	Y: 7.008	Z: 0			
22	8	N45	122.156	1695.488	0	0	0	8836.248
23	8	Totals:	122.156	1695.488	0			
24	8	COG (ft):	X: 5.365	Y: 8.177	Z: 0			
25	9	N45	122.156	1393.333	0	0	0	5700.233
26	9	Totals:	122.156	1393.333	0			
27	9	COG (ft):	X: 4.682	Y: 8.043	Z: 0			
28	10	N45	-140.702	1713.886	0	0	0	10062.7
29	10	Totals:	-140.702	1713.886	0			
30	10	COG (ft):	X: 4.904	Y: 8.164	Z: 0			
31	11	N45	-140.702	1411.732	0	0	0	6948.17
32	11	Totals:	-140.702	1411.732	0			
33	11	COG (ft):	X: 4.132	Y: 8.029	Z: 0			
34	12	N45	-36.823	853.245	0	0	0	2870.283
35	12	Totals:	-36.823	853.245	0			
36	12	COG (ft):	X: 3.268	Y: 7.686	Z: 0			
37	13	N45	0	853.245	-36.823	-286.944	127.777	2582.103
38	13	Totals:	0	853.245	-36.823			
39	13	COG (ft):	X: 3.268	Y: 7.686	Z: 0			
40	14	N45	36.823	495.337	0	0	0	1186.782
41	14	Totals:	36.823	495.337	0			
42	14	COG (ft):	X: 3.27	Y: 7.689	Z: 0			
43	15	N45	0	495.337	36.823	285.58	-124.853	1473.028

Node Reactions (Continued)

	LC	Node Label	X [lb]	Y [lb]	Z [lb]	MX [lb-ft]	MY [lb-ft]	MZ [lb-ft]
44	15	Totals:	0	495.337	36.823			
45	15	COG (ft):	X: 3.27	Y: 7.689	Z: 0			
46	16	N45	0	2290.874	-41.767	-322.347	146.557	11763.016
47	16	Totals:	0	2290.874	-41.767			
48	16	COG (ft):	X: 4.727	Y: 8.123	Z: 0			
49	17	N45	38.436	2378.781	0	0	0	12500.957
50	17	Totals:	38.436	2378.781	0			
51	17	COG (ft):	X: 4.891	Y: 8.145	Z: 0			
52	18	N45	0	1180.009	0	0	0	3550.257
53	18	Totals:	0	1180.009	0			
54	18	COG (ft):	X: 3.268	Y: 7.687	Z: 0			
55	19	N45	135.729	2638.548	0	0	0	15362.997
56	19	Totals:	135.729	2638.548	0			
57	19	COG (ft):	X: 5.713	Y: 8.282	Z: 0			
58	20	N45	135.729	1993.951	0	0	0	8681.431
59	20	Totals:	135.729	1993.951	0			
60	20	COG (ft):	X: 4.809	Y: 8.117	Z: 0			
61	21	N45	271.458	1871.753	0	0	0	8507.76
62	21	Totals:	271.458	1871.753	0			
63	21	COG (ft):	X: 5.454	Y: 8.145	Z: 0			
64	22	N45	271.458	1670.316	0	0	0	6517.349
65	22	Totals:	271.458	1670.316	0			
66	22	COG (ft):	X: 5.086	Y: 8.067	Z: 0			
67	23	N45	224.522	431.331	0	0	0	-2707.988
68	23	Totals:	224.522	431.331	0			
69	23	COG (ft):	X: -1.896	Y: 6.871	Z: 0			
70	24	N45	-52.604	1026.266	0	0	0	3490.119
71	24	Totals:	-52.604	1026.266	0			
72	24	COG (ft):	X: 3.267	Y: 7.686	Z: 0			
73	25	N45	0	1026.266	-52.604	-408.759	180.037	3080.05
74	25	Totals:	0	1026.266	-52.604			
75	25	COG (ft):	X: 3.267	Y: 7.686	Z: 0			
76	26	N45	52.604	743.747	0	0	0	1800.59
77	26	Totals:	52.604	743.747	0			
78	26	COG (ft):	X: 3.27	Y: 7.689	Z: 0			
79	27	N45	0	743.747	52.604	407.808	-178.014	2209.289
80	27	Totals:	0	743.747	52.604			
81	27	COG (ft):	X: 3.27	Y: 7.689	Z: 0			
82	28	N45	0	2630.819	-59.667	-454.611	192.412	12822.519
83	28	Totals:	0	2630.819	-59.667			
84	28	COG (ft):	X: 4.677	Y: 8.088	Z: 0			
85	29	N45	54.908	2756.4	0	0	0	13773.635
86	29	Totals:	54.908	2756.4	0			
87	29	COG (ft):	X: 4.881	Y: 8.117	Z: 0			

Envelope Node Reactions - Overstrength or Capacity Limit

No Data to Print...

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	N45	max	271.458	21	2756.4	29	52.604	27	407.808	27	192.412	28	15362.997	19
2		min	-187.603	5	282.113	7	-59.667	28	-454.611	28	-178.014	27	-2707.988	23
3	Totals:	max	271.458	21	2756.4	29	52.604	27						
4		min	-187.603	5	282.113	7	-59.667	28						

C nsulting Structural &
F rensic Engineers
3600 E. University Dr, Suite1400
Ph enix, AZ 85034
(602) 438-2500

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By: CS
Check by: JL, SE

Monolithic Footing Calc

$\gamma_c := 145pcf$ $\rho_{brg} := q_{lat} = 1500 \cdot psf$ $\mu_{soil} := 0.3$ $\rho_{sliding} := 250pcf$

Footing Geometry

Bottom of Footing Depth	3.5	ft	Footing Width (Span)	$B_{footing} := B = 12.5ft$
Width of Footing	3.00	ft		
Footing Thickness	42	in	$d := t_{footing} - 3in$	$d' := 3in$

Item	Ratio	Results	Applied/Capacity	Load Combination
Soil Bearing	$\frac{\rho_{des}}{\rho_{brg}} = 0.825$	**< 1.0 OK**	$\rho_{des} = 1238 \cdot psf$ $\rho_{brg} = 1500 \cdot psf$	LCq_{LC} = "D + 0.7Di + 0.7WA(ice) + S" ECC = "ECC OK"
Over-turning	$\frac{M_R}{M_{OT}} = 2.58$	**> 1.0 OK**	$M_{OT} = 12.5 \cdot k \cdot ft$ $M_R = 32.25 \cdot k \cdot ft$	LCq_{LC} = "D + 0.7Di + 0.7WA(ice) + S"
Sliding	$\frac{V_c}{V_a} = 90.52$	**> 1.0 OK**	$V_a = 0.19 \cdot k$ $V_c = 16.98 \cdot k$	LCq_{LC} = "D + 0.6WA180"
Uplift	$\frac{P_c}{P_{app}} = 40.48$	**No Uplift**	$P_{up} = 0 \cdot k$ $P_c = 11.42 \cdot k$	LCq_{LC} = "0.6D + 0.6WB180"

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Specifier's comments:

1 Anchor Design

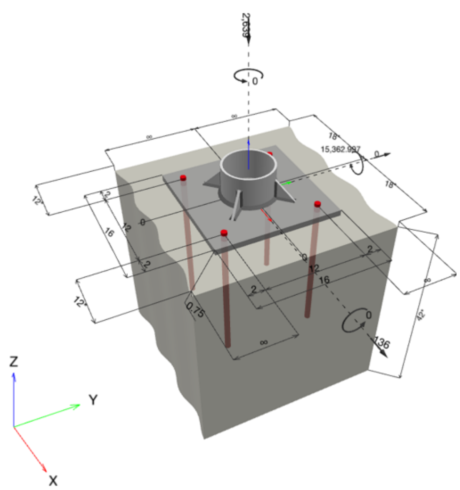
1.1 Input data

Anchor type and diameter:	**Heavy Hex Head ASTM F 1554 GR. 36 3/4**
Item number:	not available
Specification text:	∅ 3/4 in Heavy Hex Head ASTM F 1554 GR. 36 with 18 in nominal embedment depth per Technical data , cast in place installation per MPII,
Effective embedment depth:	h_{ef} = 18.000 in.
Material:	ASTM F 1554
Evaluation Service Report:	Hilti Technical Data
Issued I Valid:	- | -
Proof:	Design Method ACI 318-14 / CIP
Shear edge breakout verification:	Row closest to edge (Case 3 only from ACI 318-14 Fig. R.17.5.2.1b)
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate[CBFEM] :	l_x x l_y x t = 16.000 in. x 16.000 in. x 0.750 in.;
Profile:	Round HSS (AISC), HSS6-5/8X.280; (L x W x T) = 6.625 in. x 6.625 in. x 0.280 in.
Base material:	cracked concrete, 2500, f_c' = 2,500 psi; h = 42.000 in.
Reinforcement:	tension: condition B, shear: condition B;
	edge reinforcement: none or < No. 4 bar

In lieu of Heavy Hex Head ASTM F1554 Gr. 36
it is acceptable to use fully threaded anchor rods
ASTM F1554 Grade 36 steel w/ double nut and washer

[CBFEM] - The anchor calculation is based on a component-based Finite Element Method (CBFEM)

Geometry [in.] & Loading [lb, ft.lb]



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1.1.1 Load combination and design results

Case	Description	Forces [lb] / Moments [ft.lb]	Seismic	Max. Util. Anchor [%]
1	1.4*D	$N = -1{,}180$; $V_x = 0$; $V_y = 0$; $M_x = 0.000$; $M_y = 3{,}550.257$; $M_z = 0.000$;	no	18
2	1.2D+1.6Lr+0.5WA	$N = -2{,}639$; $V_x = 136$; $V_y = 0$; $M_x = 0.000$; $M_y = 15{,}362.997$; $M_z = 0.000$;	no	80
3	1.2D+1.6S+0.5WA	$N = -1{,}994$; $V_x = 136$; $V_y = 0$; $M_x = 0.000$; $M_y = 8{,}681.431$; $M_z = 0.000$;	no	44
4	1.2*D+0.5Lr+WA	$N = -1{,}872$; $V_x = 271$; $V_y = 0$; $M_x = 0.000$; $M_y = 8{,}507.760$; $M_z = 0.000$;	no	44
5	1.2D+0.5S+WA	$N = -1{,}670$; $V_x = 271$; $V_y = 0$; $M_x = 0.000$; $M_y = 6{,}517.349$; $M_z = 0.000$;	no	33
6	0.9*D+WB	$N = -431$; $V_x = 225$; $V_y = 0$; $M_x = 0.000$; $M_y = -2{,}707.988$; $M_z = 0.000$;	no	14
7	1.2D+ELx+Ely (w/ Ω0)	$N = -1{,}283$; $V_x = -66$; $V_y = 0$; $M_x = 0.000$; $M_y = 4{,}362.649$; $M_z = 0.000$;	yes	29
8	1.2D+ELz+Ely (w/ Ω0)	$N = -1{,}283$; $V_x = 0$; $V_y = -66$; $M_x = -510.949$; $M_y = 3{,}850.063$; $M_z = 225.046$;	yes	27
9	0.9D-ELx-Ely (w/ Ω0)	$N = -930$; $V_x = 66$; $V_y = 0$; $M_x = 0.000$; $M_y = 2{,}250.738$; $M_z = 0.000$;	yes	15
10	0.9D-ELz-Ely (w/ Ω0)	$N = -930$; $V_x = 0$; $V_y = 66$; $M_x = 509.760$; $M_y = 2{,}761.611$; $M_z = -222.518$;	yes	20
11	1.2D+Di+WL-Lat+0.5S	$N = -2{,}631$; $V_x = 0$; $V_y = -60$; $M_x = -454.611$; $M_y = 12{,}822.519$; $M_z = 192.412$;	no	67
12	1.2D+Di+WA(ice)+0.5S	$N = -2{,}756$; $V_x = 55$; $V_y = 0$; $M_x = 0.000$; $M_y = 13{,}773.635$; $M_z = 0.000$;	no	71

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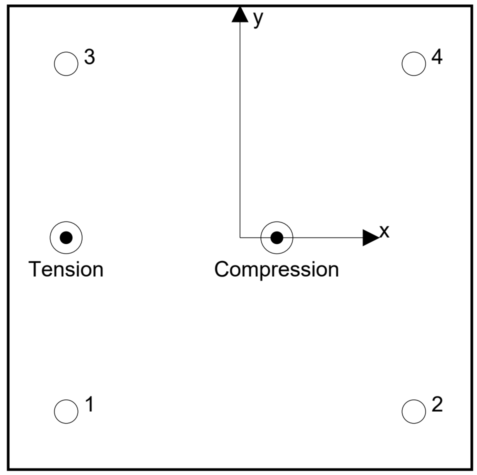
1.2 Load case/Resulting anchor forces

Controlling load case: 2 1.2D+1.6Lr+0.5WA



Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	10,121	80	44	67
2	-0	31	23	-20
3	10,124	81	44	-68
4	-0	31	24	20

Resulting tension force in (x/y)=(-6.000/0.001): 20,244 [lb]
Resulting compression force in (x/y)=(1.272/-0.001): 24,050 [lb]

Anchor forces are calculated based on a component-based Finite Element Method (CBFEM)

1.3 Tension load

	Load N_{ua} [lb]	Capacity ϕ N_n [lb]	Utilization $\beta_N = N_{ua}/\phi$ N_n	Status
Steel Strength*	10,124	14,529	70	OK
Pullout Strength*	10,124	12,754	80	OK
Concrete Breakout Failure**	20,245	47,008	44	OK
Concrete Side-Face Blowout, direction **	N/A	N/A	N/A	N/A

* highest loaded anchor **anchor group (anchors in tension)

1.3.1 Steel Strength

$N_{sa} = A_{se,N}\ f_{uta}$ ACI 318-14 Eq. (17.4.1.2)
$\phi\ N_{sa} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.33	58,000

Calculations

N_{sa} [lb]
19,372

Results

N_{sa} [lb]	ϕ_{steel}	$\phi\ N_{sa}$ [lb]	N_{ua} [lb]
19,372	0.750	14,529	10,124

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1.3.2 Pullout Strength

$N_{pN} = \psi_{c,p} N_p$ ACI 318-14 Eq. (17.4.3.1)

$N_p = 8 A_{brg} f'_c$ ACI 318-14 Eq. (17.4.3.4)

$\phi N_{pN} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$\psi_{c,p}$	A_{brg} [in.^{2}]	λ_a	f'_c [psi]
1.000	0.91	1.000	2,500

Calculations

N_p [lb]
18,220

Results

N_{pn} [lb]	$\phi_{concrete}$	ϕN_{pn} [lb]	N_{ua} [lb]
18,220	0.700	12,754	10,124

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1.3.3 Concrete Breakout Failure

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$ ACI 318-14 Eq. (17.4.2.1b)

$\phi\ N_{cbg} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

A_{Nc} see ACI 318-14, Section 17.4.2.1, Fig. R 17.4.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ ACI 318-14 Eq. (17.4.2.1c)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.4)

$\psi_{ed,N} = 0.7 + 0.3\left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.5b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.7b)

$N_b = 16\ \lambda_a\ \sqrt{f'_c}\ h_{ef}^{5/3}$ ACI 318-14 Eq. (17.4.2.2b)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
18.000	0.000	0.001	12.000	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
-	16	1.000	2,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
2,376.00	2,916.00	1.000	1.000	0.833	1.000	98,903

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi\ N_{cbg}$ [lb]	N_{ua} [lb]
67,154	0.700	47,008	20,245

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1.4 Shear load

	Load V_{ua} [lb]	Capacity ϕ V_n [lb]	Utilization $\beta_V = V_{ua}/\phi$ V_n	Status
Steel Strength*	81	7,555	2	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	136	94,019	1	OK
Concrete edge failure in direction x+**	162	17,427	1	OK

* highest loaded anchor **anchor group (relevant anchors)
When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

1.4.1 Steel Strength

$V_{sa} = 0.6\ A_{se,V}\ f_{uta}$ ACI 318-14 Eq. (17.5.1.2b)
$\phi\ V_{steel} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
0.33	58,000

Calculations

V_{sa} [lb]
11,623

Results

V_{sa} [lb]	ϕ_{steel}	$\phi\ V_{sa}$ [lb]	V_{ua} [lb]
11,623	0.650	7,555	81

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1.4.2 Pryout Strength

$V_{cpg} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N} \; \psi_{ed,N} \; \psi_{c,N} \; \psi_{cp,N} \; N_b \right]$ ACI 318-14 Eq. (17.5.3.1b)

$\phi \; V_{cpg} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

A_{Nc} see ACI 318-14, Section 17.4.2.1, Fig. R 17.4.2.1(b)

$A_{Nc0} = 9 \, h_{ef}^2$ ACI 318-14 Eq. (17.4.2.1c)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2 \, e_N'}{3 \, h_{ef}}} \right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.4)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.5b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.7b)

$N_b = 16 \, \lambda_a \sqrt{f_c'} \, h_{ef}^{5/3}$ ACI 318-14 Eq. (17.4.2.2b)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	18.000	0.000	0.000	12.000

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f_c' [psi]
1.000	-	16	1.000	2,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
2,376.00	2,916.00	1.000	1.000	0.833	1.000	98,903

Results

V_{cpg} [lb]	$\phi_{concrete}$	$\phi \; V_{cpg}$ [lb]	V_{ua} [lb]
134,312	0.700	94,019	136

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1.4.3 Concrete edge failure in direction x+

$$V_{cbg} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ec,V}\ \psi_{ed,V}\ \psi_{c,V}\ \psi_{h,V}\ \psi_{parallel,V}\ V_b$$ ACI 318-14 Eq. (17.5.2.1b)

$\phi\ V_{cbg} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

A_{Vc} see ACI 318-14, Section 17.5.2.1, Fig. R 17.5.2.1(b)*

$A_{Vc0} = 4.5\ c_{a1}^2$ ACI 318-14 Eq. (17.5.2.1c)

$$\psi_{ec,V} = \left(\frac{1}{1 + \frac{2e_V'}{3c_{a1}}}\right) \leq 1.0$$ ACI 318-14 Eq. (17.5.2.5)

$$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$$ ACI 318-14 Eq. (17.5.2.6b)

$$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$$ ACI 318-14 Eq. (17.5.2.8)

$$V_b = 9\ \lambda_a\ \sqrt{f_c'}\ c_{a1}^{1.5}$$ ACI 318-14 Eq. (17.5.2.2b)

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
12.000	-	0.033	1.000	42.000

l_e [in.]	λ_a	d_a [in.]	f_c' [psi]	$\psi_{parallel,V}$
6.000	1.000	0.750	2,500	1.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
864.00	648.00	0.998	1.000	1.000	18,706

Results

V_{cbg} [lb]	$\phi_{concrete}$	$\phi\ V_{cbg}$ [lb]	V_{ua} [lb]
24,896	0.700	17,427	162

*Anchor row defined by: Anchor 2, 4; Case 3 controls

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

1.5 Combined tension and shear loads

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.794	0.011	1.000	68	OK

$\beta_{NV} = (\beta_N + \beta_V) / 1.2 <= 1$

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1.6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates as per current regulations (ETAG 001/Annex C, EOTA TR029, etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid base plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- For additional information about ACI 318 strength design provisions, please go to https://viewer.joomag.com/profis-design-guide-us-en-summer-2021/0841849001625154758?short&/
- Attention! In case of compressive anchor forces a buckling check as well as the proof of the local load transfer into and within the base material (incl. punching) has to be done separately.
- The anchor design methods in PROFIS Engineering require rigid anchor plates, as per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means that the anchor plate should be sufficiently rigid to prevent load re-distribution to the anchors due to elastic/plastic displacements. The user accepts that the anchor plate is considered close to rigid by engineering judgment."

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6/02/25
By: CS
Check by: JL, SE

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1.7 Installation data

Profile: Round HSS (AISC), HSS6-5/8X.280; (L x W x T) = 6.625 in. x 6.625 in. x 0.280 in.

Hole diameter in the fixture: d_f = 0.812 in.

Plate thickness (input): 0.750 in.

Anchor type and diameter: Heavy Hex Head ASTM F 1554 GR. 36 3/4

Item number: not available

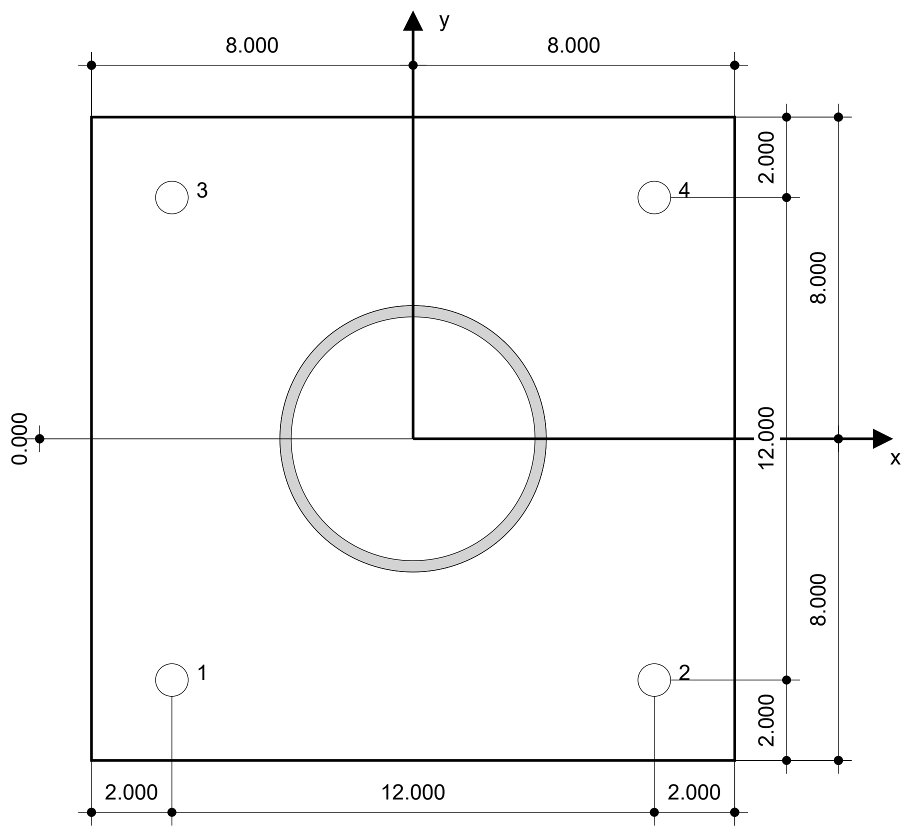
Maximum installation torque: -

Hole diameter in the base material: - in.

Hole depth in the base material: 18.000 in.

Minimum thickness of the base material: 19.000 in.

∅ 3/4 in Heavy Hex Head ASTM F 1554 GR. 36 with 18 in nominal embedment depth per Technical data , cast in place installation per MPII



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-6.000	-6.000	12.000	24.000	-	-
2	6.000	-6.000	24.000	12.000	-	-
3	-6.000	6.000	12.000	24.000	-	-
4	6.000	6.000	24.000	12.000	-	-

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2 Anchor plate design

2.1 Input data

Anchor plate:	Shape: Rectangular l_x x l_y x t = 16.000 in x 16.000 in x 0.750 in Calculation: CBFEM Material: ASTM A36; F_y = 36,000 psi; ε_{lim} = 5.00%
Anchor type and size:	Heavy Hex Head ASTM F 1554 GR. 36 3/4, h_{ef} = 18.000 in
Anchor stiffness:	The anchor is modeled considering stiffness values determined from load displacement curves tested in an independent laboratory. Please note that no simple replacement of the anchor is possible as the anchor stiffness has a major impact on the load distribution results.
Design method:	AISC and LRFD-based design using component-based FEM
Seismic loads (cat. C, D, E or F):	Tension load: Yes (17.2.3.4.3 (d)) Shear load: Yes (17.2.3.5.3 (c))
Stand-off installation:	e_b = 0.000 in (No stand-off); t = 0.750 in
Profile:	HSS6-5/8X.280; (L x W x T x FT) = 6.625 in x 6.625 in x 0.280 in x - Material: ASTM A500 Gr.B Round; F_y = 42,000 psi; ε_{lim} = 5.00% Eccentricity x: 0.000 in Eccentricity y: 0.000 in
Base material:	Cracked concrete; 2500; $f_{c,cyl}$ = 2,500 psi; h = 42.000 in
Welds (profile to anchor plate):	Type of redistribution: Plastic Material: E70xx
Stiffeners:	Geometry: Triangular; size = l_x x l_y x t = 2.500 in x 2.500 in x 0.313 in Material: ASTM A36; F_y = 36,000 psi; ε_{lim} = 5.00%
Welds (stiffeners to profile/anchor plate):	Type of redistribution: Plastic Material: E70xx
Mesh size:	Number of elements on edge: 8 Min. size of element: 0.394 in Max. size of element: 1.969 in

2.2 Summary

	Description	Profile		Stiffeners		Anchor plate			Welds [%]	Concrete [%]
		σ_{Ed} [psi]	ε_{Pl} [%]	σ_{Ed} [psi]	ε_{Pl} [%]	σ_{Ed} [psi]	ε_{Pl} [%]	Hole bearing [%]		
1	1.4*D	11,822	0.00	11,117	0.00	5,947	0.00	1	21	4
2	**1.2D+1.6Lr+ 0.5WA**	**42,016**	**0.06**	**35,133**	**0.19**	**26,503**	**0.00**	**1**	**76**	**16**
3	1.2D+1.6S+0. 5WA	29,879	0.00	28,023	0.00	14,649	0.00	1	52	9
4	1.2*D+0.5Lr+ WA	29,357	0.00	27,654	0.00	14,364	0.00	1	51	9
5	1.2D+0.5S+ WA	22,216	0.00	20,961	0.00	10,975	0.00	1	39	7
6	0.9*D+WB	9,565	0.00	8,595	0.00	4,594	0.00	1	17	3
7	1.2D+ELx+El y (w/ Ω0)	14,720	0.00	13,832	0.00	7,329	0.00	1	26	5
8	1.2D+ELz+El y (w/ Ω0)	13,949	0.00	13,332	0.00	6,548	0.00	1	24	5
9	0.9D-ELx-Ely (w/ Ω0)	7,288	0.00	6,864	0.00	3,756	0.00	1	13	3
10	0.9D-ELz-Ely (w/ Ω0)	9,909	0.00	9,500	0.00	4,732	0.00	1	18	3
11	1.2D+Di+WL-Lat+0.5S	42,004	0.01	33,852	0.11	21,858	0.00	1	73	14

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12	1.2D+Di+WA(ice)+0.5S	42,008	0.03	34,372	0.13	23,544	0.00	1	76	14

2.3 Anchor plate classification

Results below are displayed for the decisive load combinations: 1.2D+1.6Lr+0.5WA

Anchor tension forces	Equivalent rigid anchor plate (CBFEM)	Component-based Finite Element Method (CBFEM) anchor plate design
Anchor 1	6,975 lb	10,121 lb
Anchor 2	-1 lb	-0 lb
Anchor 3	6,975 lb	10,124 lb
Anchor 4	-1 lb	-0 lb

User accepted to consider the selected anchor plate as rigid by his/her engineering judgement. This means the anchor design guidelines can be applied.

2.4 Profile/Stiffeners/Plate

Profile and stiffeners are verified at the level of the steel to concrete connection. The connection design does not replace the steel design for critical cross sections, which should be performed outside of PROFIS Engineering.

2.4.1 Equivalent stress and plastic strain

Part	Load combination	Material	f_y [psi]	ε_{lim} [%]	σ_{Ed} [psi]	ε_{Pl} [%]	Status
Plate	1.2D+1.6Lr+0.5WA	ASTM A36	36,000	5.00	26,503	0.00	OK
Profile	1.2D+1.6Lr+0.5WA	ASTM A500 Gr.B Round	42,000	5.00	42,016	0.06	OK
Stiffener	1.2D+1.6Lr+0.5WA	ASTM A36	36,000	5.00	35,133	0.19	OK

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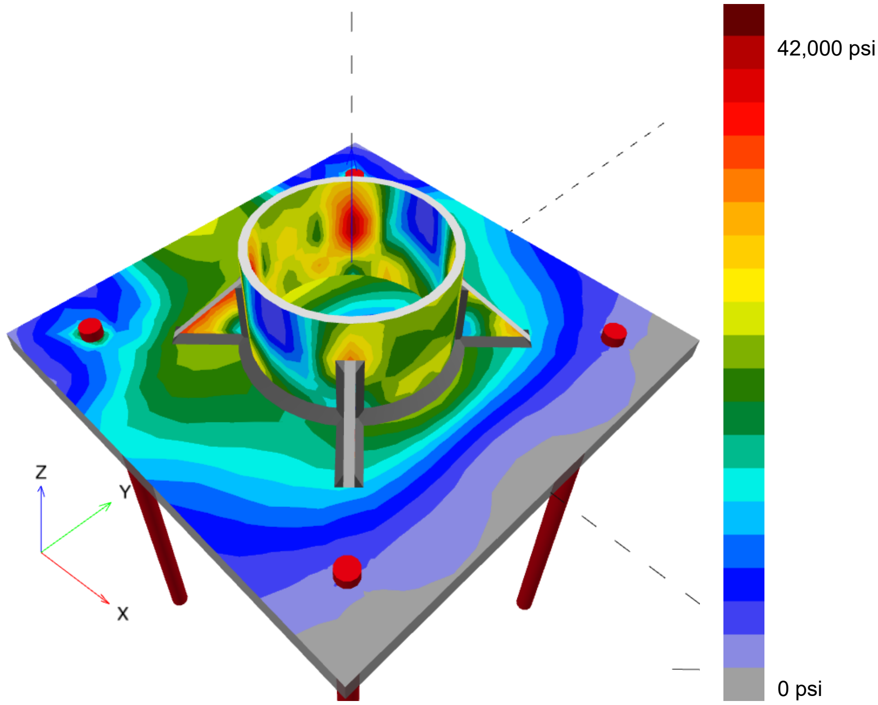
2.4.1.1 Equivalent stress

Results below are displayed for the decisive load combination: 2 - 1.2D+1.6Lr+0.5WA



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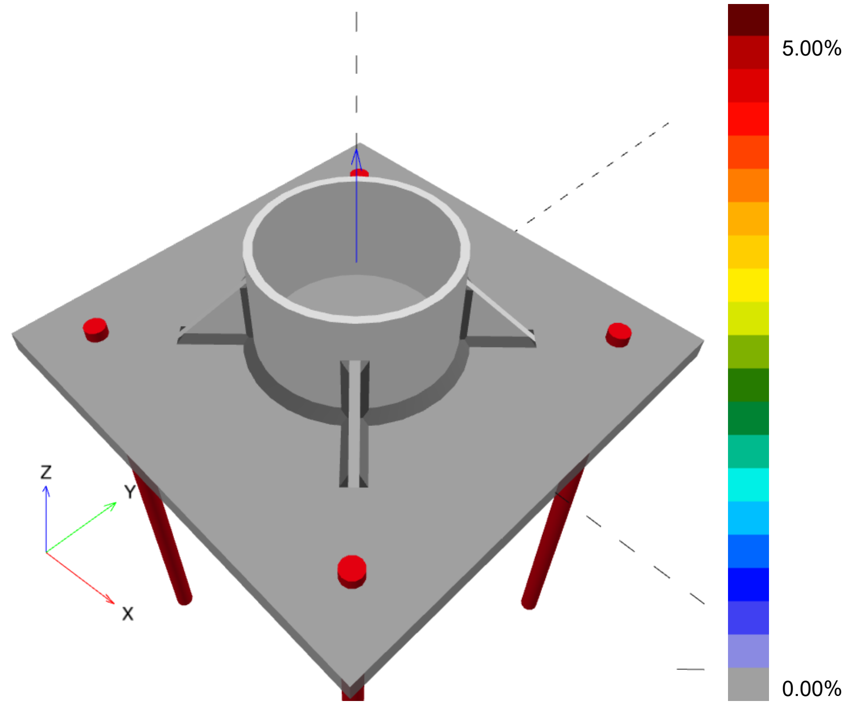
2.4.1.2 Plastic strain

Results below are displayed for the decisive load combination: 2 - 1.2D+1.6Lr+0.5WA



2.4.2 Plate hole bearing resistance, AISC 360-16 Section J3

Decisive load combination: 2 - 1.2D+1.6Lr+0.5WA

Equations

R_n = $\min(1.2\ l_c\ t\ F_u\ ,\ 2.4\ d\ t\ F_u)$ (AISC 360-16 J3-6a, c)

ΦR_n = $0.75\ R_n$

V $\leq$ ΦR_n

Variables

	l_c [in]	t [in]	F_u [psi]	d [in]	R_n [lb]
Anchor 1	1.986	0.750	58,000	0.750	78,300
Anchor 2	17.958	0.750	58,000	0.750	78,300
Anchor 3	1.987	0.750	58,000	0.750	78,300
Anchor 4	17.950	0.750	58,000	0.750	78,300

Results

	V [lb]	ΦR_n [lb]	Utilization [%]	Status
Anchor 1	80	58,725	1	OK
Anchor 2	31	58,725	1	OK
Anchor 3	81	58,725	1	OK

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	V [lb]	ΦR_n [lb]	Utilization [%]	Status
Anchor 4	31	58,725	1	OK

2.5 Welds

Profiles are modeled without taking the corner radius into account. Special rules for welding (e.g. for cold-formed profiles ...) are not taken into account by the software.

2.5.1 Anchor plate to profile

Decisive load combination: 2 - 1.2D+1.6Lr+0.5WA

Equations

$$F_{nw} = 0.6\, F_{EXX}\, (1.0 + 0.5\sin^{1.5}\Theta)$$

$$\Phi R_n = \Phi\, F_{nw}\, A_w$$

$$\text{Utilization} = \frac{F_n}{\Phi\, R_n}$$

Variables

Edge	X_u	T_h [in]	L_s [in]	L [in]	L_c [in]	F_{EXX} [psi]	Θ [°]	A_w [in²]
Member 1	E70xx	0.265◣	0.375	19.901	0.622	70,000	75.2	0.16

Results

Edge	F_n [lb]	ΦR_n [lb]	Utilization [%]	Status
Member 1	4,364	7,659	57	OK

2.5.2 Stiffeners to profile/anchor plate

Decisive load combination: 2 - 1.2D+1.6Lr+0.5WA

Equations

$$F_{nw} = 0.6\, F_{EXX}\, (1.0 + 0.5\sin^{1.5}\Theta)$$

$$\Phi R_n = \Phi\, F_{nw}\, A_w$$

$$\text{Utilization} = \frac{F_n}{\Phi\, R_n}$$

Variables

Edge	X_u	T_h [in]	L_s [in]	L [in]	L_c [in]	F_{EXX} [psi]	Θ [°]	A_w [in²]
Stiffenera (Anchor plate)	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	46.0	0.07
Stiffenera (Anchor plate) 1	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	39.8	0.07
Stiffenerb (Anchor plate)	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	42.9	0.07
Stiffenerb (Anchor plate) 1	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	49.2	0.07
Stiffenerc (Anchor plate)	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	58.2	0.07
Stiffenerc (Anchor plate) 1	E70xx	◢0.177◣	0.250	2.476	0.413	70,000	18.4	0.07

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Edge	X_u	T_h [in]	L_s [in]	L [in]	L_c [in]	F_{EXX} [psi]	Θ [°]	A_w [in²]
Stiffenerd (Anchor plate)	E70xx	◢0.177◣	0.250	2.476	0.413	70,000	19.4	0.07
Stiffenerd (Anchor plate) 1	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	57.2	0.07
Stiffenera (Member 1-arc 5)	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	48.6	0.07
Stiffenera (Member 1-arc 5) 1	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	38.8	0.07
Stiffenerb (Member 1-arc 13)	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	43.6	0.07
Stiffenerb (Member 1-arc 13) 1	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	43.2	0.07
Stiffenerc (Member 1-arc 21)	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	38.7	0.07
Stiffenerc (Member 1-arc 21) 1	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	32.5	0.07
Stiffenerd (Member 1-arc 29)	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	37.0	0.07
Stiffenerd (Member 1-arc 29) 1	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	33.9	0.07

Results

Edge	F_n [lb]	ΦR_n [lb]	Utilization [%]	Status
Stiffenera (Anchor plate)	1,976	3,018	66	OK
Stiffenera (Anchor plate) 1	2,088	2,903	72	OK
Stiffenerb (Anchor plate)	2,153	2,962	73	OK
Stiffenerb (Anchor plate) 1	2,043	3,073	67	OK
Stiffenerc (Anchor plate)	927	3,218	29	OK
Stiffenerc (Anchor plate) 1	1,555	2,505	63	OK
Stiffenerd (Anchor plate)	1,575	2,521	63	OK
Stiffenerd (Anchor plate) 1	938	3,203	30	OK
Stiffenera (Member 1-arc 5)	2,143	3,063	70	OK
Stiffenera (Member 1-arc 5) 1	2,167	2,885	76	OK
Stiffenerb (Member 1-arc 13)	2,232	2,974	76	OK
Stiffenerb (Member 1-arc 13) 1	2,178	2,968	74	OK
Stiffenerc (Member 1-arc 21)	1,522	2,884	53	OK
Stiffenerc (Member 1-arc 21) 1	1,632	2,768	59	OK
Stiffenerd (Member 1-arc 29)	1,538	2,852	54	OK
Stiffenerd (Member 1-arc 29) 1	1,601	2,793	58	OK

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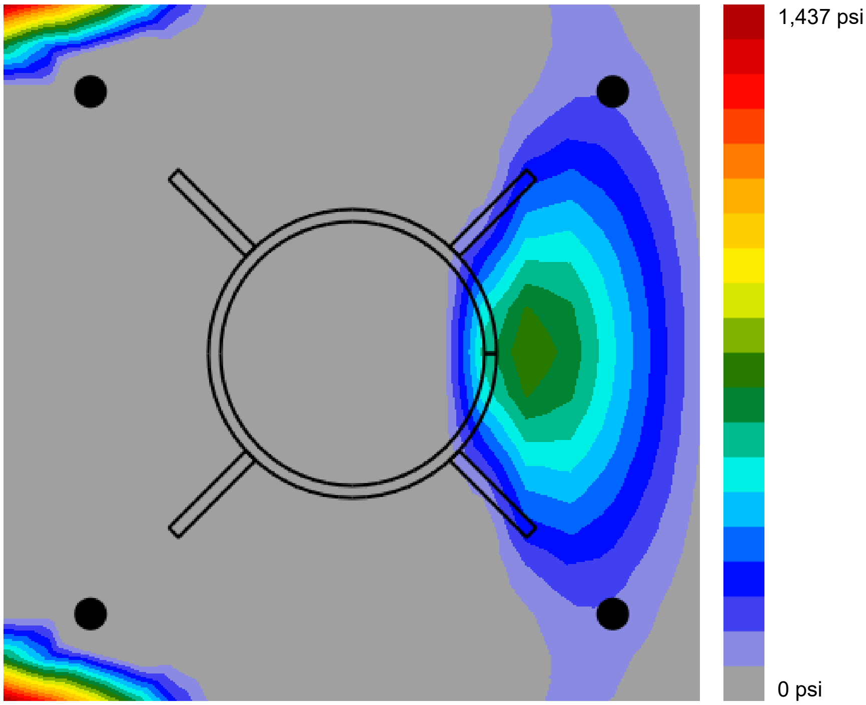
2.6 Concrete

Decisive load combination: 2 - 1.2D+1.6Lr+0.5WA

2.6.1 Compression in concrete under the anchor plate



2.6.2 Concrete block compressive strength resistance check, AISC 360-16 Section J8

Equations

$$F_p = \Phi f_{p,max}$$

$$f_{p,max} = 0.85\, f_c' \sqrt{\left(\frac{A_2}{A_1}\right)} \leq 1.7\, f_c; \quad \sqrt{\left(\frac{A_2}{A_1}\right)} \leq 2$$

$$\sigma = \frac{N}{A_1}$$

$$\text{Utilization} = \frac{\sigma}{F_p}$$

Variables

N [lb]	f_c' [psi]	Φ	A_1 [in²]	A_2 [in²]
24,050	2,500	0.65	55.69	1,109.81

Results

Load combination	F_p [psi]	σ [psi]	Utilization [%]	Status
1.2D+1.6Lr+0.5WA	2,762	432	16	OK

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2.7 Symbol explanation

A_1	Loaded area of concrete
A_2	Supporting area
A_w	Effective area of weld critical element
d	Nominal diameter of the bolt
ε_{lim}	Limit plastic strain
ε_{Pl}	Plastic strain from CBFEM results
f_c	Concrete compressive strength
f_c'	Concrete compressive strength
F_{EXX}	Electrode classification number, i.e. minimum specified tensile strength
F_u	Specified minimum tensile strength of the connected material
F_n	Force in weld critical element
F_{nw}	Nominal stress of the weld material
F_p	Concrete block design bearing strength
$f_{p,max}$	Concrete block design bearing strength maximum
f_y	Yield strength
l_c	Clear distance, in the direction of the force, between the edge of the hole and the edge of the adjacent hole or edge of the material
L	Length of weld
L_c	Length of weld critical element
L_s	Leg size of weld
N	Resulting compression force
σ	Average stress in concrete
σ_{Ed}	Equivalent stress
Φ	Resistance factor
ΦR_n	Factored resistance
R_n	Resistance
t	Thickness of the anchor plate
Θ	Angle of loading measured from the weld longitudinal axis
T_h	Throat thickness of weld
V	Resultant of shear forces Vy, Vz in bolt.
X_u	Filler metal tensile strength

2.8 Warnings

- By using the CBFEM calculation functionality of PROFIS Engineering you may act outside the applicable design codes and your specified anchor plate may not behave rigid. Please, validate the results with a professional designer and/or structural engineer to ensure suitability and adequacy for your specific jurisdiction and project requirements.
- The anchor is modeled considering stiffness values determined from load displacement curves tested in an independent laboratory. Please note that no simple replacement of the anchor is possible as the anchor stiffness has a major impact on the load distribution results.

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3 Summary of results

Design of the anchor plate, anchors, welds and other elements are based on CBFEM (component based finite element method) and AISC.

	Load combination	Max. utilization	Status
Anchors	1.2D+1.6Lr+0.5WA	80%	OK
Anchor plate	1.2D+1.6Lr+0.5WA	74%	OK
Welds	1.2D+1.6Lr+0.5WA	76%	OK
Stiffeners	1.2D+1.6Lr+0.5WA	98%	OK
Concrete	1.2D+1.6Lr+0.5WA	16%	OK
Profile	1.2D+1.6Lr+0.5WA	100%	OK

Fastening meets the design criteria!

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4 Remarks; Your Cooperation Duties

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Pipe Flange Connection

$C_c :=$ Envelope (All Nodes) / Envelope (Per Node) / Load Combo (Per Node)

LC := Envelope / D / D + RLL

NODE := N2 / N40 / N46

Number of Bolts Per Connection	$N_{bolts} := 4$
Flange Bolt Circle	$BC := 7.0in$
Max Tension at Connection	$T = 4655.41 \cdot lb$
Max Moment at Connection	$M = 1397.61 \cdot lb \cdot ft$
Max Shear at Connection	$V = 1387.78\,lb$
Max Tension per Bolt	$T_{max} := \frac{T}{N_{bolts}} + \frac{4 \cdot M}{BC \cdot N_{bolts}} = 3560\,lb$
Max Shear per Bolt	$V_{max} := \frac{V}{N_{bolts}} = 347\,lb$
Use 5/8" Dia. Grade 5 Bolts:	$T_{all} := 10848lb \quad V_{all} := 5738lb$

Use (4) 5/8" Dia. Grade 5 Bolts at Flange Connections

$$\frac{T_{max}}{T_{all}} + \frac{V_{max}}{V_{all}} = 0.39$$ **< 1.0 OK**

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Check by: JL, SE

Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

$LCq = \text{"ENVELOPE"}$

Connection Analysis- HSS Mast Arm Welded to HSS Column

ASTM A500 Grade B $\quad F_y := f_{ya500} = 50 \cdot ksi \quad F_u := f_{ua500} = 62 \cdot ksi \quad E := E_s = 29000 \cdot ksi$

$prop_{4,A} = \text{"HSS 6.625 x 0.280"}$ $\quad pprop_{4,B} = \text{"HSS 3.5 x 0.216"}$

$A := prop_{0,A} \cdot in^2 = 5.2 \cdot in^2 \quad A_b := pprop_{0,B} \cdot in^2 = 2.07 \cdot in^2 \quad P = 4.74 \cdot k$

$t := prop_{1,A} \cdot in = 0.26 \cdot in \quad t_b := pprop_{1,B} \cdot in = 0.2 \cdot in \quad M_{in} = 0.27 \cdot k \cdot ft$ M2

$D := prop_{2,A} \cdot in = 6.62 \cdot in \quad D_b := pprop_{2,B} \cdot in = 3.5 \cdot in \quad M_{out} = 0.08 \cdot k \cdot ft$

$S := prop_{3,A} \cdot in^3 = 7.96 \cdot in^3 \quad S_b := pprop_{3,B} \cdot in^3 = 1.63 \cdot in^3$

AISC Specification Section K4 and Table K4.1A - Limits of Applicability $\quad \theta := 75deg$ > 30 deg

Branch Wall Slenderness

$\frac{D_b}{t_b} = 17.41 < 50$ **OK**

$\frac{D_b}{t_b} = 17.41 < 0.05 \cdot \frac{E}{F_y} = 29$ **OK**

Column Wall Slenderness

$\frac{D}{t} = 25.48$ < 50 **OK**

Width Ratio $\quad 0.2 < \frac{D_b}{D} = 0.53$ < or = 1.0 **OK**

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Connection Analysis- HSS Mast Arm Welded to HSS Column (Cont'd)

AVAILABLE FLEXURAL STRENGTH - AISC TABLE K4.1

Chord Plastification (In-plane bending moment in branch) - AISC table K4.1

Max.Chord (Column) Axial Reaction $P_r = 2.38 \cdot k$

Max. Chord Moment (In Plane) $M_r = 12.86 \cdot k \cdot ft$ M44

$\beta := \frac{D_b}{D} = 0.53$ $\gamma := \frac{D}{2 \cdot t} = 12.74$

$F_c := 0.6 \cdot F_y = 30 \cdot ksi$

$U_T := 1.0$ $U := \left| \frac{P_r}{A \cdot F_c} + \frac{M_r}{S \cdot F_c} \right| = 0.661$

$Q_f := 1.0 - 0.3U \cdot (1 + U) = 0.67$ $\Omega := 1.67$

$$M_{nip} := \frac{5.39 \cdot F_y \cdot t^2 \cdot \gamma^{0.5} \cdot \beta \cdot D_b \cdot Q_f}{\sin(\theta)} = 6954.21\,ft \cdot lb$$

$$\frac{M_{nip}}{\Omega} = 4164.2\,ft \cdot lb$$

Shear Yielding (punching - in plane bending moment in branch) AISC Table K4.1

$D_b = 3.5 \cdot in$ < $(D - 2 \cdot t) = 6.1 \cdot in$ $\Omega_y := 1.58$

$$M_{nip2} := \left[0.6 \cdot F_y \cdot t \cdot D_b^2 \left(\frac{1 + 3 \cdot \sin(\theta)}{4 \cdot \sin(\theta)^2} \right) \right] = 8316.09\,ft \cdot lb$$

$$M_{nip2} \div \Omega_y = 5263.35\,ft \cdot lb$$

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Connection Analysis- HSS Mast Arm Welded to HSS Column (Cont'd)

Chord Plastification (Out-of-plane bending moment in branch) - AISC table K4.1

$$M_{nop} := \frac{F_y \cdot t^2 \cdot D_b}{\sin(\theta)} \cdot \left(\frac{3}{1 - 0.81\beta}\right) \cdot Q_f = 3588.01\ ft \cdot lb \qquad \Omega = 1.67$$

$$\frac{M_{nop}}{\Omega} = 2148.51\ ft \cdot lb$$

Shear Yielding - punching (Out-of-plane bending moment in branch) - AISC table K4.1

$$D_b = 3.5 \cdot in \quad < \quad (D - 2 \cdot t) = 6.1 \cdot in \qquad \Omega_y := 1.58$$

$$M_{nop2} := 0.6 F_y \cdot t \cdot D_b^{\,2} \cdot \left(\frac{3 + \sin(\theta)}{4 \cdot \sin(\theta)^2}\right) = 8461.48\ ft \cdot lb$$

$$\frac{M_{nop2}}{\Omega_y} = 5355.37\ ft \cdot lb$$

AVAILABLE AXIAL STRENGTH - AISC TABLE K3.1

Shear Yielding - punching - AISC table K3.1

$$D_b = 3.5 \cdot in < (D - 2 \cdot t) = 6.1 \cdot in$$

$$P_n := 0.6 \cdot F_y \cdot t \cdot \pi \cdot D_b \left(\frac{1 + \sin(\theta)}{2 \cdot \sin(\theta)^2}\right) = 90357 \quad \Omega_y := 1.58$$

$$\frac{P_n}{\Omega_y} = 57188.01\ lb$$

Chord Plastification

$$P_{n2} := \frac{F_y \cdot t^2 \cdot \left(3.1 + 15.6\beta^2\right) \cdot \gamma^{0.2} \cdot Q_f}{\sin(\theta)} = 29088.74\ lb \qquad \Omega = 1.67$$

$$\frac{P_{n2}}{\Omega} = 17418.41\ lb$$

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Connection Analysis- HSS Mast Arm Welded to HSS Column (Cont'd)

CONNECTION SUMMARY RESULTS $\quad LCq = \text{"ENVELOPE"}$

Allowable In-Plane Bending $\quad M_{ain} := \min\left(\frac{M_{nip}}{\Omega}, \frac{M_{nip2}}{\Omega_y}\right) = 4164.2\,ft\cdot lb$

Allowable Out of Plane Bending $\quad M_{aout} := \min\left(\frac{M_{nop}}{\Omega}, \frac{M_{nop2}}{\Omega_y}\right) = 2148.51\,ft\cdot lb$

Allowable Axial Load $\quad P_a := \min\left(\frac{P_n}{\Omega_y}, \frac{P_{n2}}{\Omega}\right) = 17418.41\,lb$

$$\frac{P}{P_a} + \left(\frac{M_{in}}{M_{ain}}\right)^2 + \frac{M_{out}}{M_{aout}} = 0.31$$ **< 1.0 OK**

Weld Check

$d := D_b = 3.5\cdot in \qquad l_w := \pi\cdot d = 11\cdot in \qquad S_w := \frac{\pi\cdot d^2}{4} = 9.62\cdot in^2$

$V = 454.68\,lb \qquad M := M_{in} = 271.29\,ft\cdot lb$

$D := 3in$ 1/16 in. weld $\qquad R_{c\_cs} := 0.928ksi\,D\cdot d \qquad \Omega_{cs} := 2.0 \qquad F_{u\_cs} := 70ksi$

$\frac{R_{c\_cs}}{d} = 2.78\cdot\frac{k}{in} > \frac{M}{S_w} + \frac{V}{l_w} = 0.38\cdot\frac{k}{in}$ **WELD OK**

USE = "3/16 FILLET WELD ALL AROUND"

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Ph enix, AZ 85034
(602) 438-2500

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Check by: JL, SE

Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Connection Analysis- HSS Welded to HSS Mast Arm $LCq = \text{"ENVELOPE"}$

ASTM A500 Grade B $F_y := f_{ya500} = 50 \cdot ksi$ $F_u := f_{ua500} = 62 \cdot ksi$ $E := E_s = 29000 \cdot ksi$

$pprop_{4,B} = \text{"HSS 3.5 x 0.216"}$

$A := pprop_{0,B} \cdot in^2 = 2.07 \cdot in^2$ $A_b := pprop_{0,B} \cdot in^2 = 2.07 \cdot in^2$ $P = 4.48 \cdot k$

$t := pprop_{1,B} \cdot in = 0.2 \cdot in$ $t_b := pprop_{1,B} \cdot in = 0.2 \cdot in$ $M_{in} = 2.82 \cdot k \cdot ft$ M35

$D := pprop_{2,B} \cdot in = 3.5 \cdot in$ $D_b := pprop_{2,B} \cdot in = 3.5 \cdot in$ $M_{out} = 0.02 \cdot k \cdot ft$

$S := pprop_{3,B} \cdot in^3 = 1.63 \cdot in^3$ $S_b := pprop_{3,B} \cdot in^3 = 1.63 \cdot in^3$

AISC Specification Section K4 and Table K4.1A - Limits of Applicability $\theta := 45deg > 30\ deg$

Branch Wall Slenderness

$\frac{D_b}{t_b} = 17.41 < 50$ **OK**

$\frac{D_b}{t_b} = 17.41 < 0.05 \cdot \frac{E}{F_y} = 29$ **OK**

Column Wall Slenderness $\frac{D}{t} = 17.41 < 50$ **OK**

Width Ratio $0.2 < \frac{D_b}{D} = 1$ < or = 1.0 **OK**

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Connection Analysis- HSS Welded to HSS Mast Arm (Cont'd)

AVAILABLE FLEXURAL STRENGTH - AISC TABLE K4.1

Chord Plastification (In-plane bending moment in branch) - AISC table K4.1

Max.Chord Axial Reaction $P_r = 0.0657 \cdot k$ M15

Max. Chord Moment (In Plane) $M_r = 3.37 \cdot k \cdot ft$

$\beta := \frac{D_b}{D} = 1$ $\gamma := \frac{D}{2 \cdot t} = 8.71$

$F_c := 0.6 \cdot F_y = 30 \cdot ksi$

$Q_f := 1.0$ TABLE K4.1
K2 -3 $\Omega := 1.67$

$$M_{nip} := \frac{5.39 \cdot F_y \cdot t^2 \cdot \gamma^{0.5} \cdot \beta \cdot D_b \cdot Q_f}{\sin(\theta)} = 13251.76\, ft \cdot lb$$

Shear Yielding (punching - in plane bending moment in branch) AISC Table K4.1

$D_b = 3.5 \cdot in$ < $(D - 2 \cdot t) = 3.1 \cdot in$ $\Omega_y := 1.58$

If D.b is greater > than (D-2t) Limit State does not need to be checked.

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Connection Analysis- HSS Welded to HSS Mast Arm (Cont'd)

Chord Plastification (Out-of-plane bending moment in branch) - AISC table K4.1

$$M_{nop} := \left[\frac{F_y \cdot t^2 \cdot D_b}{\sin(\theta)} \cdot \left(\frac{3}{1 - 0.81\beta}\right) \cdot Q_f\right] = 13156.23\,ft \cdot lb \qquad \Omega = 1.67$$

$$M_{nop} \div \Omega = 7877.98\,ft \cdot lb$$

Shear Yielding - punching (Out-of-plane bending moment in branch) - AISC table K4.1

$$D_b = 3.5 \cdot in \quad < \quad (D - 2 \cdot t) = 3.1 \cdot in \qquad \Omega_y := 1.58$$

If D.b is greater > than (D-2t) Limit State does not need to be checked.

AVAILABLE AXIAL STRENGTH - AISC TABLE K3.1

Shear Yielding - punching - AISC table K3.1

$$D_b = 3.5 \cdot in < (D - 2 \cdot t) = 3.1 \cdot in \qquad \Omega_y := 1.58$$

If D.b is greater > than (D-2t) Limit State does not need to be checked.

Chord Plastification

$$P_{n2} := \frac{F_y \cdot t^2 \cdot \left(3.1 + 15.6\beta^2\right) \cdot \gamma^{0.2} \cdot Q_f}{\sin(\theta)} = 82354.46\,lb \qquad \Omega = 1.67$$

$$P_{n2} \div \Omega = 49314.05\,lb$$

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Ph enix, AZ 85034
(602) 438-2500

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Connection Analysis- HSS Welded to HSS Mast Arm (Cont'd)

CONNECTION SUMMARY RESULTS

Allowable In-Plane Bending $M_{ain} := \min\left(\frac{M_{nip}}{\Omega}\right) = 7935.19\,ft\cdot lb$

Allowable Out of Plane Bending $M_{aout} := \min\left(\frac{M_{nop}}{\Omega}\right) = 7877.98\,ft\cdot lb$

Allowable Axial Load $P_a := \min\left(\frac{P_{n2}}{\Omega}\right) = 49314.05\,lb$

$\cos(\theta) = 0.71$ $\frac{P}{P_a} + \left(\frac{M_{in}}{M_{ain}}\right)^2 + \frac{M_{out}}{M_{aout}} = 0.22$ **< 1.0 OK**

Weld Check

$d := 2\cdot D_b\cdot \cos(\theta) = 4.9\cdot in$ $l_w := \pi\cdot d = 15.55\cdot in$ $S_w := \frac{\pi\cdot d^2}{4} = 19.24\cdot in^2$

$V = 1400.68\,lb$ $M := M_{in} = 2815.3\,ft\cdot lb$

$D := 4in$ 1/16 in. weld $R_{c\_cs} := 0.928ksi\,D\cdot d$ $\Omega_{cs} := 2.0$ $F_{u\_cs} := 70ksi$

$\frac{R_{c\_cs}}{d} = 3.71\cdot\frac{k}{in} > \frac{M}{S_w} + \frac{V}{l_w} = 1.85\cdot\frac{k}{in}$ **WELD OK**

USE = "1/4 FILLET WELD ALL AROUND"

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Ph enix, AZ 85034
(602) 438-2500

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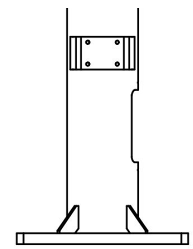
Check by: JL, SE

Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)



A500B Gr 50

Opening in Pole at Base Analysis

Risa-3D Reactions

$LCq = \text{"ENVELOPE"}$

$V_z = 0.042 \cdot k \quad V_y = 0.2 \cdot k \qquad P = 2.38 \cdot k \qquad M_z = 0.32 \cdot k \cdot ft$

$V := \sqrt{V_z^2 + V_y^2} = 200\,lb \qquad T = 0.15 \cdot k \cdot ft \qquad M_y = 12.5 \cdot k \cdot ft$

Steel Properties

$f_y := f_{ya500} = 50 \cdot ksi$

$E := 29000ksi \quad K := 2.1 \quad L := 10.647ft$

Safety Factors $\quad \Omega_c := 1.67 \quad \Omega_b := 1.67 \quad \Omega_T := 1.67 \quad \Omega_v := 1.67$

Section Properties - HSS Post with Opening

$prop_{4,A} = \text{"HSS 6.625 x 0.280"}$

$A := oprop_{0,A} in^2 = 4.15 \cdot in^2 \qquad S_z := oprop_{1,A} in^3 = 4.24 \cdot in^3 \qquad S_y := oprop_{2,A} in^3 = 7.56 \cdot in^3$

$r_z := oprop_{3,A} in = 1.89 \cdot in \qquad r_y := oprop_{4,A} in = 2.46 \cdot in \qquad t_{des} := prop_{5,A} in = 0.26 \cdot in$

Axial Compression

$$\frac{K \cdot L}{r_y} = 109.29 > 4.71 \cdot \sqrt{\frac{E}{f_y}} = 113.43 \qquad \frac{K \cdot L}{r_z} = 142.34 > 4.71 \cdot \sqrt{\frac{E}{f_y}} = 113.43$$

$$F_e := \frac{\pi^2 \cdot E}{\left(\frac{K \cdot L}{\min(r_y, r_z)}\right)^2} = 14.13 \cdot ksi \qquad F_{cr} := 0.877 \cdot F_e = 12.39 \cdot ksi$$

$$P_{all} := \frac{F_{cr} \cdot A}{\Omega_c} = 30.8 \cdot k \qquad r_m := 6.365in$$

Shear $\quad C_v := 1$

$$V_{all} := \frac{0.6 \cdot f_y \cdot A \cdot C_v}{\Omega_v} = 75 \cdot k \qquad \tau_{app} := \frac{T \cdot (6 \cdot \pi r_m + 1.8t_{des})}{4\pi^2 r_m^2 (t_{des})^2} = 1.94 \cdot ksi$$

$$\tau_{max} := \frac{0.6 \cdot f_y}{\Omega_v} = 17.96 \cdot ksi \qquad \frac{\tau_{app}}{\tau_{max}} = 0.11$$

Flexural

$$M_{zall} := \frac{f_y \cdot S_z}{\Omega_b} = 10.579 \cdot k \cdot ft \qquad M_{yall} := \frac{f_y \cdot S_y}{\Omega_b} = 18.862 \cdot k \cdot ft$$

$EQ = \text{"H2-1"} \qquad UNITY = 0.77$ **< 1.0 OK, NO STIFFENERS REQUIRED**

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Ph enix, AZ 85034
(602) 438-2500

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Half Palm Arch Vacuum Stanchion Canopy Analysis (cont'd)

Section Properties - HSS Tube with Opening Reinforced

$A := rprop_{0,A} \cdot in^2 = 5.28 \cdot in^2$ $\quad S_z := rprop_{1,A} \cdot in^3 = 7.35 \cdot in^3$ $\quad S_y := rprop_{2,A} \cdot in^3 = 8.53 \cdot in^3$

$r_z := rprop_{3,A} \cdot in = 2.16 \cdot in$ $\quad r_y := rprop_{4,A} \cdot in = 2.31 \cdot in$ $\quad I_{zz} := rprop_{5,A} \cdot in^4 = 24.69 \cdot in^4$

Axial Compression

$$\frac{K \cdot L}{r_y} = 115.95 > 4.71 \cdot \sqrt{\frac{E}{f_y}} = 113.43 \qquad \frac{K \cdot L}{r_z} = 124.04 > 4.71 \cdot \sqrt{\frac{E}{f_y}} = 113.43$$

$$F_e := \frac{\pi^2 \cdot E}{\left(\frac{K \cdot L}{\min(r_y, r_z)}\right)^2} = 18.6 \cdot ksi \qquad F_{cr} := 0.877 \cdot F_e = 16.31 \cdot ksi$$

$$P_{all} := \frac{F_{cr} \cdot A}{\Omega_c} = 51.55 \cdot k$$

Flexural

$$M_{xall} := \frac{f_y \cdot S_z}{\Omega_b} = 18.338 \cdot k \cdot ft \qquad M_{yall} := \frac{f_y \cdot S_y}{\Omega_b} = 21.287 \cdot k \cdot ft$$

EQ = "H2-1" UNITY = 0.651

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(602) 438-2500

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Cross Bar Analysis

Cross Bar Geometry

$b := D_{cb} = 2 \cdot in$ $\quad t := t_{cb} = 0.13 \cdot in$ $\quad A_g := A_{cb} = 0.94 \cdot in^2$

Max Length of Bar $\quad B = 12.5\,ft$

Spacing of Bars $\quad sp = 10.38 \cdot in$

Dead and Live Loads

Dead Load $\quad W_D := w_{sw} = 1.1 \cdot plf$

Roof Live Load $\quad w_{LL} = 20 \cdot psf$ $\quad W_{Lro} := w_{LL} \cdot sp = 17.29 \cdot plf$

Snow Load

$$W_S := \begin{cases} \left[\left(1.37 D_{cbi}^{\,2} \div 2\right) \cdot \gamma_s\right] & \text{if } D_{cbi} \le \dfrac{0.73 p_f}{\gamma_s} \\ \dfrac{D_{cbi} + \left(D_{cbi} - 2 \cdot x_s\right)}{2} \cdot p_f & \text{otherwise} \end{cases} = 1.41 \cdot plf$$

Atmospheric Ice Loads $\quad W_{Di} := A_{cbi} \cdot \rho_i = 4.04 \cdot plf$

Wind Load Analysis - Open Bldg, per Fig 27.3-4 & 27.3-5

Full Wind $\quad pWcbA = 20.8 \cdot psf$ $\quad W_{WLA} := pWcbA \cdot D_{cb} = 3.47 \cdot plf$

$pWcbB = -19.07 \cdot psf$ $\quad W_{WLB} := pWcbB \cdot D_{cb} = -3.18 \cdot plf$

Ice Wind $\quad w_{wice} := PWvai \div \left(\alpha_i \cdot B\right) \cdot D_{cbi} = 1 \cdot plf$

ASD Factored Loads

1.) DL + RLL $\quad ASD_1 := W_D + W_{Lro} = 18.42 \cdot plf$

2.) DL + SL $\quad ASD_2 := W_D + W_S = 2.54 \cdot plf$

3.) DL + 0.6WLA $\quad ASD_3 := W_D + 0.6 \cdot W_{WLA} = 3.21 \cdot plf$

4.) DL + 0.75(0.6WLA + RLL) $\quad ASD_4 := W_D + 0.75\left(0.6 \cdot W_{WLA} + W_{Lro}\right) = 15.66 \cdot plf$

5.) DL + 0.75(0.6WLA + SL) $\quad ASD_5 := W_D + 0.75\left(0.6 \cdot W_{WLA} + W_S\right) = 3.75 \cdot plf$

6.) 0.6DL + 0.6WLB $\quad ASD_6 := 0.6 \cdot W_D + 0.6 \cdot W_{WLB} = -1.23 \cdot plf$

7.) DL + 0.7Di + 0.7WLi + S

$$ASD_7 := \begin{cases} 0 & \text{if } t_{ice} = 0 \\ W_D + 0.7\left(W_{Di} + w_{wice}\right) + W_S & \text{otherwise} \end{cases} = 6.1 \cdot plf$$

$$ASD_{max} := \max\left(ASD_1, ASD_2, ASD_3, ASD_4, ASD_5, ASD_6, ASD_7\right) = 18.42 \cdot plf$$

Max Applied
Moment and Shear

$$M_a := \frac{ASD_{max} \cdot B^2}{8} = 0.36 \cdot ft \cdot k \qquad V_a := \frac{ASD_{max} \cdot B}{2} = 0.115 \cdot k$$

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Ph enix, AZ 85034
(602) 438-2500

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2" Sq. x 1/8" Thick Aluminum Tube Trellis Bar (6061-T6) per IBC 1607.7

Maximum Span: $L_b := B = 12.5\,ft$

Section Properties:

$h := D_{cb}$ $b := D_{cb}$ $t_w := t_{cb}$ $E := E_{al} = 10100 \cdot ksi$ $G := G_{al} = 3800 \cdot ksi$

$A := b \cdot h - (b - 2 \cdot t_w) \cdot ((h - 2 \cdot t_w)) = 0.938 \cdot in^2$

$I_x := \dfrac{b \cdot h^3 - (b - 2 \cdot t_w) \cdot (h - 2 \cdot t_w)^3}{12} = 0.552 \cdot in^4$ $I_y := \dfrac{h \cdot b^3 - (h - 2 \cdot t_w) \cdot (b - 2 \cdot t_w)^3}{12} = 0.552 \cdot in^4$

$S_x := \dfrac{(b \cdot h^3) - (b - 2 \cdot t_w) \cdot (h - 2 \cdot t_w)^3}{6h} = 0.552 \cdot in^3$ $S_y := \dfrac{(h \cdot b^3) - (h - 2 \cdot t_w) \cdot (b - 2 \cdot t_w)^3}{6b} = 0.552 \cdot i$

$Z_x := \dfrac{b \cdot h^2 - (b - 2 \cdot t_w) \cdot (h - 2 \cdot t_w)^2}{4} = 0.66 \cdot in^3$ $Z_y := \dfrac{b^2 \cdot h - (b - 2 \cdot t_w)^2 \cdot (h - 2 \cdot t_w)}{4} = 0.66 \cdot in^3$

$r_x := \sqrt{\dfrac{I_x}{A}} = 0.767 \cdot in$ $J := \dfrac{2 \cdot t_w \cdot t_w \cdot (h - t_w)^2 \cdot (b - t_w)^2}{h \cdot t_w + b \cdot t_w - t_w^2 - t_w^2} = 0.824 \cdot in^4$

Allowable Welded Stress: (6061-T6 Al.) $\Omega_{br} := 1.95$ $\Omega_{bo} := 1.65$

ADM 2015 F.2 Gross Yielding

$M_{1cb} := Z_x \cdot F_{cy} \div \Omega_{br} = 987.41\,ft \cdot lb$

$M_{2cb} := 1.5 \cdot S_x \cdot F_{ty} \div \Omega_{bo} = 1462.99\,ft \cdot lb$

$M_{3cb} := 1.5 S_x \cdot F_{cy} \div \Omega_{bo} = 1462.99\,ft \cdot lb$

$M_{np} := \min(M_{1cb}, M_{2cb}, M_{3cb}) = 987.41\,ft \cdot lb$ $F_{np} := M_{np} \div S_x = 21.47 \cdot ksi$

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Ph enix, AZ 85034
(602) 438-2500

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2" Sq. x 1/8" Thick Aluminum Tube Trellis Bar (6061-T6) per IBC 1607.7 (cont'd.)

Allowable Welded Stress: (6061-T6 Al.)

ADM 2015 F.4 Lateral-Torsional Buckling

F.4.1 Bending Coefficient C_b

$$M_{max} := M_a = 359.73\,ft \cdot lb$$

$$M_A := \frac{ASD_{max} \cdot (0.25B)}{2} \cdot (B - 0.25B) = 269.79\,ft \cdot lb \qquad M_B := M_{max} \qquad M_C := M_A$$

$$C_b := \frac{12.5M_{max}}{2.5M_{max} + 3 \cdot M_A + 4 \cdot M_B + 3 \cdot M_C} = 1.14 \qquad \lambda := 2.3 \cdot \sqrt{\frac{L_b \cdot S_x}{C_b \cdot \sqrt{I_y \cdot J}}} = 23.9$$

Table B.4.2 Buckling Constants

$$B_c := F_{cy} \cdot \left(1 + \frac{\sqrt{F_{cy} \cdot ksi^{-1}}}{2250}\right) = 35.09 \cdot ksi \quad D_c := \frac{B_c}{10} \cdot \sqrt{\frac{B_c}{E}} = 0.21 \cdot ksi \quad C_c := 0.41 \cdot \frac{B_c}{D_c} = 69.56$$

F.4 LTB Equation

$$M_{nmb} := \begin{cases} \left[M_{np} \cdot \left(1 - \frac{\lambda}{C_c}\right) + \frac{\pi^2 \cdot E \cdot \lambda \cdot S_x}{C_c^{\,3}}\right] & \text{if } \lambda < C_c \\ \frac{\pi^2 \cdot E \cdot S}{\lambda^2} & \text{if } \lambda \geq C_c \end{cases} = 973.64 \cdot lb \cdot ft$$

$$F_{nmb} := M_{nmb} \div S_x = 21.18 \cdot ksi$$

ADM 2015 Table 2-18 Axial Compression - B.5.4.2 (16)

$$\lambda_{B542} := \frac{b - 2 \cdot t}{t} = 14$$

$$F_{B542} := \begin{cases} 21.2ksi & \text{if } \lambda_{B542} < 20.8 \\ \left[(27.3 - 0.291 \cdot \lambda_{B542})ksi\right] & \text{if } 20.8 \leq \lambda_{B542} < 33 \\ (580 \div \lambda_{B542})ksi & \text{if } \lambda_{B542} \geq 33 \end{cases} = 21.2 \cdot ksi$$

ADM 2015 Table 2-18 Flexural Compression - B.5.5.1 (18)

$$\lambda_{B551} := \frac{b - 2t}{t} = 14$$

$$F_{B551} := \begin{cases} (31.8ksi) & \text{if } \lambda_{B551} < 33.1 \\ \left[(40.5 - 0.262 \cdot \lambda_{B551})ksi\right] & \text{if } 33.1 \leq \lambda_{B551} < 77 \\ (1563 \div \lambda_{B551})ksi & \text{if } \lambda_{B551} \geq 77 \end{cases} = 31.8 \cdot ksi$$

$$F_{bx} := \min(F_{np}, F_{nmb}, F_{B542}, F_{B551}) = 21.18 \cdot ksi$$

Applied Compressive Stress in Extreme Fiber

$$f_b := (M_a \div S_x) = 7.82 \cdot ksi$$

$$\frac{f_b}{F_{bx}} = 0.37$$ **< 1.0 OK**

Use 2" Square x 1/8" Thick
6061-T6 B211 Cross Bar

C nsulting Structural &
F rensic Engineers
3600 E. University Dr, Suite1400
Ph enix, AZ 85034
(602) 438-2500

Job. No. 25-0333
6/02/25
By: CS
Check by: JL, SE

Trellis Bar Connection

Trellis Bar Dimensions (Angle Shape)

$t := 0.1345in$ $b := 2.125in$ $d := 2.125in$

$a := b - t = 1.99 \cdot in$ $c := d - t = 1.99 \cdot in$

$$y := \frac{d^2 + a \cdot t}{2 \cdot (b + c)} = 0.58 \cdot in \qquad \Omega_b := 1.67$$

Moment of Inertia $$I_x := \frac{1}{3} \cdot \left[t \cdot (d - y)^3 + b \cdot y^3 - a \cdot (y - t)^3\right] = 0.24 \cdot in^4$$

Section Modulus $$S_x := \frac{I_x}{(d - y)} = 0.16 \cdot in^3 \qquad f_{ya1008} = 41.3 \cdot ksi$$

Allowable Moment $$M_{all} := \frac{(f_{ya1008} \cdot S_x)}{\Omega_b} = 326.89\, ft \cdot lb$$

Max Trellis Reaction $P := V_a = 115.11\, lb$

Moment Arm and Moment $M_{arm} := 6in$ $M := 1.5P \cdot M_{arm} = 86.33\, ft \cdot lb$

$$\frac{M}{M_{all}} = 0.26$$ **< 1.0 OK**

Use a 2-1/8"x2-1/8"x0.1345" thick, ASTM A1008 Steel angle

1/2" ϕ SAE Grade 5 Trellis Connector Bolt to 3/4" ϕ Bung $T_n := 6811lb$

Tension Due to Force Couple $T_a := M \div 0.375in = 2762.7\, lb$

$$\frac{T_a}{T_n} = 0.41$$ **< 1.0 OK**

Use (1) 1/2" ϕ Grade 5 Bolt at Trellis Connector
By inspection, 1/4" weld all around is OK

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Check by: JL, SE

Pay Station Canopy Analysis

Materials:

Aluminum: $\gamma_{al} := 173pcf = 0.1 \cdot pci$ $E_{al} := 10100ksi$ $G_{al} := 3800ksi$

Tube Extrusions, B211 6061-T6 $F_{ty} := 35ksi$ $F_{tu} := 42ksi$

$F_{cy} := F_{ty} = 35 \cdot ksi$

Steel: $E_s := 29000ksi$

Round HSS Tube Steel, ASTM A500-Gr.B, 50 KSI $f_{ya500} := 50.0 \cdot ksi$ $f_{ua500} := 62ksi$

Other Rolled Sections Plates, Angles,
and Bars ASTM A36 $f_{yA36} := 36.0ksi$

Bent Plate Trellis Connector Bar ASTM A1008 $f_{ya1008} := 41.3ksi$

Base Plates - ASTM A1018 $f_y := 53ksi$

SAE J429 Grade 5 Bolts $F_u := 150ksi$

Welds:

Carbon Steel to Carbon Steel $F_{u\_cs} := 70 \cdot ksi$

Carbon Steel ASD Safety factor $\Omega_{cs} := 2.0$

Area of weld $A_w := \left(\frac{\sqrt{2}}{2}\right) \cdot \left(\frac{D}{16}\right) \cdot l$

Allowable Loads:

Carbon to carbon $R_{c\_cs} := \frac{0.6}{\Omega_{cs}} \cdot F_{u\_cs} \cdot A_w$

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Pay Station Canopy Analysis

Canopy Data:

Canopy Height $H_T := 11.0ft$

Average Spacing of Supports $B := 17.00ft$ $B := \frac{B}{2}$

Separator Dimensions

$D_S := 1ft$ $L_S := 2ft$ $A_S := D_S \cdot L_S = 2\,ft^2$

Post Section Set : $A :=$ HSS 6.625 x 0.280

Mast & Support Arm Section Set : $B :=$ HSS 3.5 x 0.216

Dead and Live Loads:

Length of Canopy Tube $L_{canopy} := 10.00ft$

Canopy Tube Diameter $D_{canopy} := pprop_{2,B} \cdot in = 3.5 \cdot in$

Post Tube Diameter $D_{post} := prop_{2,A}\, in = 6.625 \cdot in$

Aluminum Trellis Geometry

$D_{cb} := 2.0in$ $l_{cb} := 2.0in$ $t_{cb} := 0.125in$

Area Calculation:

$A_{cb} := D_{cb} \cdot l_{cb} - \left[\left(D_{cb} - 2 \cdot t_{cb}\right)\left(l_{cb} - 2 \cdot t_{cb}\right)\right] = 0.94 \cdot in^2$ $w_{sw} := A_{cb} \cdot \gamma_{al} = 1.13 \cdot plf$

Length of Cross Bar $L_{cb} := 17.00ft$ <— Ref. Arch. Drawings

Cross Bar Spacing $S_{trellis} := 15.313in$

Number of Cross Bars $N_{bars} := 8$

Percent Solid $\alpha := D_{cb} \div S_{trellis} = 0.13$

Additional Loads

Trellis Dead Load

$$W_{DL} := \frac{\left(\gamma_{al} \cdot A_{cb} \cdot L_{cb} \cdot N_{bars}\right)}{2L_{canopy}} = 7.66 \cdot plf$$

$W_{DL} = 7.66 \cdot plf$

Live Loads $w_{LL} := \max\left(20 \cdot psf \cdot \alpha, 5psf\right) = 5 \cdot psf$

$B = 8.5\,ft$

$W_{LL} := B \cdot w_{LL} = 42.5 \cdot plf$

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Pay Station Canopy Analysis (cont'd)

Seismic Loading   Non-Building Structure (ASCE Chp. 15)   Ref. Appendix for ASCE Output

Importance Factor $I_e := 1.0$

Site Class $SC := \text{"D"}$

Mapped Acceleration Parameters
Ref. USGS Seismic Output $S_s := 0.075$ $S_1 := 0.045$

Site Amplification Factors
ASCE Table 11.4-1 & 11.4-2 $F_a := 1.6$ $F_v := 2.4$

Long-Period Transition $T_L := 12$

Site-Modified Spectral
Acceleration Values $S_{MS} := F_a \cdot S_s = 0.12$

$S_{M1} := F_v \cdot S_1 = 0.108$

Seismic Design Values $S_{DS} := \frac{2}{3} \cdot S_{MS} = 0.08$ $S_{D1} := \frac{2}{3} \cdot S_{M1} = 0.072$

Seismic Design Category "B"

Response Modification Factor $R := 1.25$

Values for Approx. Period Parameters
ASCE Table 12.8-2 $C_t := 0.02$ $x := 0.75$

Approx. Fundamental Period $T_a := C_t \cdot \left(\frac{H_T}{ft}\right)^x = 0.121$

$T_s := \frac{S_{D1}}{S_{DS}} = 0.9$ $T := T_a = 0.121 <= 1.5 \cdot T_s = 1.35$

query = "USE EQUATIONS 12.8-2 THROUGH 12.8-6"

$$C_{smin} := \begin{array}{|l} \max(0.44 \cdot S_{DS} \cdot I_e, 0.01) \text{ if } S_1 < 0.6 \\ \max[0.44 \cdot S_{DS} \cdot I_e, 0.01, 0.5S_1 \div (R \div I_e)] \text{ otherwise} \end{array} = 0.035$$

$$C_{s1} := \frac{S_{DS}}{\left(\frac{R}{I_e}\right)} = 0.064 \qquad C_{smax} := \text{if}\left[T \le T_L, \frac{S_{D1}}{T \cdot \left(\frac{R}{I_e}\right)}, \frac{S_{D1} \cdot T_L}{T^2 \cdot \left(\frac{R}{I_e}\right)}\right] = 0.477$$

$$C_s := \text{if}(C_{smax} \ge C_{s1}, \text{if}(C_{s1} \le C_{smin}, C_{smin}, C_{s1}), C_{smax}) = 0.06$$

$$C_s := \begin{array}{|l} C_s \text{ if } \sum Q = 0 \\ C_{se} \text{ otherwise} \end{array} = 0.064$$

Use $C_s = 0.06$

Seismic Loading

Vertical Component Coefficient $C_{sy} := 0.2S_{DS} = 0.02$

Trellis Load $W_{DL} \cdot C_s = 0.5 \cdot plf$ $W_{DL} \cdot 0.2 \cdot S_{DS} = 0.12 \cdot plf$

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Pay Station Canopy Analysis (cont'd)

Wind Loading

Directional Procedure per ASCE 7-16, Chapter 27

3 Second Gust Speed (Ultimate)	$V := 105 \cdot mph$	$V_o := V \cdot mph^{-1}$
Risk Category	I	Table 1.5-1
Exposure Category	C	26.7
Height (average)	$h := H_T = 11\,ft$	
Velocity Pressure Exposure Coefficient	$K_z := 0.85$	Table 27.10-1
Topographic Factor	$K_{zt} := 1.0$	no topographic effects
Directionality Factor	$K_d := 0.85$	Table 26.6-1
Elevation Factor	$K_e := 1.0$	Table 26.9-1

Velocity Pressure $q_h := 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \cdot K_e \cdot V_o^2 \cdot psf = 20.39 \cdot psf$ Eq. 26.10-1

Gust Effect Factor	$G := 0.85$	26.11
Width of Tributary =	$B_f := B = 8.5\,ft$	
Trellis Percent Solid	$\alpha = 0.13$	

Wind Load Analysis - Open Bldg, per Fig 27.3-4 & 27.3-5

Slope = $\theta := 0.0 \cdot deg$ $\Theta < 7.5$ deg Slope = $\theta := 24 \cdot deg$ $\Theta = 22.5$ deg

Wind Direction $\gamma = 0$ deg (Worst pressure coefficents applied)

Load Case A $C_{NW} := 1.2$ $C_{NL} := 0.3$

$pW := q_h \cdot G \cdot C_{NW}$ $pW = 20.8 \cdot psf$

$PWva := pW \cdot B_f \cdot \alpha$ $PWva = 23.1 \cdot plf$

$pL := q_h \cdot G \cdot C_{NL}$ $pL = 5.2 \cdot psf$

$PLva := pL \cdot B_f \cdot \alpha$ $PLva = 5.8 \cdot plf$

Load Case B $C_{NW} := -1.1$ $C_{NL} := -0.1$

$pW := q_h \cdot G \cdot C_{NW}$ $pW = -19.07 \cdot psf$

$PWvb := pW \cdot B_f \cdot \alpha$ $PWvb = -21.2 \cdot plf$

$pL := q_h \cdot G \cdot C_{NL}$ $pL = -1.73 \cdot psf$

$PLvb := pL \cdot B_f \cdot \alpha$ $PLvb = -1.9 \cdot plf$

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Pay Station Canopy Analysis (cont'd)

Wind Load Analysis - Open Bldg, per Fig 27.3-4 & 27.3-5

Slope = $\theta := 0.0 \cdot deg$ Θ < 7.5 deg Slope = $\theta := 24 \cdot deg$ Θ = 22.5 deg

Wind Direction γ = 180 deg (Worst pressure coefficents applied)

Load Case A $C_{NW} := 1.2$ $C_{NL} := 0.3$

$pW := q_h \cdot G \cdot C_{NW}$ $pW = 20.8 \cdot psf$

$PWva180 := pW \cdot B_f \cdot \alpha$ $PWva180 = 23.1 \cdot plf$

$pL := q_h \cdot G \cdot C_{NL}$ $pL = 5.2 \cdot psf$

$PLva180 := pL \cdot B_f \cdot \alpha$ $PLva180 = 5.8 \cdot plf$

Load Case B $C_{NW} := -1.1$ $C_{NL} := -0.1$

$pW := q_h \cdot G \cdot C_{NW}$ $pW = -19.07 \cdot psf$

$PWvb180 := pW \cdot B_f \cdot \alpha$ $PWvb180 = -21.2 \cdot plf$

$pL := q_h \cdot G \cdot C_{NL}$ $pL = -1.73 \cdot psf$

$PLvb180 := pL \cdot B_f \cdot \alpha$ $PLvb180 = -1.9 \cdot plf$

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Pay Station Canopy Analysis (cont'd)

Wind load on arch canopy members - Other Structures/Equipment, per Sec. 29.4

Post

Diameter $D_1 := prop_{2,A}\,in = 6.625 \cdot in$

Height to Depth Ratio $\frac{h}{D_1} = 19.92$

Round Coefficient Factor $D_1 \cdot ft^{-1} \cdot \sqrt{q_h \cdot psf^{-1}} = 2.49$

Wind force coefficient (Figure 29.4-1) $C_f := 1.2$

Design wind load normal to surface (Eq. 29.4-1) $q_w := q_h \cdot G \cdot C_f \cdot D_1 = 11.5 \cdot plf$

Mast / Support Arm

Diameter $D_3 := pprop_{2,B}\,in = 3.5 \cdot in$

Height to Depth Ratio $\frac{h}{D_3} = 37.71$

Round Coefficient Factor $D_3 \cdot ft^{-1} \cdot \sqrt{q_h \cdot psf^{-1}} = 1.32$

Wind force coefficient (Figure 29.4-1) $C_f := 1.2$

Design wind load normal to surface (Eq. 29.4-1) $q_w := q_h \cdot G \cdot C_f \cdot D_3 = 6.1 \cdot plf$

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Pay Station Canopy Analysis (cont'd)

Ice Weight $\rho_i := 56pcf$

Importance Factor $I_i := 0.8$

Topographic Factor $K_{zt} = 1.0$

Height Factor $f_z := \left(\frac{H_T \cdot ft^{-1}}{33}\right)^{0.10} = 0.9$ (EQ. 10.4-4)

Equivalent Radial Ice Thickness $t := 1.50in$ (Fig. 10.4-2)

Design Ice Thickness $t_d := t \cdot I_i \cdot f_z \cdot K_{zt}^{0.35} = 1.08 \cdot in$ (EQ. 10.4-5)

Ice Cross Sectional Geometry

Post $A_{i1} := \pi \cdot t_d \cdot (D_1 + t_d) = 0.18 ft^2$ (EQ. 10.4-1)

$d_{i1} := D_1 + 2 \cdot t_d = 0.73 ft$

Load per foot $D_{i1} := A_{i1} \cdot \rho_i = 10.11 \cdot plf$

Mast / Support Arm $A_{i3} := \pi \cdot t_d \cdot (D_3 + t_d) = 0.11 ft^2$ (EQ. 10.4-1)

$d_{i3} := D_3 + 2 \cdot t_d = 0.47 ft$

Load per foot $D_{i3} := A_{i3} \cdot \rho_i = 6.01 \cdot plf$

Aluminum Cross Bar $A_{cbi} := \pi \cdot t_d \cdot (D_{cb} + t_d) = 0.07 \cdot ft^2$ (EQ. 10-1)

$D_{cbi} := D_{cb} + 2 \cdot t_d = 4.15 \cdot in$

$D_{icb} := A_{cbi} \cdot \rho_i = 4.04 \cdot plf$

Load per foot of canopy $W_{cbi} := D_{icb} \cdot L_{cb} \div S_{trellis} = 53.81 \cdot plf$

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Pay Station Canopy Analysis (cont'd)

Wind Loading (Atmospheric Ice) Directional Procedure per ASCE 7-16, Chapter 27

3 Second Gust Speed (Ultimate) $V := 40 \cdot mph$ <- Per Fig. 10.4-2

Velocity Pressure $q_h := 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \cdot K_e \cdot V_o^2 \cdot psf = 2.96 \cdot psf$

Percent Solid (w/ice) $\alpha_i := D_{cbi} \div S_{trellis} = 0.271$

Wind Load Analysis - Open Bldg, per Fig 27.3-4 & 27.3-5

Slope = $\theta := 0.0 \cdot deg$ Θ < 7.5 deg Slope = $\theta := 24 \cdot deg$ Θ = 22.5 deg

Wind Direction γ = 0 deg (Worst pressure coefficents applied)

Load Case A $C_{NW} := 1.2$ $C_{NL} := 0.3$

$pW := q_h \cdot G \cdot C_{NW}$ $pW = 3.02 \cdot psf$

$PWvai := pW \cdot B_f \cdot \alpha_i$ $PWvai = 7 \cdot plf$

$pL := q_h \cdot G \cdot C_{NL}$ $pL = 0.75 \cdot psf$

$PLvai := pL \cdot B_f \cdot \alpha_i$ $PLvai = 1.7 \cdot plf$

Wind Load Analysis - Open Bldg, per Fig 27.3-4 & 27.3-5

Slope = $\theta := 0.0 \cdot deg$ Θ < 7.5 deg Slope = $\theta := 24 \cdot deg$ Θ = 22.5 deg

Wind Direction γ = 180 deg (Worst pressure coefficents applied)

Load Case A $C_{NW} := 1.2$ $C_{NL} := 0.3$

$pW := q_h \cdot G \cdot C_{NW}$ $pW = 3.02 \cdot psf$

$PWva180i := pW \cdot B_f \cdot \alpha_i$ $PWva180i = 7 \cdot plf$

$pL := q_h \cdot G \cdot C_{NL}$ $pL = 0.75 \cdot psf$

$PLva180i := pL \cdot B_f \cdot \alpha_i$ $PLva180i = 1.739 \cdot plf$

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Pay Station Canopy Analysis (cont'd)

Wind load on arch canopy members (+ ice cross section) - Other Structures/Equipment, per Sec. 29.4

Post

Diameter $d_{i1} = 8.78 \cdot in$

Height to Depth Ratio $\frac{h}{d_{i1}} = 15.04$

Round Coefficient Factor $d_{i1} \cdot ft^{-1} \cdot \sqrt{q_h \cdot psf^{-1}} = 1.26$

Wind force coefficient (Figure 29.4-1) $C_f := 1.2$

Design wind load normal to surface (Eq. 29.4-1) $q_w := q_h \cdot G \cdot C_f \cdot d_{i1} = 2.2 \cdot plf$

Mast Arm / Support Arm

Diameter $d_{i3} = 5.65 \cdot in$

Height to Depth Ratio $\frac{h}{d_{i3}} = 23.36$

Round Coefficient Factor $d_{i3} \cdot ft^{-1} \cdot \sqrt{q_h \cdot psf^{-1}} = 0.81$

Wind force coefficient (Figure 29.4-1) $C_f := 1.2$

Design wind load normal to surface (Eq. 29.4-1) $q_w := q_h \cdot G \cdot C_f \cdot d_{i3} = 1.4 \cdot plf$

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Pay Station Canopy Analysis (cont'd)

Snow Load $\theta_s := 70deg$

Ground Snow Load	$p_g := 25psf$	
Exposure Factor	$C_e := 1.0$	ASCE 7-16 Table 7.3-1
Thermal Factor	$C_t := 1.2$	ASCE 7-16 Table 7.3-2
Importance Factor	$I_s := 0.8$	ASCE 7-16 Table 1.5-2
Flat Roof Snow Load	$p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g$	ASCE 7.3-1
Roof Snow Load	$P_{SL} := p_f = 16.8 \cdot psf$	

Min Roof Snow Load

$$P_{SLmin} := \begin{cases} 0 & \text{if } p_g = 0 \\ (I_s \cdot p_g) & \text{if } p_g < 20psf \\ (20psf \cdot I_s) & \text{otherwise} \end{cases} = 16 \cdot psf$$

$$p_f := \max(P_{SL}, P_{SLmin}) = 16.8 \cdot psf$$

Snow Density

$$\gamma_s := \min(0.13p_g \div ft + 14pcf, 30pcf) = 17.25 \cdot pcf$$

Snow width (trapezoid)

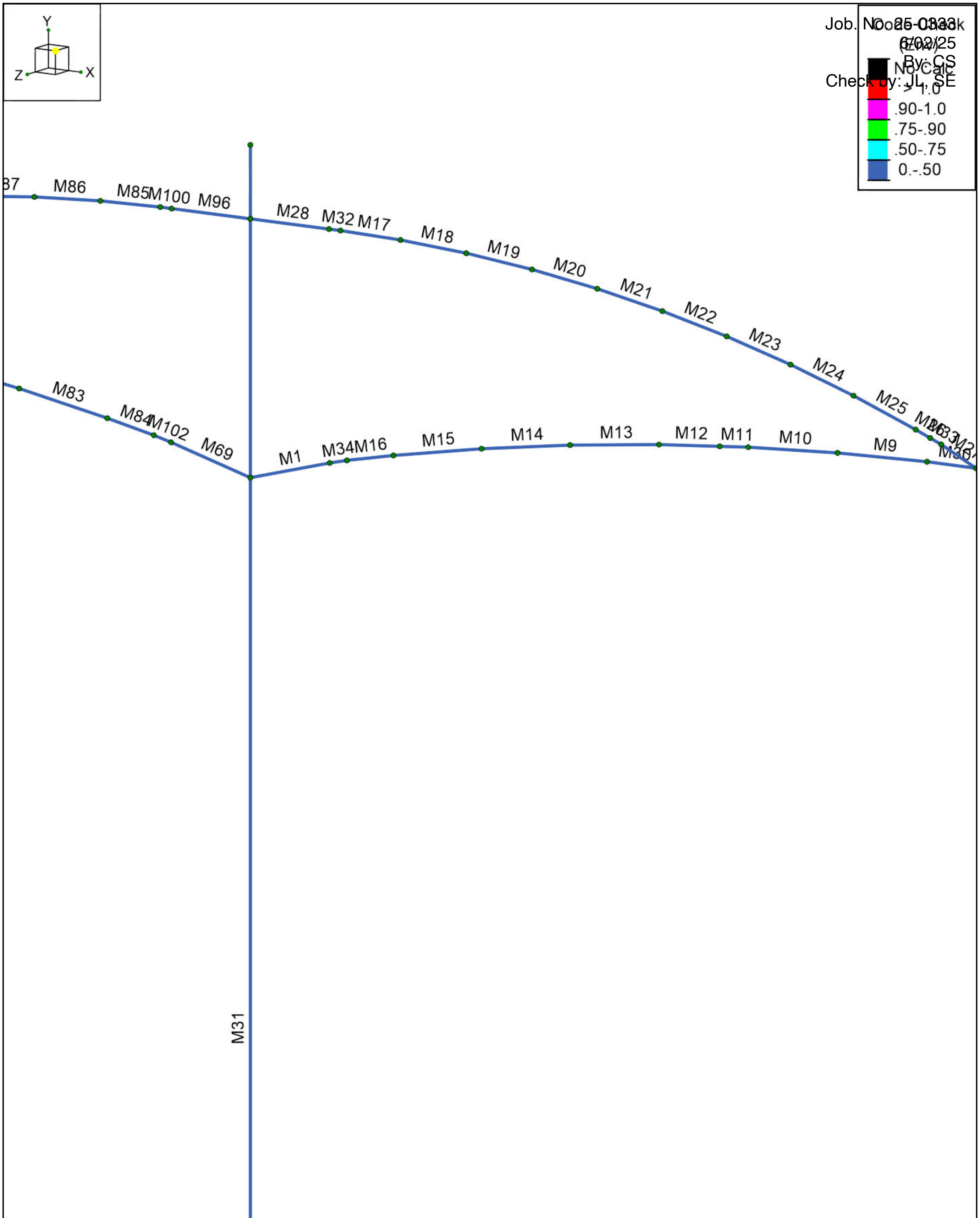
$$x_s := (p_f \div \gamma_s) \div \tan(\theta_s) = 4.25 \cdot in$$

Mast / Support Arm (per ASCE 7-16 7.13)

$$W_{SLi3} := \begin{cases} \left[\left(1.37d_{i3}^2 \div 2\right) \cdot \gamma_s\right] & \text{if } d_{i3} \le \dfrac{0.73p_f}{\gamma_s} \\ \left[\dfrac{d_{i3} + (d_{i3} - 2 \cdot x_s)}{2} \cdot p_f\right] & \text{otherwise} \end{cases} = 2.62 \cdot plf$$

Cross Bar

$$W_{SLcb} := \begin{cases} \dfrac{L_{cb}}{S_{trellis}} \cdot \left[\left(1.37D_{cbi}^2 \div 2\right) \cdot \gamma_s\right] & \text{if } D_{cbi} \le \dfrac{0.73p_f}{\gamma_s} \\ \dfrac{D_{cbi} + (D_{cbi} - 2 \cdot x_s)}{2} \cdot p_f \cdot \dfrac{L_{cb}}{S_{trellis}} & \text{otherwise} \end{cases} = 18.83 \cdot plf$$



Starling Madison Lofquist, Inc.	Pay Station Arch	SK-1
C. Soare		Jun 02, 2025
25-0333		POS- full Trellis.r3d

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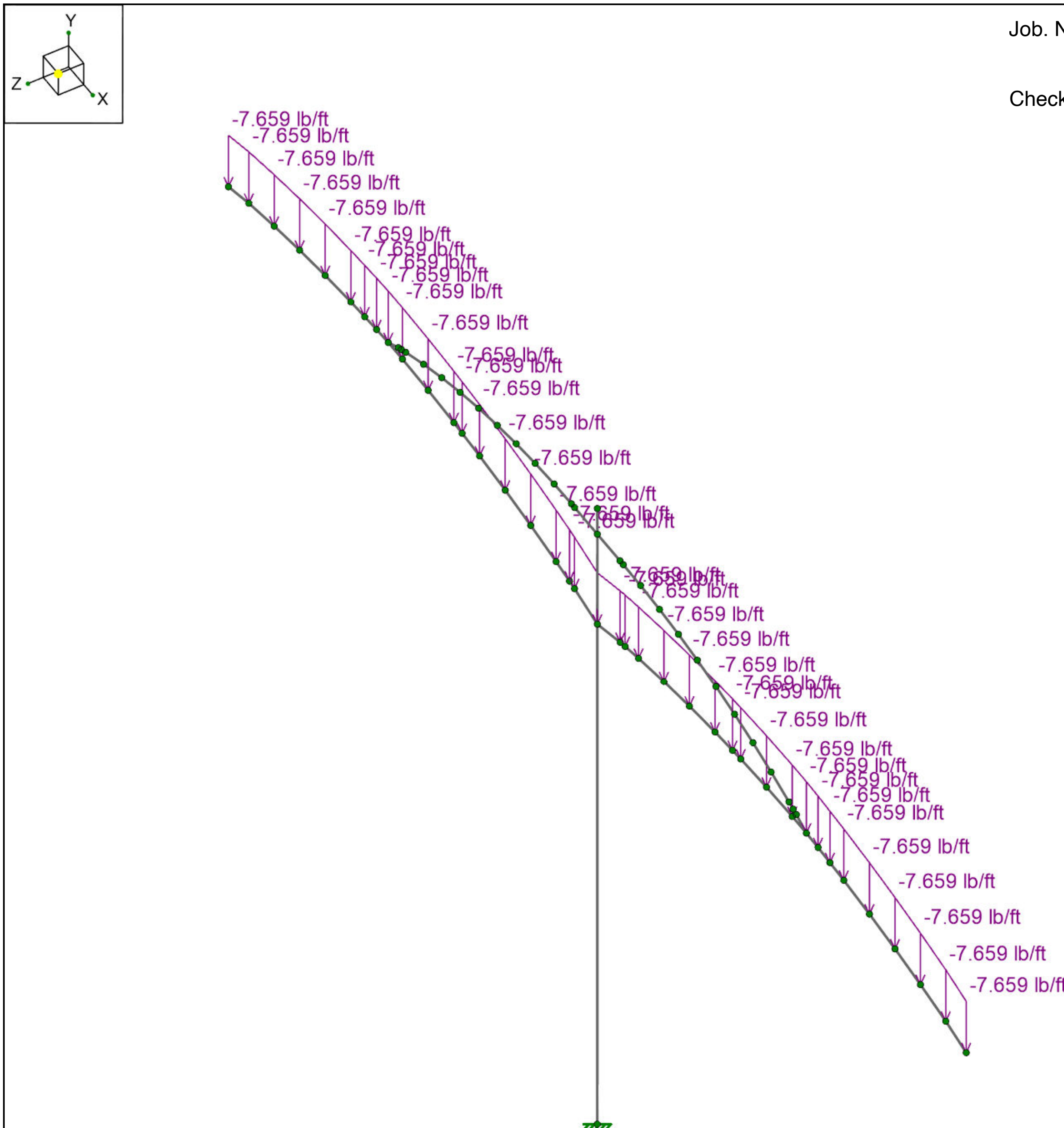

Loads: LC 1, D

Starling Madison Lofquist, Inc.	Pay Station Arch	SK-2
C. Soare		Jun 02, 2025
25-0333		POS- full Trellis.r3d

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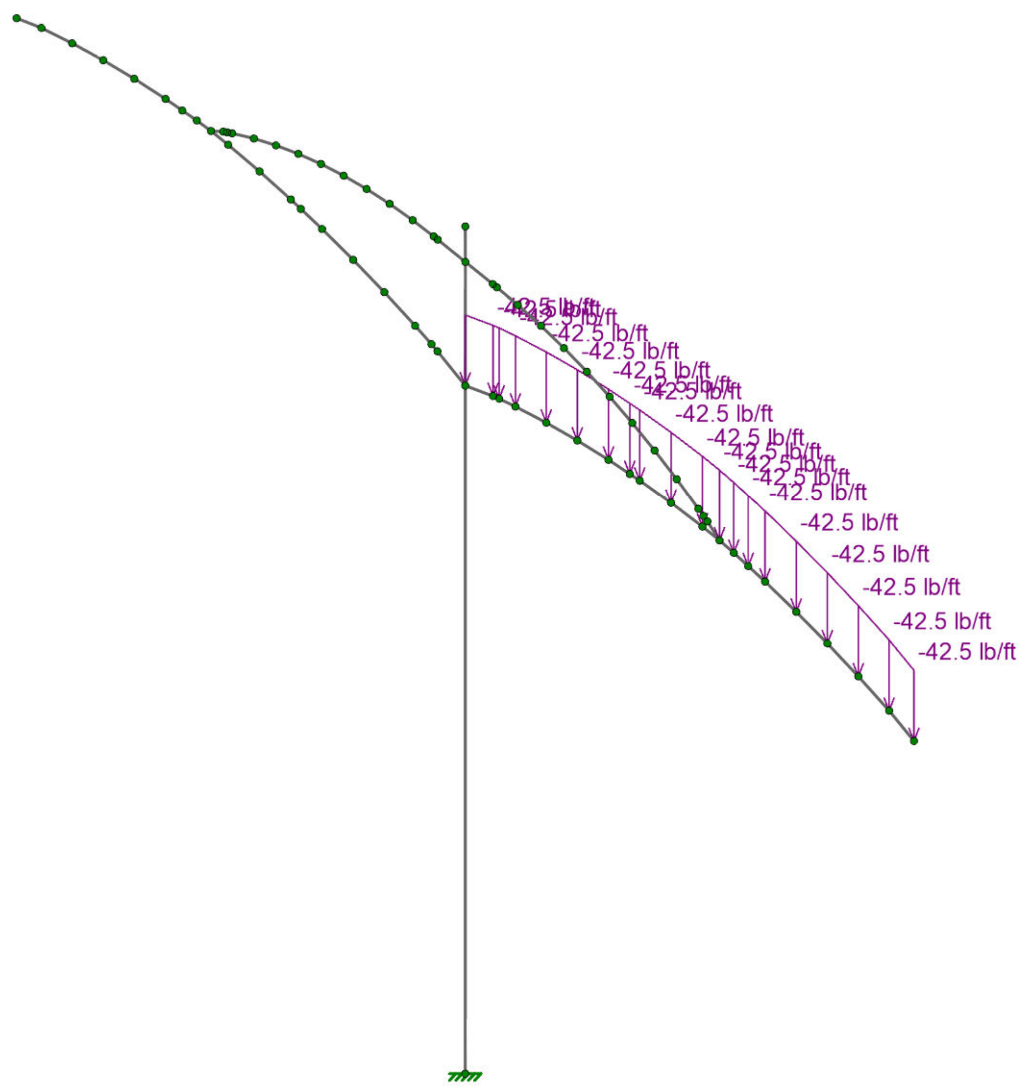

Loads: BLC 2, Lr

Starling Madison Lofquist, Inc.	Pay Station Arch	SK-3
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Loads: BLC 3, WL-A

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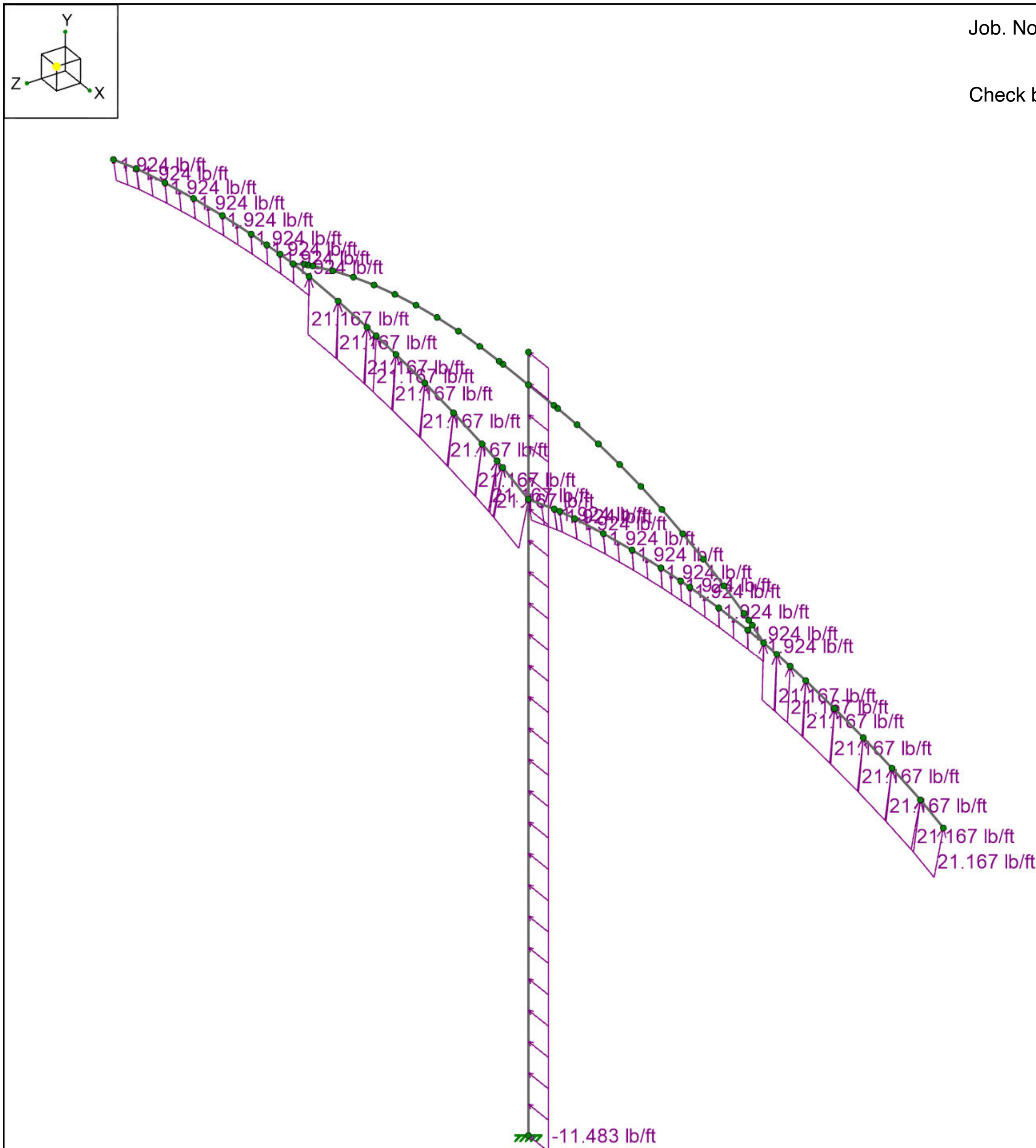

Loads: BLC 4, WL-B

Starling Madison Lofquist, Inc.	Pay Station Arch	SK-5
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25-0333		POS- full Trellis.r3d

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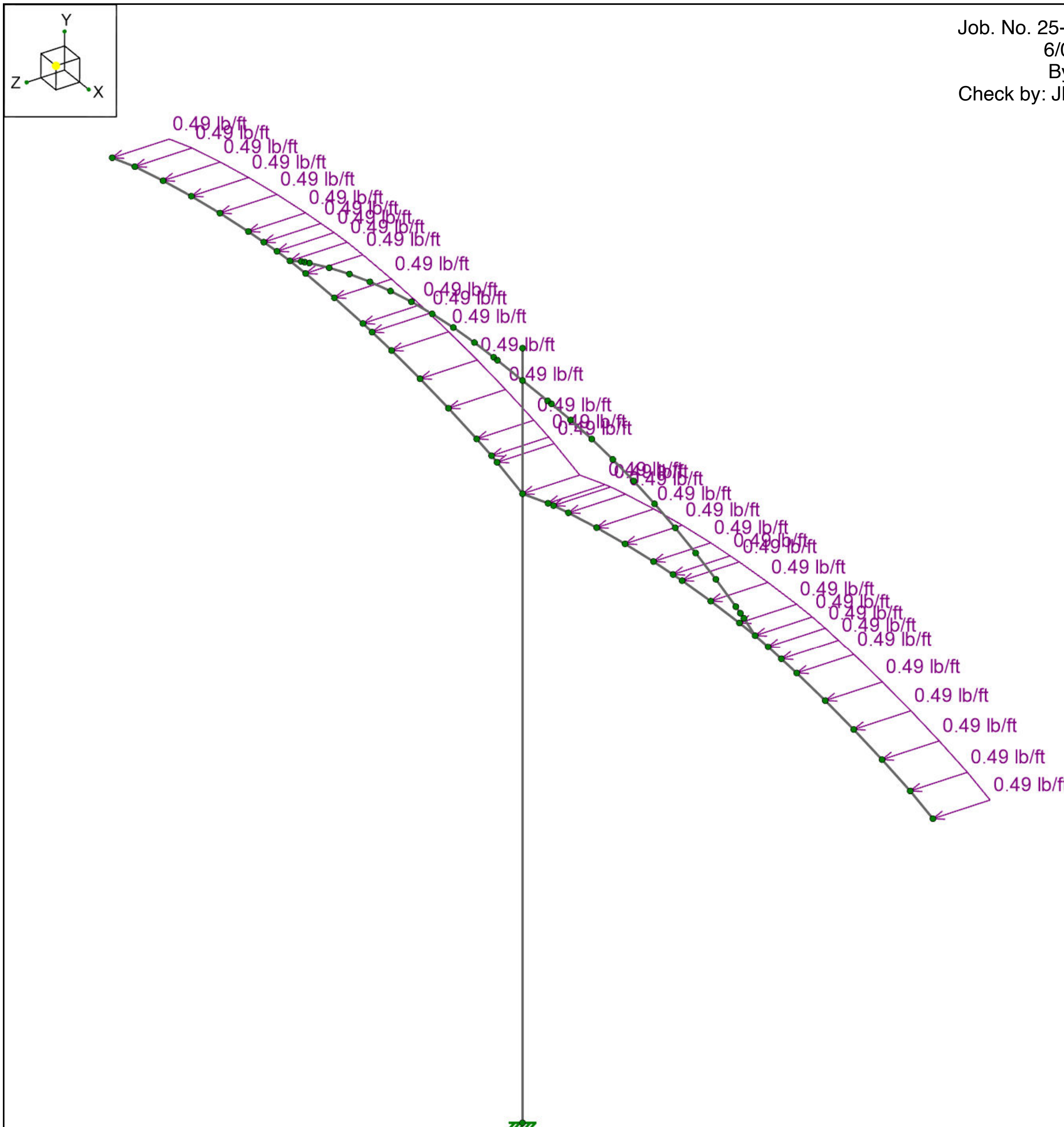

Loads: BLC 5, ELz

Starling Madison Lofquist, Inc.	Pay Station Arch	SK-6
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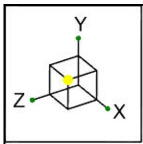
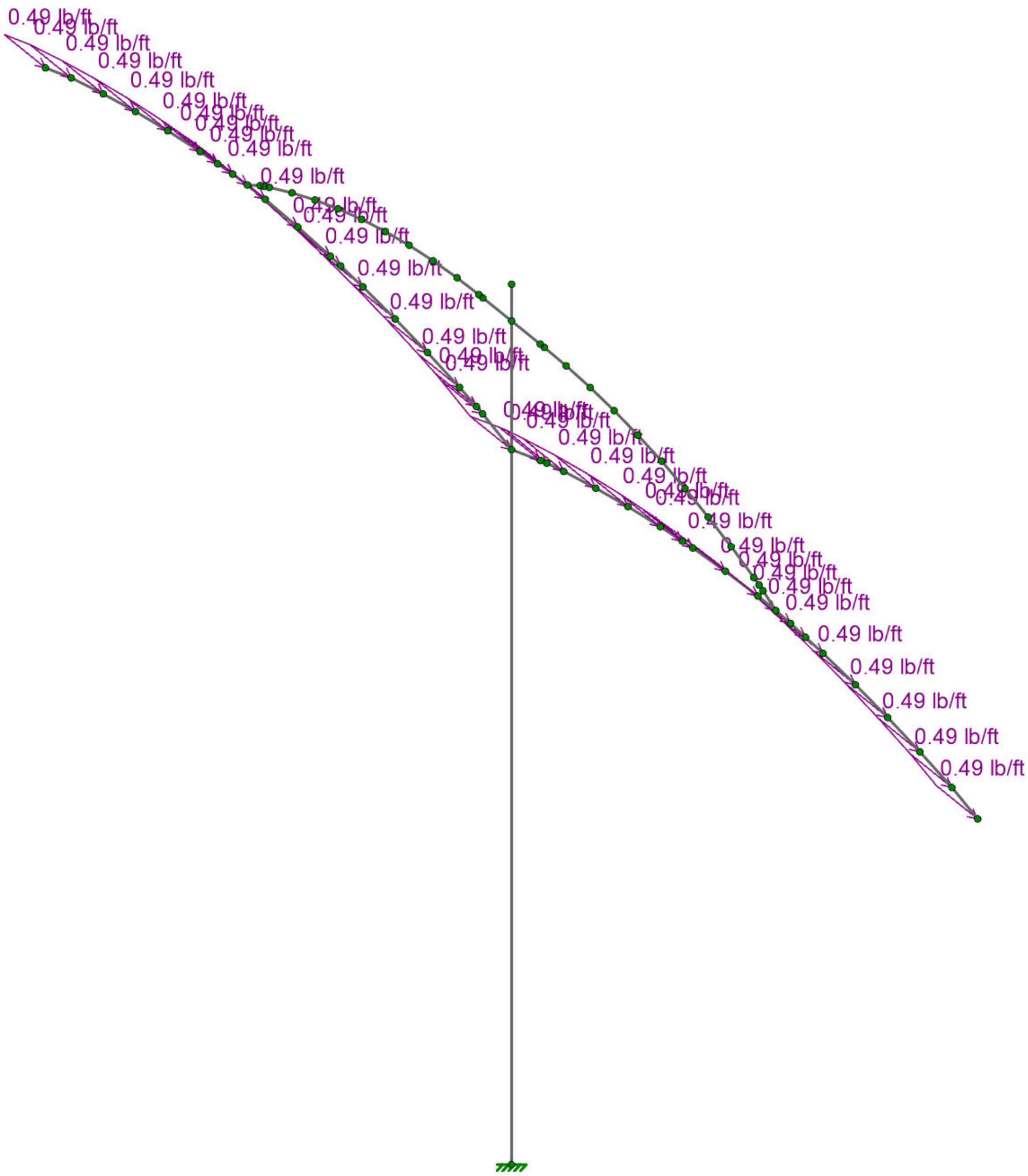
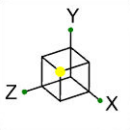




Loads: BLC 6, ELx

Starling Madison Lofquist, Inc.	Pay Station Arch	SK-7
C. Soare		Jun 02, 2025
25-0333		POS- full Trellis.r3d



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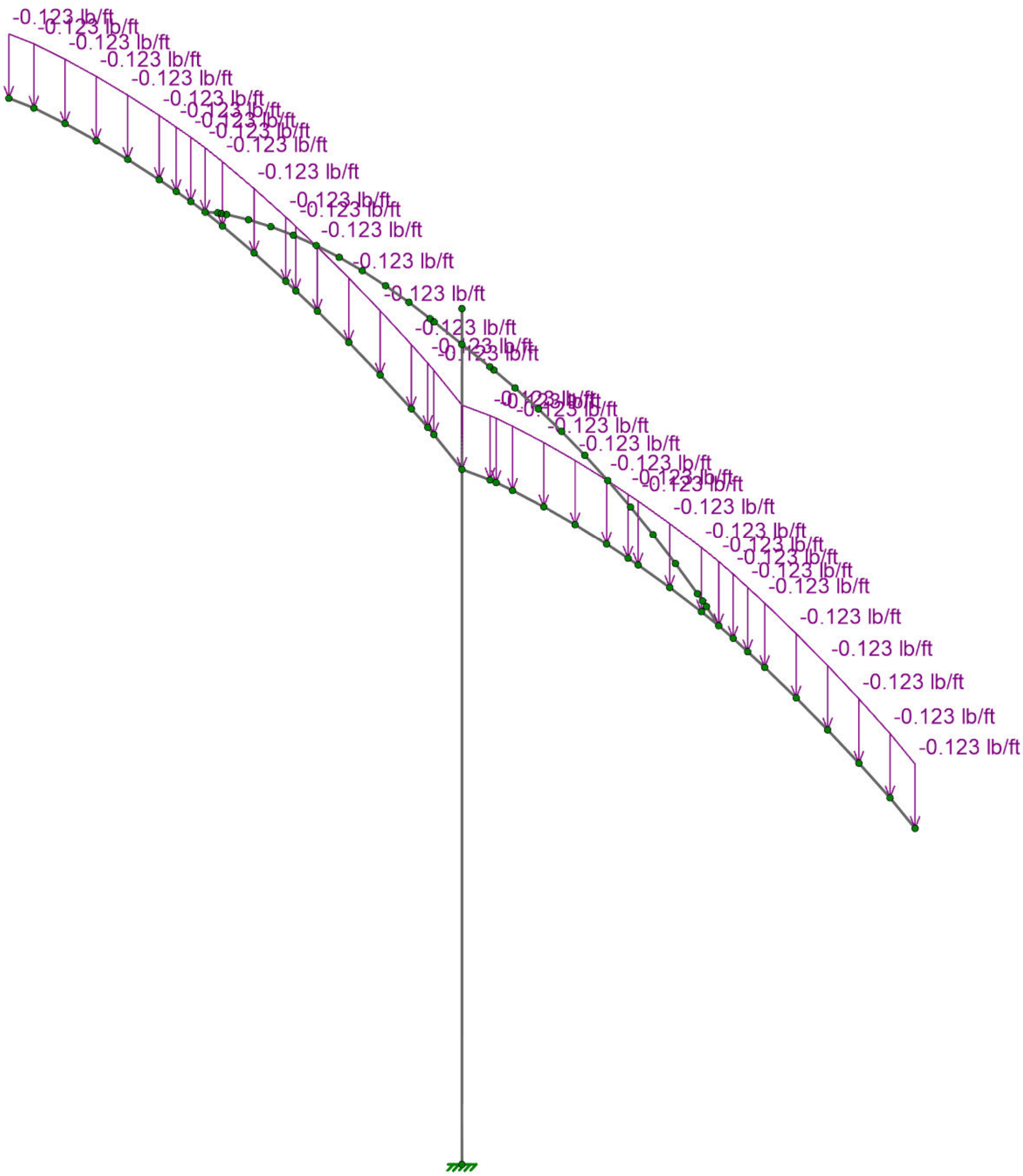

Loads: BLC 7, ELy

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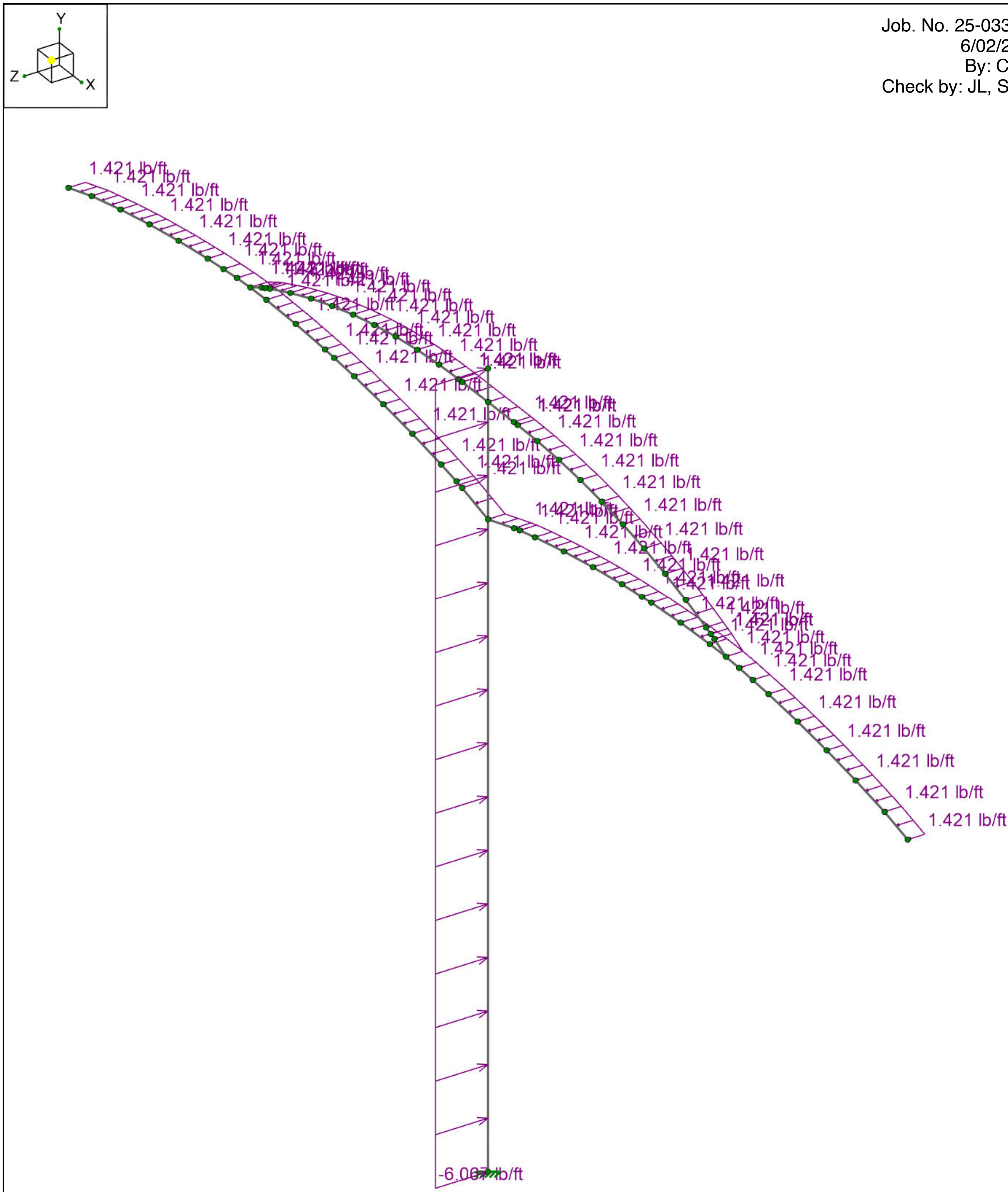
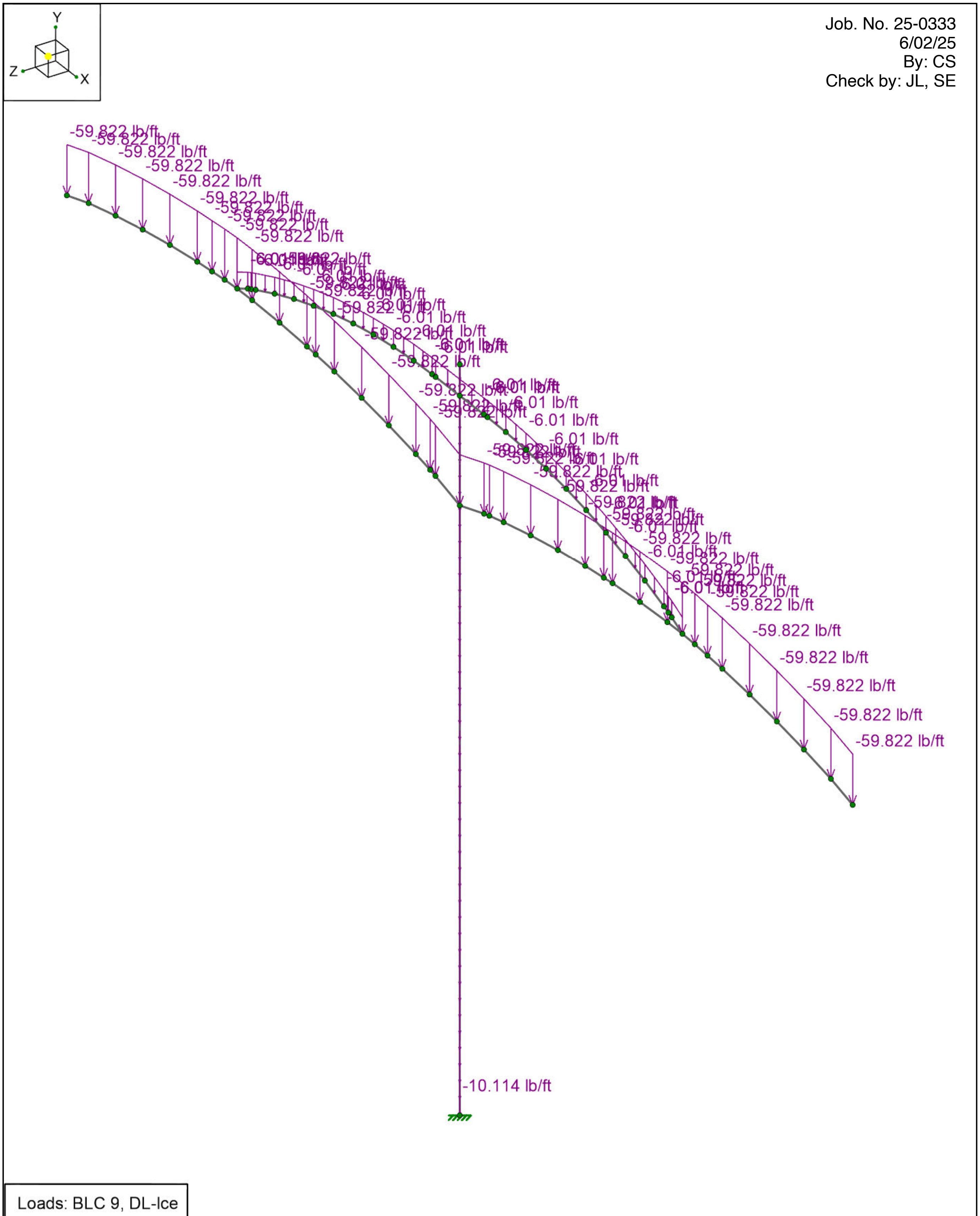
Check by: JL, SE



Loads: BLC 8, WL-Lat (w/ice)

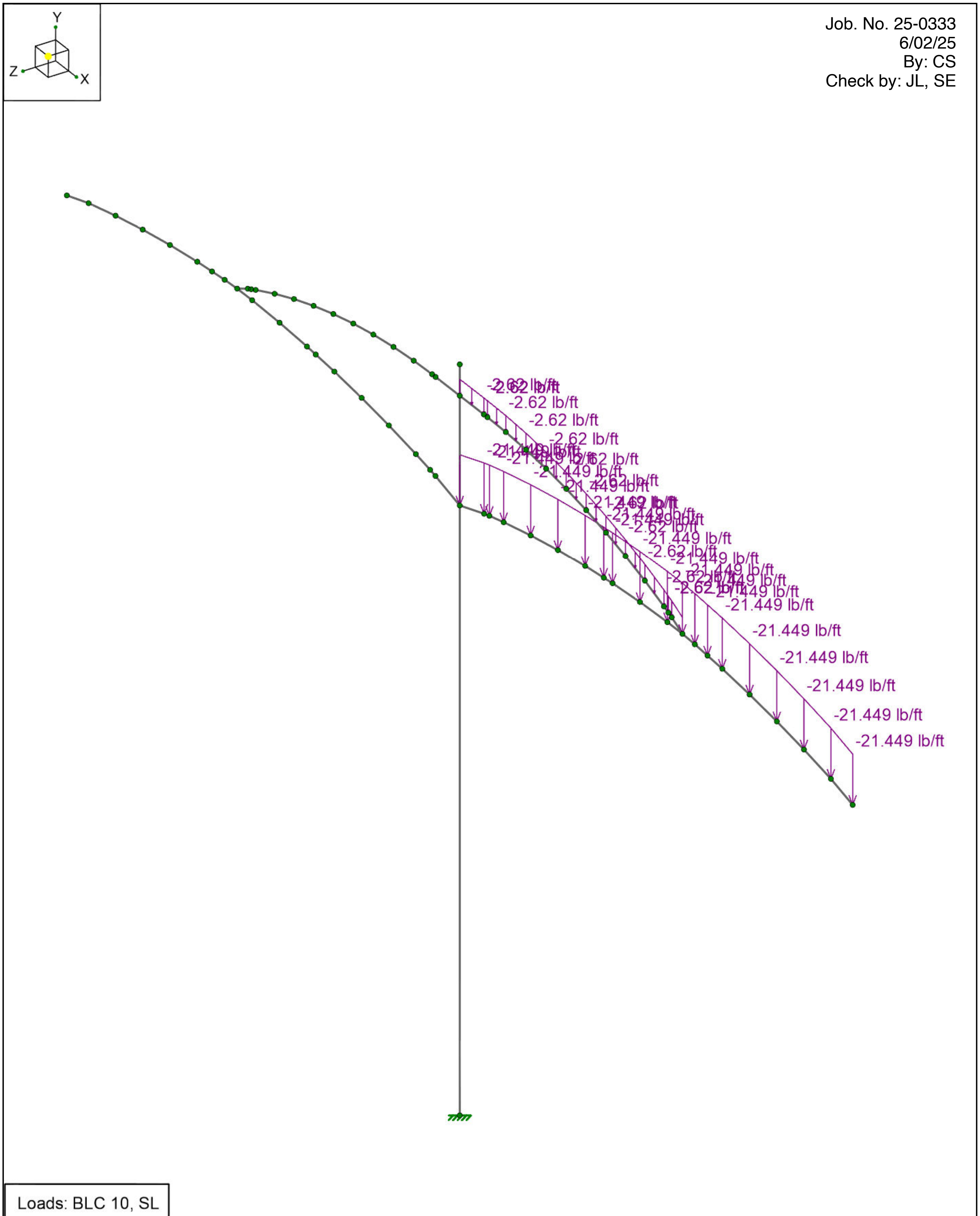
Starling Madison Lofquist, Inc.	Pay Station Arch	SK-9
C. Soare		Jun 02, 2025
25-0333		POS- full Trellis.r3d

Job. No. 25-0333
6/02/25
By: CS
Check by: JL, SE



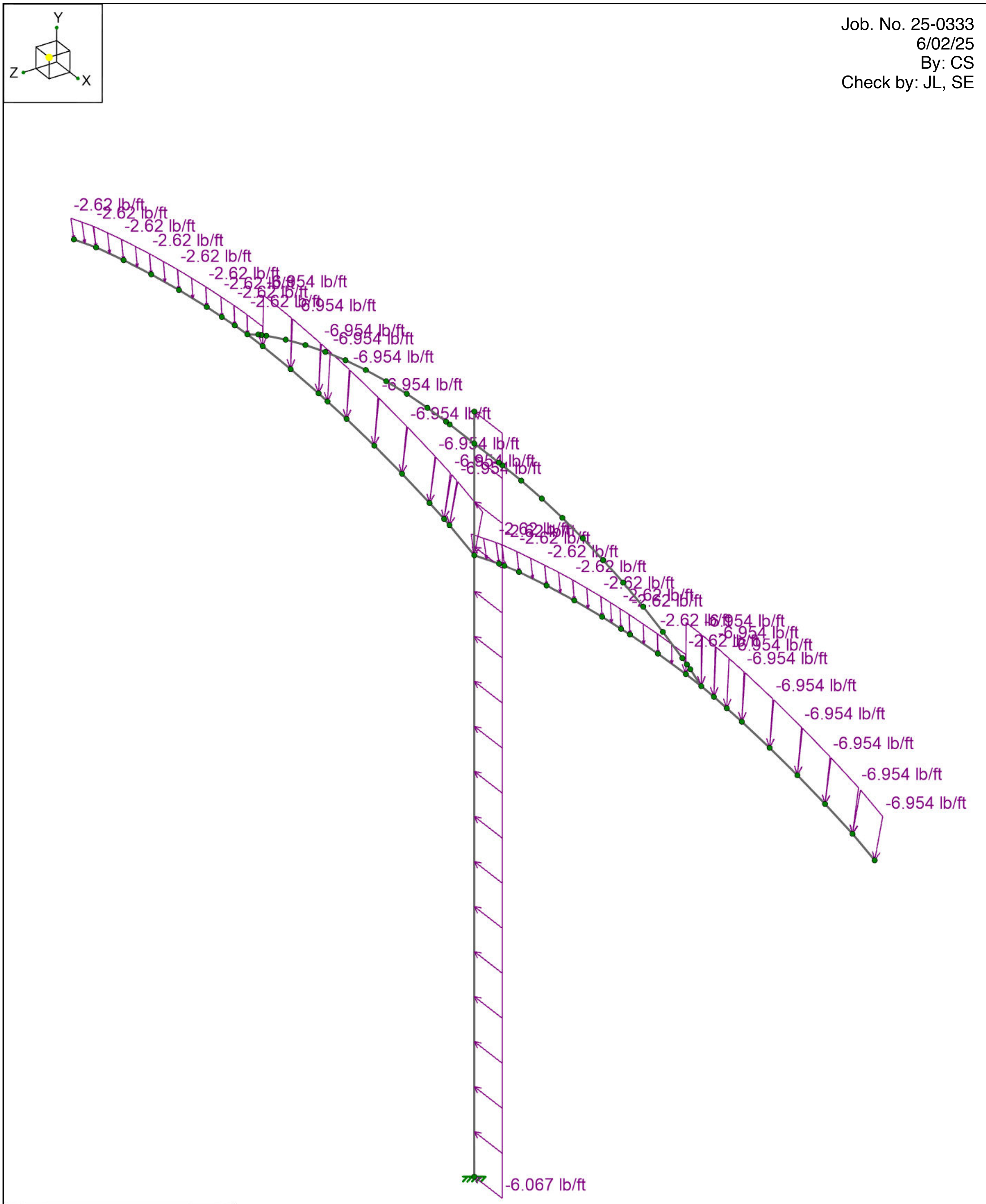
Starling Madison Lofquist, Inc.	Pay Station Arch	SK-10
C. Soare		Jun 02, 2025
25-0333		POS- full Trellis.r3d

Job. No. 25-0333
6/02/25
By: CS
Check by: JL, SE



Starling Madison Lofquist, Inc.	Pay Station Arch	SK-11
C. Soare		Jun 02, 2025
25-0333		POS- full Trellis.r3d

Job. No. 25-0333
6/02/25
By: CS
Check by: JL, SE



Loads: BLC 11, WL-A (ice)

Starling Madison Lofquist, Inc.	Pay Station Arch	SK-12
C. Soare		Jun 02, 2025
25-0333		POS- full Trellis.r3d

Model Settings

Solution

Members

Number of Reported Sections	5
Number of Internal Sections	100
Member Area Load Mesh Size (in^2)	144
Consider Shear Deformation	Yes
Consider Torsional Warping	Yes

Wall Panels

Approximate Mesh Size (in)	24
Transfer Forces Between Intersecting Wood Walls	Yes
Increase Wood Wall Nailing Capacity for Wind Loads	Yes
Include P-Delta for Walls	Yes
Optimize Masonry and Wood Walls	Yes
Maximum Number of Iterations	3

Processor Core Utilization

Single	No
Multiple (Optimum)	Yes
Maximum	No

Axis

Vertical Global Axis

Global Axis corresponding to vertical direction	Y
Convert Existing Data	Yes

Default Member Orientation

Default Global Plane for z-axis	XZ

Plate Axis

Plate Local Axis Orientation	Global

Codes

Hot Rolled Steel	AISC 15th (360-16): ASD
Stiffness Adjustment	Yes (Iterative)
Notional Annex	None
Connections	AISC 14th (360-10): ASD
Cold Formed Steel	AISI S100-16: ASD
Stiffness Adjustment	Yes (Iterative)
Wood	AWC NDS-18: ASD
Temperature	< 100F
Concrete	ACI 318-19
Masonry	TMS 402-16: ASD
Aluminum	AA ADM1-15: ASD
Structure Type	Building
Stiffness Adjustment	Yes (Iterative)
Stainless	AISC 14th (360-10): ASD
Stiffness Adjustment	Yes (Iterative)

Concrete

Compression Stress Block	Rectangular Stress Block
Analyze using Cracked Sections	Yes
Leave room for horizontal rebar splices (2*d bar spacing)	Yes
List forces which were ignored for design in the Detail Report	Yes

Rebar

Column Min Steel	1
Column Max Steel	8
Rebar Material Spec	ASTM A615

Model Settings (Continued)

Warn if beam-column framing arrangement is not understood	No

Shear Reinforcement

Number of Shear Regions	4
Region 2 & 3 Spacing Increase Increment (in)	4

Seismic

RISA-3D Seismic Load Options

Code	ASCE 7-16
Risk Category	I or II
Drift Cat	Other
Base Elevation (ft)	
Include the weight of the structure in base shear calcs	Yes

Site Parameters

S_1 (g)	1
SD_1 (g)	1
SD_S (g)	1
T_L (sec)	5

Structure Characteristics

T Z (sec)	
T X (sec)	
C_tX	0.02
C_tExp. Z	0.75
C_tExp. X	0.75
R Z	3
R X	3
Ω_0Z	1
Ω_0X	1
C_dZ	4
C_dX	4
ρ Z	1
ρ X	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0.632371	9.968007	0	
2	N2	10.2	9.88	0	
3	N3	9.63524	10.026725	0	
4	N4	8.935097	10.161331	0	
5	N5	8.231109	10.275223	0	
6	N6	7.524044	10.368268	0	
7	N7	6.814674	10.44037	0	
8	N8	6.103426	10.491489	0	
9	N9	5.39054	10.506069	0	
10	N10	4.677696	10.486742	0	
11	N11	3.96585	10.44637	0	
12	N12	3.738687	10.42674	0	
13	N13	3.255353	10.384974	0	
14	N14	2.546971	10.302612	0	
15	N15	1.841455	10.199377	0	
16	N16	1.139658	10.075408	0	
17	N17	0.769405	10.000834	0	
18	N18	0.717749	11.559381	0	
19	N19	1.195249	11.5486	0	
20	N20	1.720028	11.517073	0	
21	N21	2.243279	11.464501	0	
22	N22	2.763961	11.390983	0	
23	N23	3.281316	11.296627	0	
24	N24	3.794415	11.181602	0	
25	N25	4.302541	11.04607	0	
26	N26	4.804756	10.89028	0	
27	N27	5.299743	10.71467	0	
28	N28	5.414902	10.670353	0	
29	N29	5.502786	10.636363	0	
30	N30	6.431842	10.467885	0	
31	N31	0	12.062985	0	
32	N32	0	0	0	
33	N33	0.626983	11.559406	0	
34	N34	0	11.559406	0	
35	N35	0	9.797352	0	
36	N36	5.7807	10.505	0	
37	N37	-0.632371	9.968007	0	
38	N38	-10.2	9.88	0	
39	N39	-9.63524	10.026725	0	
40	N40	-8.935097	10.161331	0	
41	N41	-8.231109	10.275223	0	
42	N42	-7.524044	10.368268	0	
43	N43	-6.814674	10.44037	0	
44	N44	-6.103426	10.491489	0	
45	N45	-5.39054	10.506069	0	
46	N46	-4.677696	10.486742	0	
47	N47	-3.96585	10.44637	0	
48	N48	-3.738687	10.42674	0	
49	N49	-3.255353	10.384974	0	
50	N50	-2.546971	10.302612	0	
51	N51	-1.841455	10.199377	0	
52	N52	-1.139658	10.075408	0	
53	N53	-0.769405	10.000834	0	
54	N54	-0.717749	11.559381	0	
55	N55	-1.195249	11.5486	0	
56	N56	-1.720028	11.517073	0	
57	N57	-2.243279	11.464501	0	
58	N58	-2.763961	11.390983	0	
59	N59	-3.281316	11.296627	0	
60	N60	-3.794415	11.181602	0	
61	N61	-4.302541	11.04607	0	

Node Coordinates (Continued)

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
62	N62	-4.804756	10.89028	0	
63	N63	-5.299743	10.71467	0	
64	N64	-5.414902	10.670353	0	
65	N65	-5.502786	10.636363	0	
66	N66	-6.431842	10.467885	0	
67	N69	-0.626983	11.559406	0	
68	N72	-5.7807	10.505	0	

Node Boundary Conditions

	Node 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	N32	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction

Hot Rolled Steel Properties

	Label	E [psi]	G [psi]	Nu	Therm. Coeff. [1e⁵°F⁻¹]	Density [lb/ft³]	Yield [psi]	Ry	Fu [psi]	Rt
1	A992	2.9e+07	1.115e+07	0.3	0.65	490	49999.999	1.1	64999.999	1.1
2	A36 Gr.36	2.9e+07	1.115e+07	0.3	0.65	490	36000	1.5	58000	1.2
3	A572 Gr.50	2.9e+07	1.115e+07	0.3	0.65	490	49999.999	1.1	64999.999	1.1
4	A500 Gr.B RND	2.9e+07	1.115e+07	0.3	0.65	527	42000	1.4	58000	1.3
5	A500 Gr.B RECT	2.9e+07	1.115e+07	0.3	0.65	527	46000	1.4	58000	1.3
6	A500 Gr.C RND	2.9e+07	1.115e+07	0.3	0.65	527	46000	1.4	62000	1.3
7	A500 Gr.C RECT	2.9e+07	1.115e+07	0.3	0.65	527	50000	1.4	62000	1.3
8	A53 Gr.B	2.9e+07	1.115e+07	0.3	0.65	490	35000	1.6	60000	1.2
9	A1085	2.9e+07	1.115e+07	0.3	0.65	490	50000	1.4	65000	1.3
10	A913 Gr.65	2.9e+07	1.115e+07	0.3	0.65	490	65000	1.1	80000	1.1
11	A500 Gr.42	2.9e+07	1.115e+07	0.3	0.65	490	42000.001	1.4	58000	1.3
12	A500 Gr.46	2.9e+07	1.115e+07	0.3	0.65	490	46000.001	1.4	58000	1.3
13	A53 Gr. B	2.9e+07	1.115e+07	0.3	0.65	490	35000.001	1.5	60000	1.2
14	A500 Gr. 50	2.9e+07	1.115e+07	0.3	0.65	490	49999.999	1.5	58000	1.2

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in²]	Iyy [in⁴]	Izz [in⁴]	J [in⁴]
1	HR1	W10X33	Beam	Wide Flange	A992	Typical	9.71	36.6	171	0.583

Hot Rolled Steel Design Parameters

	Label	Shape	Length [ft]	Lb y-y [ft]	Lb z-z [ft]	Lcomp top [ft]	Lcomp bot [ft]	L-Torque [ft]	Function
1	M1	HSS3.500X0.216	0.655	0	0	0	0	0	Lateral
2	M2	HSS3.500X0.216	0.584	0	0	0	0	0	Lateral
3	M3	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
4	M4	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
5	M5	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
6	M6	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
7	M7	HSS3.500X0.216	0.384	0	0	0	0	0	Lateral
8	M8	HSS3.500X0.216	0.323	0	0	0	0	0	Lateral
9	M9	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
10	M10	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
11	M11	HSS3.500X0.216	0.228	0	0	0	0	0	Lateral
12	M12	HSS3.500X0.216	0.485	0	0	0	0	0	Lateral
13	M13	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
14	M14	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
15	M15	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
16	M16	HSS3.500X0.216	0.378	0	0	0	0	0	Lateral
17	M17	HSS3.500X0.216	0.478	0	0	0	0	0	Lateral
18	M18	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
19	M19	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
20	M20	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
21	M21	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
22	M22	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
23	M23	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
24	M24	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral

Hot Rolled Steel Design Parameters (Continued)

	Label	Shape	Length [ft]	Lb y-y [ft]	Lb z-z [ft]	Lcomp top [ft]	Lcomp bot [ft]	L-Torque [ft]	Function
25	M25	HSS3.500X0.216	0.525	0	0	0	0	0	Lateral
26	M26	HSS3.500X0.216	0.123	0	0	0	0	0	Lateral
27	M27	HSS3.500X0.216	0.307	0	0	0	0	0	Lateral
28	M28	HSS3.500X0.216	0.627	0	0	0	0	0	Lateral
29	M29	HSS3.500X0.216	0.329	0	0	0	0	0	Lateral
30	M30	HSS3.500X0.216	0.39	0	0	0	0	0	Lateral
31	M31	HSS6.625X0.280	12.063	0	0	0	0	0	Lateral
32	M32	HSS3.500X0.216	0.091	0	0	0	0	0	Lateral
33	M33	HSS3.500X0.216	0.094	0	0	0	0	0	Lateral
34	M34	HSS3.500X0.216	0.141	0	0	0	0	0	Lateral
35	M69	HSS3.500X0.216	0.655	0	0	0	0	0	Lateral
36	M70	HSS3.500X0.216	0.584	0	0	0	0	0	Lateral
37	M71	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
38	M72	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
39	M73	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
40	M74	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
41	M75	HSS3.500X0.216	0.384	0	0	0	0	0	Lateral
42	M76	HSS3.500X0.216	0.323	0	0	0	0	0	Lateral
43	M77	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
44	M78	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
45	M79	HSS3.500X0.216	0.228	0	0	0	0	0	Lateral
46	M80	HSS3.500X0.216	0.485	0	0	0	0	0	Lateral
47	M81	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
48	M82	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
49	M83	HSS3.500X0.216	0.713	0	0	0	0	0	Lateral
50	M84	HSS3.500X0.216	0.378	0	0	0	0	0	Lateral
51	M85	HSS3.500X0.216	0.478	0	0	0	0	0	Lateral
52	M86	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
53	M87	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
54	M88	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
55	M89	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
56	M90	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
57	M91	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
58	M92	HSS3.500X0.216	0.526	0	0	0	0	0	Lateral
59	M93	HSS3.500X0.216	0.525	0	0	0	0	0	Lateral
60	M94	HSS3.500X0.216	0.123	0	0	0	0	0	Lateral
61	M95	HSS3.500X0.216	0.307	0	0	0	0	0	Lateral
62	M96	HSS3.500X0.216	0.627	0	0	0	0	0	Lateral
63	M97	HSS3.500X0.216	0.329	0	0	0	0	0	Lateral
64	M98	HSS3.500X0.216	0.39	0	0	0	0	0	Lateral
65	M100	HSS3.500X0.216	0.091	0	0	0	0	0	Lateral
66	M101	HSS3.500X0.216	0.094	0	0	0	0	0	Lateral
67	M102	HSS3.500X0.216	0.141	0	0	0	0	0	Lateral

Nodal Loads and Enforced Displacements

No Data to Print...

Member Point Loads

No Data to Print...

Member Distributed Loads (BLC 1 : DL)

	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	M102	Y	-7.659	-7.659	0	%100
2	M98	Y	-7.659	-7.659	0	%100
3	M82	Y	-7.659	-7.659	0	%100
4	M80	Y	-7.659	-7.659	0	%100
5	M79	Y	-7.659	-7.659	0	%100
6	M78	Y	-7.659	-7.659	0	%100
7	M73	Y	-7.659	-7.659	0	%100
8	M83	Y	-7.659	-7.659	0	%100

Job. No. 25-0333
6/02/25
By: CS
Check by: JL, SE

Member Distributed Loads (BLC 1 : DL) (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, %)]
7	M73	Y	-7.659	-7.659	0	%100
8	M83	Y	-7.659	-7.659	0	%100
9	M84	Y	-7.659	-7.659	0	%100
10	M72	Y	-7.659	-7.659	0	%100
11	M70	Y	-7.659	-7.659	0	%100
12	M81	Y	-7.659	-7.659	0	%100
13	M74	Y	-7.659	-7.659	0	%100
14	M69	Y	-7.659	-7.659	0	%100
15	M34	Y	-7.659	-7.659	0	%100
16	M30	Y	-7.659	-7.659	0	%100
17	M29	Y	-7.659	-7.659	0	%100
18	M77	Y	-7.659	-7.659	0	%100
19	M97	Y	-7.659	-7.659	0	%100
20	M16	Y	-7.659	-7.659	0	%100
21	M71	Y	-7.659	-7.659	0	%100
22	M14	Y	-7.659	-7.659	0	%100
23	M13	Y	-7.659	-7.659	0	%100
24	M11	Y	-7.659	-7.659	0	%100
25	M10	Y	-7.659	-7.659	0	%100
26	M75	Y	-7.659	-7.659	0	%100
27	M9	Y	-7.659	-7.659	0	%100
28	M8	Y	-7.659	-7.659	0	%100
29	M12	Y	-7.659	-7.659	0	%100
30	M76	Y	-7.659	-7.659	0	%100
31	M5	Y	-7.659	-7.659	0	%100
32	M4	Y	-7.659	-7.659	0	%100
33	M2	Y	-7.659	-7.659	0	%100
34	M6	Y	-7.659	-7.659	0	%100
35	M7	Y	-7.659	-7.659	0	%100
36	M1	Y	-7.659	-7.659	0	%100
37	M3	Y	-7.659	-7.659	0	%100
38	M15	Y	-7.659	-7.659	0	%100

Member Distributed Loads (BLC 2 : Lr)

	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	M15	Y	-42.5	-42.5	0	%100
2	M3	Y	-42.5	-42.5	0	%100
3	M1	Y	-42.5	-42.5	0	%100
4	M7	Y	-42.5	-42.5	0	%100
5	M6	Y	-42.5	-42.5	0	%100
6	M2	Y	-42.5	-42.5	0	%100
7	M4	Y	-42.5	-42.5	0	%100
8	M5	Y	-42.5	-42.5	0	%100
9	M12	Y	-42.5	-42.5	0	%100
10	M8	Y	-42.5	-42.5	0	%100
11	M9	Y	-42.5	-42.5	0	%100
12	M10	Y	-42.5	-42.5	0	%100
13	M11	Y	-42.5	-42.5	0	%100
14	M13	Y	-42.5	-42.5	0	%100
15	M14	Y	-42.5	-42.5	0	%100
16	M16	Y	-42.5	-42.5	0	%100
17	M29	Y	-42.5	-42.5	0	%100
18	M30	Y	-42.5	-42.5	0	%100
19	M34	Y	-42.5	-42.5	0	%100

Member Distributed Loads (BLC 3 : WL-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	M3	y	-23.091	-23.091	0	%100
2	M7	y	-23.091	-23.091	0	%100
3	M6	y	-23.091	-23.091	0	%100

Member Distributed Loads (BLC 3 : WL-A) (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	M2	y	-23.091	-23.091	0	%100
5	M4	y	-23.091	-23.091	0	%100
6	M5	y	-23.091	-23.091	0	%100
7	M8	y	-23.091	-23.091	0	%100
8	M77	y	-23.091	-23.091	0	%100
9	M29	y	-23.091	-23.091	0	%100
10	M69	y	-23.091	-23.091	0	%100
11	M81	y	-23.091	-23.091	0	%100
12	M84	y	-23.091	-23.091	0	%100
13	M83	y	-23.091	-23.091	0	%100
14	M78	y	-23.091	-23.091	0	%100
15	M79	y	-23.091	-23.091	0	%100
16	M80	y	-23.091	-23.091	0	%100
17	M82	y	-23.091	-23.091	0	%100
18	M102	y	-23.091	-23.091	0	%100
19	M98	y	-5.773	-5.773	0	%100
20	M73	y	-5.773	-5.773	0	%100
21	M72	y	-5.773	-5.773	0	%100
22	M70	y	-5.773	-5.773	0	%100
23	M74	y	-5.773	-5.773	0	%100
24	M34	y	-5.773	-5.773	0	%100
25	M30	y	-5.773	-5.773	0	%100
26	M97	y	-5.773	-5.773	0	%100
27	M16	y	-5.773	-5.773	0	%100
28	M71	y	-5.773	-5.773	0	%100
29	M14	y	-5.773	-5.773	0	%100
30	M13	y	-5.773	-5.773	0	%100
31	M11	y	-5.773	-5.773	0	%100
32	M10	y	-5.773	-5.773	0	%100
33	M75	y	-5.773	-5.773	0	%100
34	M9	y	-5.773	-5.773	0	%100
35	M12	y	-5.773	-5.773	0	%100
36	M76	y	-5.773	-5.773	0	%100
37	M1	y	-5.773	-5.773	0	%100
38	M15	y	-5.773	-5.773	0	%100
39	M31	X	-11.483	-11.483	0	%100

Member Distributed Loads (BLC 4 : WL-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	M73	y	1.924	1.924	0	%100
2	M72	y	1.924	1.924	0	%100
3	M70	y	1.924	1.924	0	%100
4	M74	y	1.924	1.924	0	%100
5	M34	y	1.924	1.924	0	%100
6	M30	y	1.924	1.924	0	%100
7	M97	y	1.924	1.924	0	%100
8	M16	y	1.924	1.924	0	%100
9	M71	y	1.924	1.924	0	%100
10	M14	y	1.924	1.924	0	%100
11	M13	y	1.924	1.924	0	%100
12	M11	y	1.924	1.924	0	%100
13	M10	y	1.924	1.924	0	%100
14	M75	y	1.924	1.924	0	%100
15	M9	y	1.924	1.924	0	%100
16	M12	y	1.924	1.924	0	%100
17	M76	y	1.924	1.924	0	%100
18	M1	y	1.924	1.924	0	%100
19	M15	y	1.924	1.924	0	%100
20	M98	y	1.924	1.924	0	%100
21	M3	y	21.167	21.167	0	%100
22	M7	y	21.167	21.167	0	%100

Member Distributed Loads (BLC 4 : WL-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, %)]
23	M6	y	21.167	21.167	0	%100
24	M2	y	21.167	21.167	0	%100
25	M4	y	21.167	21.167	0	%100
26	M5	y	21.167	21.167	0	%100
27	M8	y	21.167	21.167	0	%100
28	M77	y	21.167	21.167	0	%100
29	M29	y	21.167	21.167	0	%100
30	M69	y	21.167	21.167	0	%100
31	M81	y	21.167	21.167	0	%100
32	M84	y	21.167	21.167	0	%100
33	M83	y	21.167	21.167	0	%100
34	M78	y	21.167	21.167	0	%100
35	M79	y	21.167	21.167	0	%100
36	M80	y	21.167	21.167	0	%100
37	M82	y	21.167	21.167	0	%100
38	M102	y	21.167	21.167	0	%100
39	M31	X	-11.483	-11.483	0	%100

Member Distributed Loads (BLC 5 : ELz)

	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	M15	Z	0.49	0.49	0	%100
2	M3	Z	0.49	0.49	0	%100
3	M1	Z	0.49	0.49	0	%100
4	M7	Z	0.49	0.49	0	%100
5	M6	Z	0.49	0.49	0	%100
6	M2	Z	0.49	0.49	0	%100
7	M4	Z	0.49	0.49	0	%100
8	M5	Z	0.49	0.49	0	%100
9	M76	Z	0.49	0.49	0	%100
10	M12	Z	0.49	0.49	0	%100
11	M8	Z	0.49	0.49	0	%100
12	M9	Z	0.49	0.49	0	%100
13	M75	Z	0.49	0.49	0	%100
14	M10	Z	0.49	0.49	0	%100
15	M11	Z	0.49	0.49	0	%100
16	M13	Z	0.49	0.49	0	%100
17	M14	Z	0.49	0.49	0	%100
18	M71	Z	0.49	0.49	0	%100
19	M16	Z	0.49	0.49	0	%100
20	M97	Z	0.49	0.49	0	%100
21	M77	Z	0.49	0.49	0	%100
22	M29	Z	0.49	0.49	0	%100
23	M30	Z	0.49	0.49	0	%100
24	M34	Z	0.49	0.49	0	%100
25	M69	Z	0.49	0.49	0	%100
26	M74	Z	0.49	0.49	0	%100
27	M81	Z	0.49	0.49	0	%100
28	M70	Z	0.49	0.49	0	%100
29	M72	Z	0.49	0.49	0	%100
30	M84	Z	0.49	0.49	0	%100
31	M83	Z	0.49	0.49	0	%100
32	M73	Z	0.49	0.49	0	%100
33	M78	Z	0.49	0.49	0	%100
34	M79	Z	0.49	0.49	0	%100
35	M80	Z	0.49	0.49	0	%100
36	M82	Z	0.49	0.49	0	%100
37	M98	Z	0.49	0.49	0	%100
38	M102	Z	0.49	0.49	0	%100

Member Distributed Loads (BLC 6 : ELx)

	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	M15	X	0.49	0.49	0	%100
2	M3	X	0.49	0.49	0	%100
3	M1	X	0.49	0.49	0	%100
4	M7	X	0.49	0.49	0	%100
5	M6	X	0.49	0.49	0	%100
6	M2	X	0.49	0.49	0	%100
7	M4	X	0.49	0.49	0	%100
8	M5	X	0.49	0.49	0	%100
9	M76	X	0.49	0.49	0	%100
10	M12	X	0.49	0.49	0	%100
11	M8	X	0.49	0.49	0	%100
12	M9	X	0.49	0.49	0	%100
13	M75	X	0.49	0.49	0	%100
14	M10	X	0.49	0.49	0	%100
15	M11	X	0.49	0.49	0	%100
16	M13	X	0.49	0.49	0	%100
17	M14	X	0.49	0.49	0	%100
18	M71	X	0.49	0.49	0	%100
19	M16	X	0.49	0.49	0	%100
20	M97	X	0.49	0.49	0	%100
21	M77	X	0.49	0.49	0	%100
22	M29	X	0.49	0.49	0	%100
23	M30	X	0.49	0.49	0	%100
24	M34	X	0.49	0.49	0	%100
25	M69	X	0.49	0.49	0	%100
26	M74	X	0.49	0.49	0	%100
27	M81	X	0.49	0.49	0	%100
28	M70	X	0.49	0.49	0	%100
29	M72	X	0.49	0.49	0	%100
30	M84	X	0.49	0.49	0	%100
31	M83	X	0.49	0.49	0	%100
32	M73	X	0.49	0.49	0	%100
33	M78	X	0.49	0.49	0	%100
34	M79	X	0.49	0.49	0	%100
35	M80	X	0.49	0.49	0	%100
36	M82	X	0.49	0.49	0	%100
37	M98	X	0.49	0.49	0	%100
38	M102	X	0.49	0.49	0	%100

Member Distributed Loads (BLC 7 : ELy)

	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	M15	Y	-0.123	-0.123	0	%100
2	M3	Y	-0.123	-0.123	0	%100
3	M1	Y	-0.123	-0.123	0	%100
4	M7	Y	-0.123	-0.123	0	%100
5	M6	Y	-0.123	-0.123	0	%100
6	M2	Y	-0.123	-0.123	0	%100
7	M4	Y	-0.123	-0.123	0	%100
8	M5	Y	-0.123	-0.123	0	%100
9	M76	Y	-0.123	-0.123	0	%100
10	M12	Y	-0.123	-0.123	0	%100
11	M8	Y	-0.123	-0.123	0	%100
12	M9	Y	-0.123	-0.123	0	%100
13	M75	Y	-0.123	-0.123	0	%100
14	M10	Y	-0.123	-0.123	0	%100
15	M11	Y	-0.123	-0.123	0	%100
16	M13	Y	-0.123	-0.123	0	%100
17	M14	Y	-0.123	-0.123	0	%100
18	M71	Y	-0.123	-0.123	0	%100
19	M16	Y	-0.123	-0.123	0	%100
20	M97	Y	-0.123	-0.123	0	%100

Member Distributed Loads (BLC 7 : ELy) (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, %)]
21	M77	Y	-0.123	-0.123	0	%100
22	M29	Y	-0.123	-0.123	0	%100
23	M30	Y	-0.123	-0.123	0	%100
24	M34	Y	-0.123	-0.123	0	%100
25	M69	Y	-0.123	-0.123	0	%100
26	M74	Y	-0.123	-0.123	0	%100
27	M81	Y	-0.123	-0.123	0	%100
28	M70	Y	-0.123	-0.123	0	%100
29	M72	Y	-0.123	-0.123	0	%100
30	M84	Y	-0.123	-0.123	0	%100
31	M83	Y	-0.123	-0.123	0	%100
32	M73	Y	-0.123	-0.123	0	%100
33	M78	Y	-0.123	-0.123	0	%100
34	M79	Y	-0.123	-0.123	0	%100
35	M80	Y	-0.123	-0.123	0	%100
36	M82	Y	-0.123	-0.123	0	%100
37	M98	Y	-0.123	-0.123	0	%100
38	M102	Y	-0.123	-0.123	0	%100

Member Distributed Loads (BLC 8 : WL-Lat (w/ice))

	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	M15	Z	1.421	1.421	0	%100
2	M3	Z	1.421	1.421	0	%100
3	M22	Z	1.421	1.421	0	%100
4	M21	Z	1.421	1.421	0	%100
5	M1	Z	1.421	1.421	0	%100
6	M7	Z	1.421	1.421	0	%100
7	M6	Z	1.421	1.421	0	%100
8	M2	Z	1.421	1.421	0	%100
9	M4	Z	1.421	1.421	0	%100
10	M5	Z	1.421	1.421	0	%100
11	M76	Z	1.421	1.421	0	%100
12	M12	Z	1.421	1.421	0	%100
13	M8	Z	1.421	1.421	0	%100
14	M18	Z	1.421	1.421	0	%100
15	M9	Z	1.421	1.421	0	%100
16	M75	Z	1.421	1.421	0	%100
17	M10	Z	1.421	1.421	0	%100
18	M28	Z	1.421	1.421	0	%100
19	M11	Z	1.421	1.421	0	%100
20	M13	Z	1.421	1.421	0	%100
21	M87	Z	1.421	1.421	0	%100
22	M14	Z	1.421	1.421	0	%100
23	M71	Z	1.421	1.421	0	%100
24	M16	Z	1.421	1.421	0	%100
25	M17	Z	1.421	1.421	0	%100
26	M97	Z	1.421	1.421	0	%100
27	M23	Z	1.421	1.421	0	%100
28	M19	Z	1.421	1.421	0	%100
29	M77	Z	1.421	1.421	0	%100
30	M20	Z	1.421	1.421	0	%100
31	M24	Z	1.421	1.421	0	%100
32	M25	Z	1.421	1.421	0	%100
33	M94	Z	1.421	1.421	0	%100
34	M26	Z	1.421	1.421	0	%100
35	M27	Z	1.421	1.421	0	%100
36	M91	Z	1.421	1.421	0	%100
37	M29	Z	1.421	1.421	0	%100
38	M90	Z	1.421	1.421	0	%100
39	M30	Z	1.421	1.421	0	%100
40	M92	Z	1.421	1.421	0	%100

Job. No. 25-0333
6/02/25
By: CS
Check by: JL, SE

Member Distributed Loads (BLC 8 : WL-Lat (w/ice)) (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, %)]
41	M32	Z	1.421	1.421	0	%100
42	M89	Z	1.421	1.421	0	%100
43	M33	Z	1.421	1.421	0	%100
44	M34	Z	1.421	1.421	0	%100
45	M69	Z	1.421	1.421	0	%100
46	M93	Z	1.421	1.421	0	%100
47	M74	Z	1.421	1.421	0	%100
48	M81	Z	1.421	1.421	0	%100
49	M70	Z	1.421	1.421	0	%100
50	M72	Z	1.421	1.421	0	%100
51	M85	Z	1.421	1.421	0	%100
52	M84	Z	1.421	1.421	0	%100
53	M83	Z	1.421	1.421	0	%100
54	M73	Z	1.421	1.421	0	%100
55	M78	Z	1.421	1.421	0	%100
56	M79	Z	1.421	1.421	0	%100
57	M80	Z	1.421	1.421	0	%100
58	M82	Z	1.421	1.421	0	%100
59	M86	Z	1.421	1.421	0	%100
60	M88	Z	1.421	1.421	0	%100
61	M95	Z	1.421	1.421	0	%100
62	M96	Z	1.421	1.421	0	%100
63	M98	Z	1.421	1.421	0	%100
64	M100	Z	1.421	1.421	0	%100
65	M101	Z	1.421	1.421	0	%100
66	M102	Z	1.421	1.421	0	%100
67	M31	Z	-6.067	-6.067	0	%100

Member Distributed Loads (BLC 9 : DL-Ice)

	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	M102	Y	-59.822	-59.822	0	%100
2	M98	Y	-59.822	-59.822	0	%100
3	M82	Y	-59.822	-59.822	0	%100
4	M80	Y	-59.822	-59.822	0	%100
5	M79	Y	-59.822	-59.822	0	%100
6	M78	Y	-59.822	-59.822	0	%100
7	M73	Y	-59.822	-59.822	0	%100
8	M83	Y	-59.822	-59.822	0	%100
9	M84	Y	-59.822	-59.822	0	%100
10	M72	Y	-59.822	-59.822	0	%100
11	M70	Y	-59.822	-59.822	0	%100
12	M81	Y	-59.822	-59.822	0	%100
13	M74	Y	-59.822	-59.822	0	%100
14	M69	Y	-59.822	-59.822	0	%100
15	M34	Y	-59.822	-59.822	0	%100
16	M30	Y	-59.822	-59.822	0	%100
17	M29	Y	-59.822	-59.822	0	%100
18	M77	Y	-59.822	-59.822	0	%100
19	M97	Y	-59.822	-59.822	0	%100
20	M16	Y	-59.822	-59.822	0	%100
21	M71	Y	-59.822	-59.822	0	%100
22	M14	Y	-59.822	-59.822	0	%100
23	M13	Y	-59.822	-59.822	0	%100
24	M11	Y	-59.822	-59.822	0	%100
25	M10	Y	-59.822	-59.822	0	%100
26	M75	Y	-59.822	-59.822	0	%100
27	M9	Y	-59.822	-59.822	0	%100
28	M8	Y	-59.822	-59.822	0	%100
29	M12	Y	-59.822	-59.822	0	%100
30	M76	Y	-59.822	-59.822	0	%100
31	M5	Y	-59.822	-59.822	0	%100

Member Distributed Loads (BLC 9 : DL-Ice) (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, %)]
32	M4	Y	-59.822	-59.822	0	%100
33	M2	Y	-59.822	-59.822	0	%100
34	M6	Y	-59.822	-59.822	0	%100
35	M7	Y	-59.822	-59.822	0	%100
36	M1	Y	-59.822	-59.822	0	%100
37	M3	Y	-59.822	-59.822	0	%100
38	M15	Y	-59.822	-59.822	0	%100
39	M31	Y	-10.114	-10.114	0	%100
40	M101	Y	-6.01	-6.01	0	%100
41	M100	Y	-6.01	-6.01	0	%100
42	M96	Y	-6.01	-6.01	0	%100
43	M95	Y	-6.01	-6.01	0	%100
44	M88	Y	-6.01	-6.01	0	%100
45	M86	Y	-6.01	-6.01	0	%100
46	M85	Y	-6.01	-6.01	0	%100
47	M93	Y	-6.01	-6.01	0	%100
48	M33	Y	-6.01	-6.01	0	%100
49	M89	Y	-6.01	-6.01	0	%100
50	M32	Y	-6.01	-6.01	0	%100
51	M92	Y	-6.01	-6.01	0	%100
52	M90	Y	-6.01	-6.01	0	%100
53	M91	Y	-6.01	-6.01	0	%100
54	M27	Y	-6.01	-6.01	0	%100
55	M26	Y	-6.01	-6.01	0	%100
56	M94	Y	-6.01	-6.01	0	%100
57	M25	Y	-6.01	-6.01	0	%100
58	M24	Y	-6.01	-6.01	0	%100
59	M20	Y	-6.01	-6.01	0	%100
60	M19	Y	-6.01	-6.01	0	%100
61	M23	Y	-6.01	-6.01	0	%100
62	M17	Y	-6.01	-6.01	0	%100
63	M87	Y	-6.01	-6.01	0	%100
64	M28	Y	-6.01	-6.01	0	%100
65	M18	Y	-6.01	-6.01	0	%100
66	M21	Y	-6.01	-6.01	0	%100
67	M22	Y	-6.01	-6.01	0	%100

Member Distributed Loads (BLC 10 : SL)

	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	M34	Y	-21.449	-21.449	0	%100
2	M30	Y	-21.449	-21.449	0	%100
3	M29	Y	-21.449	-21.449	0	%100
4	M16	Y	-21.449	-21.449	0	%100
5	M14	Y	-21.449	-21.449	0	%100
6	M13	Y	-21.449	-21.449	0	%100
7	M11	Y	-21.449	-21.449	0	%100
8	M10	Y	-21.449	-21.449	0	%100
9	M9	Y	-21.449	-21.449	0	%100
10	M8	Y	-21.449	-21.449	0	%100
11	M12	Y	-21.449	-21.449	0	%100
12	M5	Y	-21.449	-21.449	0	%100
13	M4	Y	-21.449	-21.449	0	%100
14	M2	Y	-21.449	-21.449	0	%100
15	M6	Y	-21.449	-21.449	0	%100
16	M7	Y	-21.449	-21.449	0	%100
17	M1	Y	-21.449	-21.449	0	%100
18	M3	Y	-21.449	-21.449	0	%100
19	M15	Y	-21.449	-21.449	0	%100
20	M22	Y	-2.62	-2.62	0	%100
21	M21	Y	-2.62	-2.62	0	%100
22	M18	Y	-2.62	-2.62	0	%100

Member Distributed Loads (BLC 10 : SL) (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, %)]
23	M28	Y	-2.62	-2.62	0	%100
24	M17	Y	-2.62	-2.62	0	%100
25	M23	Y	-2.62	-2.62	0	%100
26	M19	Y	-2.62	-2.62	0	%100
27	M20	Y	-2.62	-2.62	0	%100
28	M24	Y	-2.62	-2.62	0	%100
29	M25	Y	-2.62	-2.62	0	%100
30	M26	Y	-2.62	-2.62	0	%100
31	M27	Y	-2.62	-2.62	0	%100
32	M32	Y	-2.62	-2.62	0	%100
33	M33	Y	-2.62	-2.62	0	%100

Member Distributed Loads (BLC 11 : WL-A (ice))

	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	M98	y	-2.62	-2.62	0	%100
2	M73	y	-2.62	-2.62	0	%100
3	M72	y	-2.62	-2.62	0	%100
4	M70	y	-2.62	-2.62	0	%100
5	M74	y	-2.62	-2.62	0	%100
6	M34	y	-2.62	-2.62	0	%100
7	M97	y	-2.62	-2.62	0	%100
8	M16	y	-2.62	-2.62	0	%100
9	M71	y	-2.62	-2.62	0	%100
10	M14	y	-2.62	-2.62	0	%100
11	M13	y	-2.62	-2.62	0	%100
12	M11	y	-2.62	-2.62	0	%100
13	M10	y	-2.62	-2.62	0	%100
14	M75	y	-2.62	-2.62	0	%100
15	M9	y	-2.62	-2.62	0	%100
16	M12	y	-2.62	-2.62	0	%100
17	M76	y	-2.62	-2.62	0	%100
18	M1	y	-2.62	-2.62	0	%100
19	M15	y	-2.62	-2.62	0	%100
20	M3	y	-6.954	-6.954	0	%100
21	M7	y	-6.954	-6.954	0	%100
22	M6	y	-6.954	-6.954	0	%100
23	M2	y	-6.954	-6.954	0	%100
24	M4	y	-6.954	-6.954	0	%100
25	M5	y	-6.954	-6.954	0	%100
26	M8	y	-6.954	-6.954	0	%100
27	M77	y	-6.954	-6.954	0	%100
28	M29	y	-6.954	-6.954	0	%100
29	M30	y	-6.954	-6.954	0	%100
30	M69	y	-6.954	-6.954	0	%100
31	M81	y	-6.954	-6.954	0	%100
32	M84	y	-6.954	-6.954	0	%100
33	M83	y	-6.954	-6.954	0	%100
34	M78	y	-6.954	-6.954	0	%100
35	M79	y	-6.954	-6.954	0	%100
36	M80	y	-6.954	-6.954	0	%100
37	M82	y	-6.954	-6.954	0	%100
38	M102	y	-6.954	-6.954	0	%100
39	M31	X	-6.067	-6.067	0	%100

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Distributed
1	DL	None		-1		38
2	Lr	LL				19
3	WL-A	None				39
4	WL-B	None				39

Basic Load Cases (Continued)

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Distributed
5	ELz	None			0.06	38
6	ELx	None	0.06			38
7	ELy	None		-0.02		38
8	WL-Lat (w/ice)	None				67
9	DL-Ice	None				67
10	SL	None				33
11	WL-A (ice)	None				39

Load Combinations

	Description	Solve	PDelta	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	D	Yes	C	1	1						
2	D+Lr	Yes	C	1	1	2	1				
3	D + S	Yes	C	1	1						
4	D+0.6*WA	Yes	C	1	1	3	0.6				
5	0.6*D+0.6*WB	Yes	C	1	0.6	4	0.6				
6	D+0.45*WA+0.75*Lr	Yes	C	1	1	3	0.45	2	0.75		
7	D +0.7ELx + 0.7ELy	Yes	C	1	1	6	0.7	7	0.7		
8	D+0.7ELz+0.7ELy	Yes	C	1	1	5	0.7	7	0.7		
9	0.6D-0.7ELx-0.7ELy	Yes	C	1	0.6	6	-0.7	7	-0.7		
10	0.6D-0.7ELz-0.7ELy	Yes	C	1	0.6	5	-0.7	7	-0.7		
11	D+0.7Di+0.7WL-Lat+S	Yes	C	1	1	9	0.7	8	0.7	10	1
12	D+0.7Di+0.7WA(ice)+S	Yes	C	1	1	9	0.7	11	0.7	10	1
13	1.4*D	Yes	C	1	1.4						
14	1.2D+1.6Lr+0.5WA	Yes	C	1	1.2	2	1.6	3	0.5		
15	1.2D+1.6S+0.5WA	Yes	C	1	1.2	10	1.6	3	0.5		
16	1.2*D+0.5Lr+WA	Yes	C	1	1.2	2	0.5	3	1		
17	1.2D+0.5S+WA	Yes	C	1	1.2	10	0.5	3	1		
18	0.9*D+WB	Yes	C	1	0.9	4	1				
19	1.2D+ELx+ELy	Yes	C	1	1.2	6	1	7	1		
20	1.2D+ELz+ELy	Yes	C	1	1.2	5	1	7	1		
21	0.9D-ELx-ELy	Yes	C	1	0.9	6	-1	7	-1		
22	0.9D-ELz-ELy	Yes	C	1	0.9	5	-1	7	-1		
23	1.2D+Di+WL-Lat+0.5S	Yes	C	1	1.2	9	1	8	1	10	0.5
24	1.2D+Di+WA(ice)+0.5S	Yes	C	1	1.2	9	1	11	1	10	0.5

Load Combination Design

	Description	Service	Hot Rolled	Cold Formed	Wood	Concrete	Masonry	Aluminum	Stainless	Connection
1	D		Yes							
2	D+Lr		Yes							
3	D + S		Yes							
4	D+0.6*WA		Yes							
5	0.6*D+0.6*WB		Yes							
6	D+0.45*WA+0.75*Lr		Yes							
7	D +0.7ELx + 0.7ELy		Yes							
8	D+0.7ELz+0.7ELy		Yes							
9	0.6D-0.7ELx-0.7ELy		Yes							
10	0.6D-0.7ELz-0.7ELy		Yes							
11	D+0.7Di+0.7WL-Lat+S		Yes							
12	D+0.7Di+0.7WA(ice)+S		Yes							
13	1.4*D									
14	1.2D+1.6Lr+0.5WA									
15	1.2D+1.6S+0.5WA									
16	1.2*D+0.5Lr+WA									
17	1.2D+0.5S+WA									
18	0.9*D+WB									
19	1.2D+ELx+ELy									
20	1.2D+ELz+ELy									
21	0.9D-ELx-ELy									
22	0.9D-ELz-ELy									
23	1.2D+Di+WL-Lat+0.5S									

Load Combination Design (Continued)

	Description	Service	Hot Rolled	Cold Formed	Wood	Concrete	Masonry	Aluminum	Stainless	Connection
24	1.2D+Di+WA(ice)+0.5S									

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	M1	max	2377.171	0.655	12	169.755	0	12	4.805	0.655	10	7.41	0.655	11	19.914	0.655	10	116.713	0	2
2		min	3.603	0	5	-28.636	0.655	5	-8.149	0.655	11	-4.172	0	10	-36.056	0.655	11	-39.522	0.655	4
3	M2	max	0	0	12	2.417	0.584	5	0.374	0.584	10	0	0.584	12	0.109	0.584	10	13.691	0.584	12
4		min	-11.454	0.584	11	-46.926	0.584	12	-0.58	0.584	11	0	0	1	-0.169	0.584	11	-0.705	0.584	5
5	M3	max	-0.587	0	9	5.193	0.713	5	0.83	0.713	10	0.011	0.713	11	0.538	0.713	10	68.323	0.713	12
6		min	-19.107	0.713	11	-105.689	0.713	12	-1.29	0.713	11	-0.007	0	10	-0.836	0.713	11	-3.386	0.713	5
7	M4	max	-0.973	0	9	7.945	0.713	5	1.287	0.713	10	0.036	0.713	11	1.292	0.713	10	164.893	0.713	12
8		min	-25.053	0.713	11	-164.628	0.713	12	-1.999	0.713	11	-0.023	0	10	-2.008	0.713	11	-8.042	0.713	5
9	M5	max	-0.994	0	9	10.635	0.713	5	1.743	0.713	10	0.095	0.713	11	2.371	0.713	10	303.687	0.713	12
10		min	-27.73	0.713	11	-223.951	0.713	12	-2.708	0.713	11	-0.061	0	10	-3.684	0.713	11	-14.626	0.713	5
11	M6	max	-0.649	0	9	13.27	0.713	5	2.2	0.713	10	0.204	0.713	11	3.774	0.713	10	484.85	0.713	12
12		min	-27.121	0.713	11	-283.498	0.713	12	-3.418	0.713	11	-0.131	0	10	-5.864	0.713	11	-23.096	0.713	5
13	M7	max	0.752	0	4	14.582	0.384	5	2.446	0.384	10	0.377	0.384	11	4.66	0.384	10	600.004	0.384	12
14		min	-21.374	0.384	11	-315.897	0.384	12	-3.799	0.384	11	-0.243	0	10	-7.24	0.384	11	-28.407	0.384	5
15	M8	max	3.533	0	4	16.903	0.323	5	2.863	0.323	10	0.632	0.323	11	6.382	0.323	10	823.82	0.323	12
16		min	-14.601	0.323	11	-370.396	0.323	12	-4.448	0.323	11	-0.407	0	10	-9.915	0.323	11	-38.676	0.323	5
17	M9	max	2332.482	0.713	12	12.901	0	5	1.79	0.713	10	2.551	0.713	11	4.883	0.713	10	118.656	0.713	12
18		min	-3.696	0	5	-67.661	0.713	12	-4.016	0.713	11	-1.509	0	10	-8.12	0.713	11	-23.923	0.713	5
19	M10	max	2336.156	0.713	12	7.314	0	5	2.246	0.713	10	2.79	0.713	11	6.275	0.713	10	137.566	0.713	12
20		min	-3.743	0	5	-54.96	0.713	12	-4.694	0.713	11	-1.653	0	10	-11.135	0.713	11	-27.187	0.713	5
21	M11	max	2337.853	0.228	12	14.564	0	12	2.393	0.228	10	3.118	0.228	11	6.752	0.228	10	137.566	0	12
22		min	-3.439	0	5	-14.726	0.228	2	-4.896	0.228	11	-1.838	0	10	-12.138	0.228	11	-27.385	0.228	5
23	M12	max	2341.113	0.485	12	-0.003	0	5	2.701	0.485	10	3.118	0.485	11	7.987	0.485	10	147.239	0.485	12
24		min	-3.266	0	5	-42.209	0.485	2	-5.345	0.485	11	-1.838	0	10	-14.614	0.485	11	-27.385	0	5
25	M13	max	2347.342	0.713	12	28.034	0	12	3.157	0.713	10	3.548	0.713	11	10.018	0.713	10	147.43	0.713	12
26		min	-2.785	0	5	-34.835	0.713	2	-5.999	0.713	11	-2.073	0	10	-18.541	0.713	11	-26.483	0	5
27	M14	max	2354.827	0.713	12	41.585	0	12	3.61	0.713	10	4.094	0.713	11	12.363	0.713	10	147.43	0	12
28		min	-1.783	0	5	-27.068	0.713	2	-6.619	0.713	11	-2.368	0	10	-22.895	0.713	11	-21.832	0	5
29	M15	max	2363.544	0.713	12	55.513	0	12	4.061	0.713	10	4.769	0.713	11	15.02	0.713	10	137.88	0	12
30		min	-0.435	0	5	-20.115	0.713	5	-7.216	0.713	11	-2.732	0	10	-27.654	0.713	11	-13.272	0	5
31	M16	max	2368.421	0.378	12	56.433	0	12	4.299	0.378	10	5.429	0.378	11	16.528	0.378	10	128.1	0	2
32		min	1.142	0	5	-22.929	0.378	5	-7.489	0.378	11	-3.09	0	10	-30.289	0.378	11	-0.855	0	5
33	M17	max	-5.032	0.478	5	364.377	0	12	3.382	0	10	2.257	0.478	11	30.747	0	11	235.187	0	12
34		min	-2336.02	0	12	19.394	0.478	5	-7.523	0	11	-1.382	0	10	-16.32	0	10	10.735	0.478	10
35	M18	max	-5.621	0.526	5	270.075	0	12	3.24	0	10	1.235	0.526	11	27.333	0	11	62.738	0	12
36		min	-2347.621	0	12	16.963	0.526	5	-7.048	0	11	-0.829	0	10	-14.779	0	10	-77.329	0.526	12
37	M19	max	-6.074	0.526	5	168.395	0	12	3.084	0	10	0.305	0.526	8	23.795	0	11	2.083	0	5
38		min	-2355.836	0	12	14.502	0.526	5	-6.525	0	11	-0.302	0	10	-13.14	0	10	-163.972	0.526	12
39	M20	max	-6.338	0.526	5	66.501	0	12	2.928	0	10	0.162	0.526	10	20.496	0	11	-6.127	0	5
40		min	-2359.673	0	12	9.519	0.526	9	-6.002	0	11	-0.542	0	11	-11.562	0	10	-197.038	0.526	12
41	M21	max	-6.415	0.526	5	11.771	0	5	2.772	0	10	0.565	0.526	10	17.442	0	11	-13.037	0	5
42		min	-2359.129	0	12	-42.611	0.526	12	-5.479	0	11	-1.243	0	11	-10.049	0	10	-197.038	0	12
43	M22	max	-6.306	0.526	5	9.309	0	5	2.615	0	10	0.911	0.526	10	14.636	0	11	-17.117	0.526	9
44		min	-2354.209	0	12	-144.308	0.526	12	-4.956	0	11	-1.831	0	11	-8.603	0	10	-176.521	0	12
45	M23	max	-6.011	0.526	5	6.872	0	5	2.459	0	10	1.202	0.526	10	12.084	0	11	36.124	0.526	6
46		min	-2344.926	0	12	-245.645	0.526	12	-4.433	0	11	-2.318	0	11	-7.226	0	10	-102.514	0	12
47	M24	max	-5.534	0.526	5	4.469	0	5	2.303	0	10	1.441	0.526	10	9.79	0	11	205.137	0.526	12
48		min	-2331.3	0	12	-346.433	0.526	12	-3.91	0	11	-2.713	0	11	-5.921	0	10	-27.808	0.526	5
49	M25	max	-4.878	0.525	5	2.112	0	5	2.146	0	10	1.63	0.525	10	7.756	0	11	437.828	0.525	12
50		min	-2313.359	0	12	-446.481	0.525	12	-3.387	0	11	-3.027	0	11	-4.69	0	10	-28.365	0.525	5
51	M26	max	-4.688	0.123	5	-0.119	0	5	1.99	0	10	1.725	0.123	10	6.033	0	11	500.541	0.123	12
52		min	-2298.302	0	12	-509.039	0.123	12	-2.864	0	11	-3.187	0	11	-3.559	0	10	-28.365	0	5
53	M27	max	-3.901	0.307	5	-1.315	0	5	1.925	0	10	1.953	0.307	10	5.182	0	11	758.273	0.307	12
54		min	-2253.083	0	12	-682.968	0.307	12	-2.648	0	11	-3.581	0	11	-2.997	0	10	-28.245	0	5
55	M28	max	-4.593	0.627	5	-21.916	0	5	3.596	0.627	10	2.951	0.627	11	18.789	0.627	10	538.079	0.627	12
56		min	-2327.2	0	12	-426.993	0.627	12	-8.237	0.627	11	-1.75	0	10	-36.344	0.627	11	23.306	0	5
57	M29	max	0.346	0	4	15.86	0.329	5	2.656	0.329	10	0.377	0.329	11	5.5	0.329	10	708.502	0.329	12

Envelope Maximum Member Section Forces (Continued)

	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
58		min	-23.217	0.329	11	-343.137	0.329	12	-4.127	0.329	11	-0.243	0	10	-8.545	0.329	11	-33.418	0.329	5
59	M30	max	2330.163	0	12	16.005	0	5	1.332	0.39	10	2.386	0.39	11	3.813	0.39	10	90.714	0.39	12
60		min	-3.31	0.39	5	-80.681	0.39	12	-3.318	0.39	11	-1.396	0	10	-5.583	0.39	11	-16.677	0.39	5
61	M31	max	1905.48	0	12	1143.27	11.435	2	25.78	0	10	1.099	9.676	11	231.141	0	8	2399.598	0	2
62		min	0	12.063	1	-179.794	9.801	5	-25.843	0	8	0	0	1	-230.413	0	10	-587.616	0	5
63	M32	max	-4.593	0.091	5	-21.531	0	5	3.409	0.091	10	2.951	0.091	11	16.593	0.091	10	273.095	0.091	12
64		min	-2327.2	0	12	-418.275	0.091	12	-7.613	0.091	11	-1.75	0	10	-31.375	0.091	11	21.334	0	5
65	M33	max	-4.543	0	5	514.096	0	12	1.953	0.094	10	1.731	0.094	10	3.313	0.094	10	548.925	0	12
66		min	-2296.833	0.094	12	0.616	0.094	5	-2.741	0.094	11	-3.197	0	11	-5.682	0.094	11	-28.32	0.094	5
67	M34	max	2368.032	0.141	12	113.172	0	12	4.389	0.141	10	6.527	0.141	11	17.017	0.141	10	124.421	0	2
68		min	2.634	0	5	-23.896	0.141	5	-7.585	0.141	11	-3.689	0	10	-31.131	0.141	11	5.56	0.141	9
69	M69	max	1695.063	0.655	12	132.331	0	11	8.149	0.655	11	4.172	0.655	10	35.505	0.655	11	19.965	0	4
70		min	171.213	0	5	3.578	0.655	4	-4.805	0.655	10	-7.273	0	11	-19.914	0.655	10	-115.601	0.655	2
71	M70	max	0	0	12	0	0	12	0.58	0.584	11	0	0.584	12	0.169	0.584	11	9.64	0.584	12
72		min	-8.306	0.584	11	-33.042	0.584	12	-0.374	0.584	10	0	0	1	-0.109	0.584	10	0	0	1
73	M71	max	-0.954	0	10	-4.394	0	5	1.29	0.713	11	0.007	0.713	10	0.836	0.713	11	48.126	0.713	12
74		min	-13.857	0.713	11	-74.452	0.713	12	-0.83	0.713	10	-0.011	0	11	-0.538	0.713	10	1.26	0	5
75	M72	max	-1.792	0	10	-9.823	0	5	1.999	0.713	11	0.023	0.713	10	2.008	0.713	11	116.165	0.713	12
76		min	-18.169	0.713	11	-115.989	0.713	12	-1.287	0.713	10	-0.036	0	11	-1.292	0.713	10	6.307	0	5
77	M73	max	-2.27	0	10	-15.304	0	5	2.708	0.713	11	0.061	0.713	10	3.684	0.713	11	213.967	0.713	12
78		min	-20.111	0.713	11	-157.807	0.713	12	-1.743	0.713	10	-0.095	0	11	-2.371	0.713	10	15.238	0	5
79	M74	max	-2.374	0	7	-20.821	0	5	3.418	0.713	11	0.131	0.713	10	5.864	0.713	11	341.641	0.713	12
80		min	-19.669	0.713	11	-199.792	0.713	12	-2.2	0.713	10	-0.204	0	11	-3.774	0.713	10	28.088	0	5
81	M75	max	-1.481	0	7	-26.357	0	5	3.799	0.384	11	0.243	0.384	10	7.24	0.384	11	422.804	0.384	12
82		min	-15.501	0.384	11	-222.651	0.384	12	-2.446	0.384	10	-0.377	0	11	-4.66	0.384	10	44.877	0	5
83	M76	max	0.07	0.323	7	-31.898	0	5	4.448	0.323	11	0.407	0.323	10	9.915	0.323	11	580.562	0.323	12
84		min	-10.589	0.323	11	-261.088	0.323	12	-2.863	0.323	10	-0.632	0	11	-6.382	0.323	10	65.621	0	5
85	M77	max	1663.062	0.713	12	28.743	0	6	3.843	0.713	11	1.509	0.713	10	8.006	0.713	11	88.865	0	12
86		min	168.656	0	5	-23.107	0	5	-1.79	0.713	10	-2.511	0	11	-4.883	0.713	10	2.876	0	5
87	M78	max	1665.34	0.713	12	31.723	0	12	4.531	0.713	11	1.653	0.713	10	10.906	0.713	11	85.909	0	12
88		min	169.346	0	5	-15.351	0	5	-2.246	0.713	10	-2.746	0	11	-6.275	0.713	10	5.521	0.713	6
89	M79	max	1666.285	0.228	12	37.383	0	12	4.74	0.228	11	1.838	0.228	10	11.875	0.228	11	80.641	0	11
90		min	169.993	0	5	-7.565	0	5	-2.393	0.228	10	-3.067	0	11	-6.752	0.228	10	0.091	0.228	6
91	M80	max	1668.649	0.485	12	23.563	0	12	5.199	0.485	11	1.838	0.485	10	14.28	0.485	11	74.281	0	11
92		min	170.166	0	5	-9.314	0.485	4	-2.701	0.485	10	-3.067	0	11	-7.987	0.485	10	-7.126	0.485	6
93	M81	max	1672.981	0.713	12	43.382	0	12	5.869	0.713	11	2.073	0.713	10	18.116	0.713	11	70.433	0	11
94		min	170.595	0	5	-11.963	0.713	4	-3.157	0.713	10	-3.488	0	11	-10.018	0.713	10	-20.067	0.713	2
95	M82	max	1678.323	0.713	12	49.465	0	12	6.517	0.713	11	2.368	0.713	10	22.399	0.713	11	54.925	0	11
96		min	171.15	0	5	-14.528	0.713	4	-3.61	0.713	10	-4.021	0	11	-12.363	0.713	10	-39.308	0.713	2
97	M83	max	1684.659	0.713	12	57.153	0	11	7.146	0.713	11	2.732	0.713	10	27.111	0.713	11	33.97	0	11
98		min	171.657	0	5	-16.982	0.713	4	-4.061	0.713	10	-4.681	0	11	-15.02	0.713	10	-60.901	0.713	2
99	M84	max	1688.287	0.378	12	56.137	0	11	7.45	0.378	11	3.09	0.378	10	29.734	0.378	11	20.916	0.378	4
100		min	172.247	0	5	-13.243	0.378	4	-4.299	0.378	10	-5.328	0	11	-16.528	0.378	10	-73.549	0.378	2
101	M85	max	-169.336	0.478	5	279.732	0	12	7.444	0	11	1.382	0.478	10	16.32	0	10	205.355	0	12
102		min	-1667.477	0	12	26.328	0.478	5	-3.382	0	10	-2.226	0	11	-30.271	0	11	0.62	0.478	5
103	M86	max	-170.068	0.526	5	211.756	0	12	6.969	0	11	0.829	0.526	10	14.779	0	10	73.036	0	12
104		min	-1676.453	0	12	17.744	0.526	5	-3.24	0	10	-1.22	0	11	-26.894	0	11	-36.733	0.526	12
105	M87	max	-170.42	0.526	5	138.421	0	12	6.446	0	11	0.302	0.526	10	13.14	0	10	3.887	0	2
106		min	-1683.006	0	12	8.685	0.526	5	-3.084	0	10	-0.305	0	8	-23.397	0	11	-107.974	0.526	12
107	M88	max	-170.319	0.526	5	64.91	0	12	5.923	0	11	0.527	0.526	11	11.562	0	10	-14.446	0	5
108		min	-1686.375	0	12	-0.371	0.526	5	-2.928	0	10	-0.162	0	10	-20.14	0	11	-140.562	0.526	12
109	M89	max	-169.766	0.526	5	11.996	0	2	5.4	0	11	1.215	0.526	11	10.049	0	10	-10.466	0.526	5
110		min	-1686.557	0	12	-15.429	0.526	11	-2.772	0	10	-0.565	0	10	-17.128	0	11	-140.562	0	12
111	M90	max	-168.764	0.526	5	-10.591	0	2	4.877	0	11	1.793	0.526	11	8.603	0	10	-1.372	0.526	5
112		min	-1683.554	0	12	-87.878	0.526	12	-2.615	0	10	-0.911	0	10	-14.365	0	11	-134.484	0	12
113	M91	max	-167.315	0.526	5	-25.14	0	5	4.354	0	11	2.27	0.526	11	7.226	0	10	12.416	0.526	5
114		min	-1677.376	0	12	-161.034	0.526	12	-2.459	0	10	-1.202	0	10	-11.856	0	11	-89.797	0	12
115	M92	max	-165.424	0.526	5	-33.988	0	5	3.831	0	11	2.658	0.526	11	5.921	0	10	114.833	0.526	12
116		min	-1668.037	0	12	-233.807	0.526	12	-2.303	0	10	-1.441	0	10	-9.605	0	11	-27.954	0	6
117	M93	max	-163.096	0.525	5	-42.729	0	5	3.308	0	11	2.966	0.525	11	4.69	0	10	274.111	0.525	12
118		min	-1655.557	0	12	-306.055	0.525	12	-2.146	0	10	-1.63	0	10	-7.616	0	11	7.162	0	2

Envelope Maximum Member Section Forces (Continued)

	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
119	M94	max	-161.665	0.123	5	-49.128	0	5	2.785	0	11	3.124	0.123	11	3.559	0	10	317.338	0.123	12
120		min	-1644.903	0	12	-350.977	0.123	12	-1.99	0	10	-1.725	0	10	-5.935	0	11	45.004	0	9
121	M95	max	-156.814	0.307	5	-61.823	0	5	2.569	0	11	3.512	0.307	11	2.997	0	10	496.546	0.307	12
122		min	-1613.416	0	12	-475.974	0.307	12	-1.925	0	10	-1.953	0	10	-5.106	0	11	58.208	0	9
123	M96	max	-168.698	0.627	5	-32.557	0	5	8.158	0.627	11	1.75	0.627	10	35.813	0.627	11	436.003	0.627	12
124		min	-1660.738	0	12	-325.399	0.627	12	-3.596	0.627	10	-2.908	0	11	-18.789	0.627	10	16.617	0	5
125	M97	max	-1.647	0	7	-29.299	0	5	4.127	0.329	11	0.243	0.329	10	8.545	0.329	11	499.275	0.329	12
126		min	-16.838	0.329	11	-241.847	0.329	12	-2.656	0.329	10	-0.377	0	11	-5.5	0.329	10	55.558	0	5
127	M98	max	1661.87	0	12	18.443	0	6	3.142	0.39	11	1.396	0.39	10	5.591	0.39	11	88.865	0.39	12
128		min	167.9	0.39	5	-28.131	0.39	5	-1.332	0.39	10	-2.345	0	11	-3.813	0.39	10	-7.514	0	5
129	M100	max	-168.698	0.091	5	-32.172	0	5	7.535	0.091	11	1.75	0.091	10	30.893	0.091	11	234.201	0.091	12
130		min	-1660.737	0	12	-318.323	0.091	12	-3.409	0.091	10	-2.908	0	11	-16.593	0.091	10	13.679	0	5
131	M101	max	-161.437	0	5	354.713	0	12	2.663	0.094	11	3.133	0.094	11	5.594	0.094	11	350.715	0	12
132		min	-1643.815	0.094	12	49.887	0.094	5	-1.953	0.094	10	-1.731	0	10	-3.313	0.094	10	52.446	0.094	9
133	M102	max	1688.223	0.141	12	94.087	0	11	7.559	0.141	11	3.689	0.141	10	30.576	0.141	11	20.916	0	4
134		min	171.892	0	5	4.76	0.141	4	-4.389	0.141	10	-6.406	0	11	-17.017	0.141	10	-80.124	0.141	2

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	M1	HSS3.500X0.216	0.038	0.655	12	0.01	0	11	62275.448	62275.448	5464.072	5464.072	1.87	H1-1b*
2	M2	HSS3.500X0.216	0.003	0.584	12	0.003	0.584	12	62275.448	62275.448	5464.072	5464.072	2.326	H1-1b
3	M3	HSS3.500X0.216	0.013	0.713	12	0.006	0.713	12	62275.448	62275.448	5464.072	5464.072	1.591	H1-1b
4	M4	HSS3.500X0.216	0.03	0.713	12	0.009	0.713	12	62275.448	62275.448	5464.072	5464.072	1.344	H1-1b
5	M5	HSS3.500X0.216	0.056	0.713	12	0.012	0.713	12	62275.448	62275.448	5464.072	5464.072	1.241	H1-1b
6	M6	HSS3.500X0.216	0.089	0.713	12	0.015	0.713	12	62275.448	62275.448	5464.072	5464.072	1.186	H1-1b
7	M7	HSS3.500X0.216	0.11	0.384	12	0.017	0.384	12	62275.448	62275.448	5464.072	5464.072	1.085	H1-1b
8	M8	HSS3.500X0.216	0.151	0.323	12	0.02	0.323	12	62275.448	62275.448	5464.072	5464.072	1.06	H1-1b
9	M9	HSS3.500X0.216	0.04	0.713	12	0.004	0.713	11	62275.448	62275.448	5464.072	5464.072	1.141	H1-1b
10	M10	HSS3.500X0.216	0.044	0.713	12	0.003	0.713	11	62275.448	62275.448	5464.072	5464.072	1.087	H1-1b
11	M11	HSS3.500X0.216	0.044	0	12	0.001	0	11	62275.448	62275.448	5464.072	5464.072	1.006	H1-1b
12	M12	HSS3.500X0.216	0.046	0.485	12	0.003	0.485	11	62275.448	62275.448	5464.072	5464.072	1.042	H1-1b
13	M13	HSS3.500X0.216	0.046	0.713	12	0.002	0.713	11	62275.448	62275.448	5464.072	5464.072	1.024	H1-1b
14	M14	HSS3.500X0.216	0.046	0	12	0.003	0	11	62275.448	62275.448	5464.072	5464.072	1.052	H1-1b
15	M15	HSS3.500X0.216	0.044	0	12	0.004	0	11	62275.448	62275.448	5464.072	5464.072	1.089	H1-1b
16	M16	HSS3.500X0.216	0.041	0	12	0.004	0	11	62275.448	62275.448	5464.072	5464.072	1.065	H1-1b
17	M17	HSS3.500X0.216	0.062	0	12	0.02	0	12	62275.448	62275.448	5464.072	5464.072	1.417	H1-1b
18	M18	HSS3.500X0.216	0.033	0.526	12	0.014	0	12	62275.448	62275.448	5464.072	5464.072	2.225	H1-1b
19	M19	HSS3.500X0.216	0.049	0.526	12	0.009	0	12	62275.448	62275.448	5464.072	5464.072	1.265	H1-1b
20	M20	HSS3.500X0.216	0.055	0.526	12	0.004	0	11	62275.448	62275.448	5464.072	5464.072	1.07	H1-1b
21	M21	HSS3.500X0.216	0.055	0	12	0.002	0.526	11	62275.448	62275.448	5464.072	5464.072	1.042	H1-1b
22	M22	HSS3.500X0.216	0.051	0	12	0.008	0.526	12	62275.448	62275.448	5464.072	5464.072	1.199	H1-1b
23	M23	HSS3.500X0.216	0.038	0	12	0.013	0.526	12	62275.448	62275.448	5464.072	5464.072	1.975	H1-1b
24	M24	HSS3.500X0.216	0.056	0.526	12	0.019	0.526	12	62275.448	62275.448	5464.072	5464.072	1.546	H1-1b
25	M25	HSS3.500X0.216	0.099	0.525	12	0.024	0.525	12	62275.448	62275.448	5464.072	5464.072	1.271	H1-1b
26	M26	HSS3.500X0.216	0.11	0.123	12	0.027	0.123	12	62275.448	62275.448	5464.072	5464.072	1.053	H1-1b
27	M27	HSS3.500X0.216	0.157	0.307	12	0.037	0.307	12	62275.448	62275.448	5464.072	5464.072	1.124	H1-1b
28	M28	HSS3.500X0.216	0.117	0.627	12	0.023	0.627	12	62275.448	62275.448	5464.072	5464.072	1.247	H1-1b
29	M29	HSS3.500X0.216	0.13	0.329	12	0.018	0.329	12	62275.448	62275.448	5464.072	5464.072	1.066	H1-1b
30	M30	HSS3.500X0.216	0.037	0	12	0.004	0.39	11	62275.448	62275.448	5464.072	5464.072	1.14	H1-1b*
31	M31	HSS6.625X0.280	0.095	0	2	0.024	11.435	2	155688.62	155688.62	26197.604	26197.604	1.008	H1-1b
32	M32	HSS3.500X0.216	0.069	0.091	12	0.022	0.091	12	62275.448	62275.448	5464.072	5464.072	1.059	H1-1b
33	M33	HSS3.500X0.216	0.119	0	12	0.028	0	12	62275.448	62275.448	5464.072	5464.072	1.037	H1-1b
34	M34	HSS3.500X0.216	0.038	0.141	12	0.007	0	11	62275.448	62275.448	5464.072	5464.072	1.064	H1-1b*
35	M69	HSS3.500X0.216	0.032	0.655	11	0.009	0	11	62275.448	62275.448	5464.072	5464.072	1.403	H1-1b
36	M70	HSS3.500X0.216	0.002	0.584	12	0.002	0.584	12	62275.448	62275.448	5464.072	5464.072	2.326	H1-1b
37	M71	HSS3.500X0.216	0.009	0.713	12	0.004	0.713	12	62275.448	62275.448	5464.072	5464.072	1.591	H1-1b
38	M72	HSS3.500X0.216	0.021	0.713	12	0.006	0.713	12	62275.448	62275.448	5464.072	5464.072	1.344	H1-1b
39	M73	HSS3.500X0.216	0.039	0.713	12	0.008	0.713	12	62275.448	62275.448	5464.072	5464.072	1.242	H1-1b
40	M74	HSS3.500X0.216	0.063	0.713	12	0.011	0.713	12	62275.448	62275.448	5464.072	5464.072	1.186	H1-1b
41	M75	HSS3.500X0.216	0.077	0.384	12	0.012	0.384	12	62275.448	62275.448	5464.072	5464.072	1.085	H1-1b
42	M76	HSS3.500X0.216	0.106	0.323	12	0.014	0.323	12	62275.448	62275.448	5464.072	5464.072	1.06	H1-1b

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

	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
43	M77	HSS3.500X0.216	0.03	0	12	0.002	0.713	11	62275.448	62275.448	5464.072	5464.072	1.045	H1-1b
44	M78	HSS3.500X0.216	0.029	0	12	0.002	0	11	62275.448	62275.448	5464.072	5464.072	1.068	H1-1b
45	M79	HSS3.500X0.216	0.028	0	12	0.002	0	11	62275.448	62275.448	5464.072	5464.072	1.04	H1-1b
46	M80	HSS3.500X0.216	0.027	0.48	12	0.002	0	11	62275.448	62275.448	5464.072	5464.072	1.042	H1-1b*
47	M81	HSS3.500X0.216	0.027	0.713	12	0.003	0	11	62275.448	62275.448	5464.072	5464.072	1.149	H1-1b*
48	M82	HSS3.500X0.216	0.027	0.713	12	0.003	0	11	62275.448	62275.448	5464.072	5464.072	1.252	H1-1b*
49	M83	HSS3.500X0.216	0.027	0.713	12	0.004	0	11	62275.448	62275.448	5464.072	5464.072	1.612	H1-1b*
50	M84	HSS3.500X0.216	0.027	0.378	12	0.004	0	11	62275.448	62275.448	5464.072	5464.072	2.182	H1-1b*
51	M85	HSS3.500X0.216	0.051	0	12	0.015	0	12	62275.448	62275.448	5464.072	5464.072	1.349	H1-1b
52	M86	HSS3.500X0.216	0.027	0	12	0.011	0	12	62275.448	62275.448	5464.072	5464.072	2.183	H1-1b
53	M87	HSS3.500X0.216	0.033	0.526	12	0.007	0	12	62275.448	62275.448	5464.072	5464.072	1.354	H1-1b
54	M88	HSS3.500X0.216	0.039	0.526	12	0.003	0	12	62275.448	62275.448	5464.072	5464.072	1.1	H1-1b
55	M89	HSS3.500X0.216	0.039	0	12	0.001	0.526	11	62275.448	62275.448	5464.072	5464.072	1.016	H1-1b
56	M90	HSS3.500X0.216	0.038	0	12	0.005	0.526	11	62275.448	62275.448	5464.072	5464.072	1.151	H1-1b
57	M91	HSS3.500X0.216	0.03	0	12	0.009	0.526	11	62275.448	62275.448	5464.072	5464.072	1.581	H1-1b
58	M92	HSS3.500X0.216	0.034	0.526	12	0.013	0.526	11	62275.448	62275.448	5464.072	5464.072	1.74	H1-1b
59	M93	HSS3.500X0.216	0.063	0.525	12	0.016	0.525	11	62275.448	62275.448	5464.072	5464.072	1.304	H1-1b
60	M94	HSS3.500X0.216	0.071	0.123	12	0.019	0.123	11	62275.448	62275.448	5464.072	5464.072	1.058	H1-1b
61	M95	HSS3.500X0.216	0.104	0.307	12	0.025	0.307	12	62275.448	62275.448	5464.072	5464.072	1.133	H1-1b
62	M96	HSS3.500X0.216	0.093	0.627	12	0.017	0.627	12	62275.448	62275.448	5464.072	5464.072	1.229	H1-1b
63	M97	HSS3.500X0.216	0.092	0.329	12	0.013	0.329	12	62275.448	62275.448	5464.072	5464.072	1.066	H1-1b
64	M98	HSS3.500X0.216	0.03	0.39	12	0.002	0.39	11	62275.448	62275.448	5464.072	5464.072	1.031	H1-1b
65	M100	HSS3.500X0.216	0.056	0.091	12	0.017	0.091	12	62275.448	62275.448	5464.072	5464.072	1.052	H1-1b
66	M101	HSS3.500X0.216	0.077	0	12	0.019	0	11	62275.448	62275.448	5464.072	5464.072	1.04	H1-1b
67	M102	HSS3.500X0.216	0.027	0.141	12	0.006	0	11	62275.448	62275.448	5464.072	5464.072	1.322	H1-1b*

Node Reactions

	LC	Node Label	X [lb]	Y [lb]	Z [lb]	MX [lb-ft]	MY [lb-ft]	MZ [lb-ft]
1	1	N32	0	601.323	0	0	0	0
2	1	Totals:	0	601.323	0			
3	1	COG (ft):	X: 0	Y: 8.905	Z: 0			
4	2	N32	0	1039.657	0	0	0	2399.598
5	2	Totals:	0	1039.657	0			
6	2	COG (ft):	X: 2.149	Y: 9.483	Z: 0			
7	3	N32	0	601.323	0	0	0	0
8	3	Totals:	0	601.323	0			
9	3	COG (ft):	X: 0	Y: 8.905	Z: 0			
10	4	N32	96.97	773.917	0	0	0	-429.427
11	4	Totals:	96.97	773.917	0			
12	4	COG (ft):	X: 0.279	Y: 9.21	Z: 0			
13	5	N32	67.713	223.982	0	0	0	-587.616
14	5	Totals:	67.713	223.982	0			
15	5	COG (ft):	X: -1.071	Y: 8.071	Z: 0			
16	6	N32	72.727	1059.518	0	0	0	1479.404
17	6	Totals:	72.727	1059.518	0			
18	6	COG (ft):	X: 1.734	Y: 9.497	Z: 0			
19	7	N32	-25.695	609.306	0	0	0	233.376
20	7	Totals:	-25.695	609.306	0			
21	7	COG (ft):	X: 0	Y: 8.904	Z: 0			
22	8	N32	0	609.306	-25.695	-231.141	0	0
23	8	Totals:	0	609.306	-25.695			
24	8	COG (ft):	X: 0	Y: 8.904	Z: 0			
25	9	N32	25.695	352.811	0	0	0	-231.685
26	9	Totals:	25.695	352.811	0			
27	9	COG (ft):	X: 0	Y: 8.907	Z: 0			
28	10	N32	0	352.811	25.695	230.413	0	0
29	10	Totals:	0	352.811	25.695			
30	10	COG (ft):	X: 0	Y: 8.907	Z: 0			
31	11	N32	0	1837.122	18.922	-37.345	1.099	1342.16
32	11	Totals:	0	1837.122	18.922			
33	11	COG (ft):	X: 0.639	Y: 9.664	Z: 0			

Node Reactions (Continued)

	LC	Node Label	X [lb]	Y [lb]	Z [lb]	MX [lb-ft]	MY [lb-ft]	MZ [lb-ft]
34	12	N32	55.28	1905.48	0	0	0	1058.471
35	12	Totals:	55.28	1905.48	0			
36	12	COG (ft):	X: 0.652	Y: 9.686	Z: 0			
37	13	N32	0	841.852	0	0	0	0
38	13	Totals:	0	841.852	0			
39	13	COG (ft):	X: 0	Y: 8.905	Z: 0			
40	14	N32	80.808	1566.749	0	0	0	3479.028
41	14	Totals:	80.808	1566.749	0			
42	14	COG (ft):	X: 2.397	Y: 9.644	Z: 0			
43	15	N32	80.808	1244.21	0	0	0	1619.745
44	15	Totals:	80.808	1244.21	0			
45	15	COG (ft):	X: 1.653	Y: 9.5	Z: 0			
46	16	N32	161.617	1228.41	0	0	0	460.71
47	16	Totals:	161.617	1228.41	0			
48	16	COG (ft):	X: 1.202	Y: 9.47	Z: 0			
49	17	N32	161.617	1127.617	0	0	0	-101.107
50	17	Totals:	161.617	1127.617	0			
51	17	COG (ft):	X: 0.839	Y: 9.404	Z: 0			
52	18	N32	112.855	313.17	0	0	0	-978.98
53	18	Totals:	112.855	313.17	0			
54	18	COG (ft):	X: -1.277	Y: 7.911	Z: 0			
55	19	N32	-36.708	732.992	0	0	0	331.962
56	19	Totals:	-36.708	732.992	0			
57	19	COG (ft):	X: 0	Y: 8.904	Z: 0			
58	20	N32	0	732.992	-36.708	-329.587	0	0
59	20	Totals:	0	732.992	-36.708			
60	20	COG (ft):	X: 0	Y: 8.904	Z: 0			
61	21	N32	36.708	529.787	0	0	0	-330.776
62	21	Totals:	36.708	529.787	0			
63	21	COG (ft):	X: 0	Y: 8.907	Z: 0			
64	22	N32	0	529.787	36.708	329.073	0	0
65	22	Totals:	0	529.787	36.708			
66	22	COG (ft):	X: 0	Y: 8.907	Z: 0			
67	23	N32	0	2267.179	27.031	-52.369	0.461	649.631
68	23	Totals:	0	2267.179	27.031			
69	23	COG (ft):	X: 0.259	Y: 9.645	Z: 0			
70	24	N32	78.971	2364.833	0	0	0	239.772
71	24	Totals:	78.971	2364.833	0			
72	24	COG (ft):	X: 0.29	Y: 9.671	Z: 0			

Envelope Node Reactions - Overstrength or Capacity Limit

No Data to Print...

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	N32	max	161.617	17	2364.833	24	36.708	22	329.073	22	1.099	11	3479.028	14
2		min	-36.708	19	223.982	5	-36.708	20	-329.587	20	0	22	-978.98	18
3	Totals:	max	161.617	17	2364.833	24	36.708	22						
4		min	-36.708	19	223.982	5	-36.708	20						

C nsulting Structural &
F rensic Engineers
3600 E. University Dr, Suite1400
Ph enix, AZ 85034
(602) 438-2500

Job. No. 25-0333
6/02/25
By: CS
Check by: JL, SE

Monolithic Footing Calc

$\gamma_c := 145pcf$ $\quad \rho_{brg} := q_{lat} = 1500 \cdot psf$ $\quad \mu_{soil} := 0.3$ $\quad \rho_{sliding} := 250pcf$

Footing Geometry

Bottom of Footing Depth	3.5	ft	Footing Length (Span)	$B_{footing} := 3ft$
Width of Footing	3.00	ft		
Footing Thickness	42	in	$d := t_{footing} - 3in$	$d' := 3in$

Item	Ratio	Results	Applied/Capacity	Load Combination
Soil Bearing	$\frac{\rho_{des}}{\rho_{brg}} = 0.771$	**< 1.0 OK**	$\rho_{des} = 1156 \cdot psf$ $\rho_{brg} = 1500 \cdot psf$	$LCq_{LC} =$ "D + RLL" ECC = "ECC OK"
Over-turning	$\frac{M_R}{M_{OT}} = 3.51$	**> 1.0 OK**	$M_{OT} = 2.4 \cdot k \cdot ft$ $M_R = 8.41 \cdot k \cdot ft$	$LCq_{LC} =$ "D + RLL"
Sliding	$\frac{V_c}{V_a} = 43.6$	**> 1.0 OK**	$V_a = 0.1 \cdot k$ $V_c = 4.23 \cdot k$	$LCq_{LC} =$ "D + 0.6WA"
Uplift	$\frac{P_c}{P_{app}} = 12.24$	**No Uplift**	$P_{up} = 0 \cdot k$ $P_c = 2.74 \cdot k$	$LCq_{LC} =$ "0.6D + 0.6WB"

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Specifier's comments:

1 Anchor Design

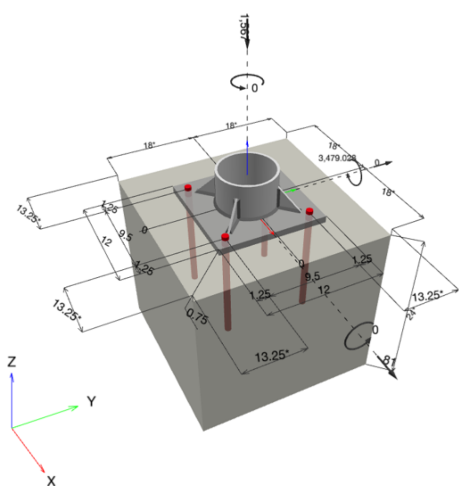
1.1 Input data

Anchor type and diameter:	**Hex Head ASTM F 1554 GR. 36 3/4**
Item number:	not available
Specification text:	∅ 3/4 in Hex Head ASTM F 1554 GR. 36 with 12 in nominal embedment depth per Technical data , cast in place installation per MPII,
Effective embedment depth:	h_{ef} = 12.000 in.
Material:	ASTM F 1554
Evaluation Service Report:	Hilti Technical Data
Issued I Valid:	- | -
Proof:	Design Method ACI 318-14 / CIP
Shear edge breakout verification:	Row closest to edge (Case 3 only from ACI 318-14 Fig. R.17.5.2.1b)
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate[CBFEM] :	l_x x l_y x t = 12.000 in. x 12.000 in. x 0.750 in.;
Profile:	Round HSS (AISC), HSS6-5/8X.280; (L x W x T) = 6.625 in. x 6.625 in. x 0.280 in.
Base material:	cracked concrete, 2500, f_c' = 2,500 psi; h = 24.000 in.
Reinforcement:	tension: condition A, shear: condition A; anchor reinforcement: tension
	edge reinforcement: > No. 4 bar with stirrups

In lieu of Heavy Hex Head ASTM F1554 Gr. 36
it is acceptable to use fully threaded anchor rods
ASTM F1554 Grade 36 steel w/ double nut and washer

[CBFEM] - The anchor calculation is based on a component-based Finite Element Method (CBFEM)

Geometry [in.] & Loading [lb, ft.lb]



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1.1.1 Load combination and design results

Case	Description	Forces [lb] / Moments [ft.lb]	Seismic	Max. Util. Anchor [%]
1	1.4*D	$N = -842; V_x = 0; V_y = 0;$ $M_x = 0.000; M_y = 0.000; M_z = 0.000;$	no	1
2	1.2D+1.6Lr+0.5WA	$N = -1,567; V_x = 81; V_y = 0;$ $M_x = 0.000; M_y = 3,479.028; M_z = 0.000;$	no	23
3	1.2D+1.6S+0.5WA	$N = -1,244; V_x = 81; V_y = 0;$ $M_x = 0.000; M_y = 1,619.745; M_z = 0.000;$	no	10
4	1.2*D+0.5Lr+WA	$N = -1,228; V_x = 162; V_y = 0;$ $M_x = 0.000; M_y = 460.710; M_z = 0.000;$	no	2
5	1.2D+0.5S+WA	$N = -1,128; V_x = 162; V_y = 0;$ $M_x = 0.000; M_y = -101.107; M_z = 0.000;$	no	1
6	0.9*D+WB	$N = -313; V_x = 113; V_y = 0;$ $M_x = 0.000; M_y = -978.980; M_z = 0.000;$	no	7
7	1.2D+ELx+Ely (w/ Ω0)	$N = -916; V_x = -46; V_y = 0;$ $M_x = 0.000; M_y = 414.953; M_z = 0.000;$	yes	2
8	1.2D+ELz+Ely (w/ Ω0)	$N = -916; V_x = 0; V_y = -46;$ $M_x = -411.984; M_y = 0.000; M_z = 0.000;$	yes	2
9	0.9D-ELx-Ely (w/ Ω0)	$N = -662; V_x = 46; V_y = 0;$ $M_x = 0.000; M_y = -413.470; M_z = 0.000;$	yes	3
10	0.9D-ELz-Ely (w/ Ω0)	$N = -662; V_x = 0; V_y = 46;$ $M_x = 411.341; M_y = 0.000; M_z = 0.000;$	yes	3
11	1.2D+Di+WL-Lat+0.5S	$N = -2,267; V_x = 0; V_y = 27;$ $M_x = -52.369; M_y = 649.631; M_z = 0.461;$	no	2
12	1.2D+Di+WA(ice)+0.5S	$N = -2,365; V_x = 79; V_y = 0;$ $M_x = 0.000; M_y = 239.772; M_z = 0.000;$	no	1

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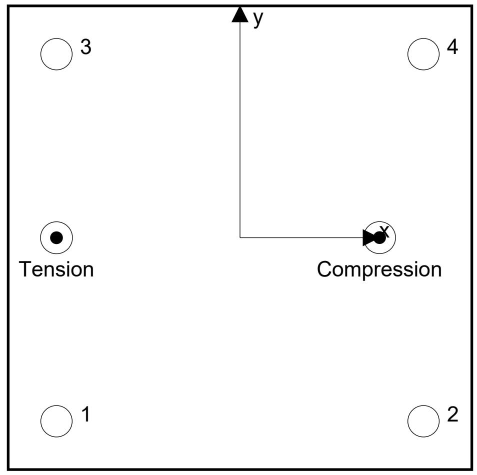
1.2 Load case/Resulting anchor forces

Controlling load case: 2 1.2D+1.6Lr+0.5WA



Anchor reactions [lb]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	2,086	31	23	20
2	-0	19	17	-8
3	2,085	31	23	-20
4	-0	19	17	8

Resulting tension force in (x/y)=(-4.750/-0.001): 4,170 [lb]
Resulting compression force in (x/y)=(3.612/0.003): 5,816 [lb]

Anchor forces are calculated based on a component-based Finite Element Method (CBFEM)

1.3 Tension load

	Load N_{ua} [lb]	Capacity ϕ N_n [lb]	Utilization $\beta_N = N_{ua}/\phi$ N_n	Status
Steel Strength*	2,086	14,529	15	OK
Pullout Strength*	2,086	9,156	23	OK
Concrete Breakout Failure**[1]	N/A	N/A	N/A	N/A
Concrete Side-Face Blowout, direction **	N/A	N/A	N/A	N/A

* highest loaded anchor **anchor group (anchors in tension)
[1] Tension Anchor Reinforcement has been selected!

1.3.1 Steel Strength

$N_{sa} = A_{se,N}\, f_{uta}$ ACI 318-14 Eq. (17.4.1.2)
$\phi\ N_{sa} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.33	58,000

Calculations

N_{sa} [lb]
19,372

Results

N_{sa} [lb]	ϕ_{steel}	ϕ N_{sa} [lb]	N_{ua} [lb]
19,372	0.750	14,529	2,086

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1.3.2 Pullout Strength

$N_{pN} = \psi_{c,p} N_p$ ACI 318-14 Eq. (17.4.3.1)

$N_p = 8 A_{brg} f'_c$ ACI 318-14 Eq. (17.4.3.4)

$\phi N_{pN} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$\psi_{c,p}$	A_{brg} [in.^{2}]	λ_a	f'_c [psi]
1.000	0.65	1.000	2,500

Calculations

N_p [lb]
13,080

Results

N_{pn} [lb]	$\phi_{concrete}$	ϕN_{pn} [lb]	N_{ua} [lb]
13,080	0.700	9,156	2,086

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1.4 Shear load

	Load V_{ua} [lb]	Capacity ϕ V_n [lb]	Utilization $\beta_V = V_{ua}/\phi$ V_n	Status
Steel Strength*	31	7,555	1	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength**	81	81,396	1	OK
Concrete edge failure in direction y-**	85	17,980	1	OK

* highest loaded anchor **anchor group (relevant anchors)

1.4.1 Steel Strength

$V_{sa} = 0.6\ A_{se,V}\ f_{uta}$ ACI 318-14 Eq. (17.5.1.2b)
$\phi\ V_{steel} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
0.33	58,000

Calculations

V_{sa} [lb]
11,623

Results

V_{sa} [lb]	ϕ_{steel}	ϕ V_{sa} [lb]	V_{ua} [lb]
11,623	0.650	7,555	31

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1.4.2 Pryout Strength

$V_{cpg} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b\right]$ ACI 318-14 Eq. (17.5.3.1b)

$\phi\ V_{cpg} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

A_{Nc} see ACI 318-14, Section 17.4.2.1, Fig. R 17.4.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ ACI 318-14 Eq. (17.4.2.1c)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.4)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.5b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.7b)

$N_b = k_c\ \lambda_a\ \sqrt{f'_c}\ h_{ef}^{1.5}$ ACI 318-14 Eq. (17.4.2.2a)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	8.833	0.000	0.000	13.250

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f'_c [psi]
1.000	-	24	1.000	2,500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
1,296.00	702.25	1.000	1.000	1.000	1.000	31,504

Results

V_{cpg} [lb]	$\phi_{concrete}$	$\phi\ V_{cpg}$ [lb]	V_{ua} [lb]
116,280	0.700	81,396	81

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1.4.3 Concrete edge failure in direction y-

$V_{cbg} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ec,V}\ \psi_{ed,V}\ \psi_{c,V}\ \psi_{h,V}\ \psi_{parallel,V}\ V_b$ — ACI 318-14 Eq. (17.5.2.1b)

$\phi\ V_{cbg} \geq V_{ua}$ — ACI 318-14 Table 17.3.1.1

A_{Vc} see ACI 318-14, Section 17.5.2.1, Fig. R 17.5.2.1(b)*

$A_{Vc0} = 4.5\ c_{a1}^2$ — ACI 318-14 Eq. (17.5.2.1c)

$\psi_{ec,V} = \left(\frac{1}{1 + \frac{2e'_V}{3c_{a1}}}\right) \leq 1.0$ — ACI 318-14 Eq. (17.5.2.5)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ — ACI 318-14 Eq. (17.5.2.6b)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ — ACI 318-14 Eq. (17.5.2.8)

$V_b = 9\ \lambda_a\ \sqrt{f'_c}\ c_{a1}^{1.5}$ — ACI 318-14 Eq. (17.5.2.2b)

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
13.250	13.250	0.658	1.400	24.000

l_e [in.]	λ_a	d_a [in.]	f'_c [psi]	$\psi_{parallel,V}$
6.000	1.000	0.750	2,500	1.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
715.50	790.03	0.968	0.900	1.000	21,704

Results

V_{cbg} [lb]	$\phi_{concrete}$	$\phi\ V_{cbg}$ [lb]	V_{ua} [lb]
23,973	0.750	17,980	85

*Anchor row defined by: Anchor 1, 2; Case 3 controls

1.5 Combined tension and shear loads

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.228	0.005	5/3	9	OK

$\beta_{NV} = \beta_N^{\zeta} + \beta_V^{\zeta} <= 1$

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1.6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates as per current regulations (ETAG 001/Annex C, EOTA TR029, etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid base plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- For additional information about ACI 318 strength design provisions, please go to https://viewer.joomag.com/profis-design-guide-us-en-summer-2021/0841849001625154758?short&/
- Attention! In case of compressive anchor forces a buckling check as well as the proof of the local load transfer into and within the base material (incl. punching) has to be done separately.
- The design of Anchor Reinforcement is beyond the scope of PROFIS Engineering. Refer to ACI 318-14, Section 17.4.2.9 for information about Anchor Reinforcement.
- Anchor Reinforcement has been selected as a design option, calculations should be compared with PROFIS Engineering calculations.
- The anchor design methods in PROFIS Engineering require rigid anchor plates, as per current regulations (AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means that the anchor plate should be sufficiently rigid to prevent load re-distribution to the anchors due to elastic/plastic displacements. The user accepts that the anchor plate is considered close to rigid by engineering judgment."

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1.7 Installation data

Profile: Round HSS (AISC), HSS6-5/8X.280; (L x W x T) = 6.625 in. x 6.625 in. x 0.280 in.

Hole diameter in the fixture: d_f = 0.812 in.

Plate thickness (input): 0.750 in.

Anchor type and diameter: Hex Head ASTM F 1554 GR. 36 3/4

Item number: not available

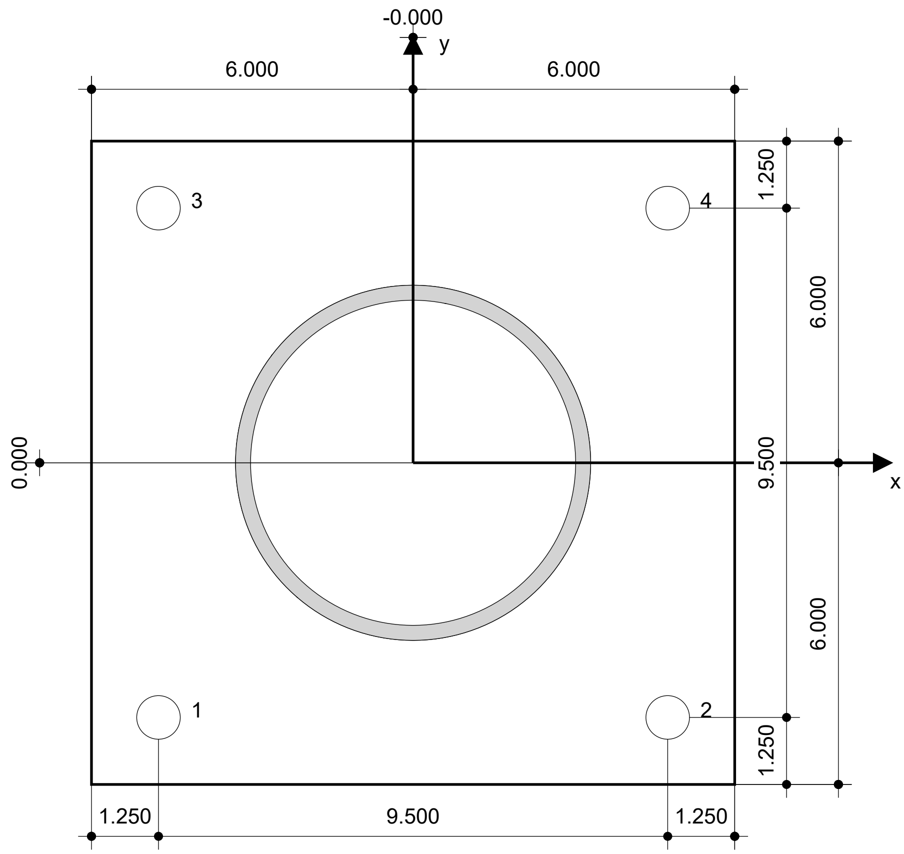
Maximum installation torque: -

Hole diameter in the base material: - in.

Hole depth in the base material: 12.000 in.

Minimum thickness of the base material: 13.000 in.

∅ 3/4 in Hex Head ASTM F 1554 GR. 36 with 12 in nominal embedment depth per Technical data , cast in place installation per MPII



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-4.750	-4.750	13.250	22.750	13.250	22.750
2	4.750	-4.750	22.750	13.250	13.250	22.750
3	-4.750	4.750	13.250	22.750	22.750	13.250
4	4.750	4.750	22.750	13.250	22.750	13.250

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2 Anchor plate design

2.1 Input data

Anchor plate:	Shape: Rectangular l_x x l_y x t = 12.000 in x 12.000 in x 0.750 in Calculation: CBFEM Material: ASTM A36; F_y = 36,000 psi; ε_{lim} = 5.00%
Anchor type and size:	Hex Head ASTM F 1554 GR. 36 3/4, h_{ef} = 12.000 in
Anchor stiffness:	The anchor is modeled considering stiffness values determined from load displacement curves tested in an independent laboratory. Please note that no simple replacement of the anchor is possible as the anchor stiffness has a major impact on the load distribution results.
Design method:	AISC and LRFD-based design using component-based FEM
Seismic loads (cat. C, D, E or F):	Tension load: Yes (17.2.3.4.3 (d)) Shear load: Yes (17.2.3.5.3 (c))
Stand-off installation:	e_b = 0.000 in (No stand-off); t = 0.750 in
Profile:	HSS6-5/8X.280; (L x W x T x FT) = 6.625 in x 6.625 in x 0.280 in x - Material: ASTM A500 Gr.B Round; F_y = 42,000 psi; ε_{lim} = 5.00% Eccentricity x: -0.000 in Eccentricity y: 0.000 in
Base material:	Cracked concrete; 2500; $f_{c,cyl}$ = 2,500 psi; h = 24.000 in
Welds (profile to anchor plate):	Type of redistribution: Plastic Material: E70xx
Stiffeners:	Geometry: Triangular; size = l_x x l_y x t = 2.500 in x 2.500 in x 0.250 in Material: ASTM A36; F_y = 36,000 psi; ε_{lim} = 5.00%
Welds (stiffeners to profile/anchor plate):	Type of redistribution: Plastic Material: E70xx
Mesh size:	Number of elements on edge: 8 Min. size of element: 0.394 in Max. size of element: 1.969 in

2.2 Summary

	Description	Profile		Stiffeners		Anchor plate			Welds [%]	Concrete [%]
		σ_{Ed} [psi]	ε_{Pl} [%]	σ_{Ed} [psi]	ε_{Pl} [%]	σ_{Ed} [psi]	ε_{Pl} [%]	Hole bearing [%]		
1	1.4*D	245	0.00	233	0.00	105	0.00	1	1	1
2	**1.2D+1.6Lr+0.5WA**	**11,222**	**0.00**	**12,016**	**0.00**	**5,453**	**0.00**	**1**	**18**	**5**
3	1.2D+1.6S+0.5WA	4,726	0.00	5,065	0.00	2,477	0.00	1	9	3
4	1.2*D+0.5Lr+WA	1,227	0.00	1,201	0.00	693	0.00	1	3	1
5	1.2D+0.5S+WA	587	0.00	496	0.00	247	0.00	1	2	1
6	0.9*D+WB	3,301	0.00	3,371	0.00	1,586	0.00	1	6	2
7	1.2D+ELx+Ely (w/ Ω0)	1,088	0.00	1,051	0.00	624	0.00	1	3	1
8	1.2D+ELz+Ely (w/ Ω0)	1,081	0.00	1,044	0.00	624	0.00	1	3	1
9	0.9D-ELx-Ely (w/ Ω0)	1,018	0.00	983	0.00	625	0.00	1	3	1
10	0.9D-ELz-Ely (w/ Ω0)	1,012	0.00	980	0.00	627	0.00	1	3	1
11	1.2D+Di+WL-Lat+0.5S	1,979	0.00	1,852	0.00	1,011	0.00	1	5	2

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12	1.2D+Di+WA(ice)+0.5S	1,096	0.00	1,062	0.00	538	0.00	1	3	1

2.3 Anchor plate classification

Results below are displayed for the decisive load combinations: 1.2D+1.6Lr+0.5WA

Anchor tension forces	Equivalent rigid anchor plate (CBFEM)	Component-based Finite Element Method (CBFEM) anchor plate design
Anchor 1	1,965 lb	2,086 lb
Anchor 2	-0 lb	-0 lb
Anchor 3	1,965 lb	2,085 lb
Anchor 4	-0 lb	-0 lb

User accepted to consider the selected anchor plate as rigid by his/her engineering judgement. This means the anchor design guidelines can be applied.

2.4 Profile/Stiffeners/Plate

Profile and stiffeners are verified at the level of the steel to concrete connection. The connection design does not replace the steel design for critical cross sections, which should be performed outside of PROFIS Engineering.

2.4.1 Equivalent stress and plastic strain

Part	Load combination	Material	f_y [psi]	ε_{lim} [%]	σ_{Ed} [psi]	ε_{Pl} [%]	Status
Plate	1.2D+1.6Lr+0.5WA	ASTM A36	36,000	5.00	5,453	0.00	OK
Profile	1.2D+1.6Lr+0.5WA	ASTM A500 Gr.B Round	42,000	5.00	11,222	0.00	OK
Stiffener	1.2D+1.6Lr+0.5WA	ASTM A36	36,000	5.00	12,016	0.00	OK

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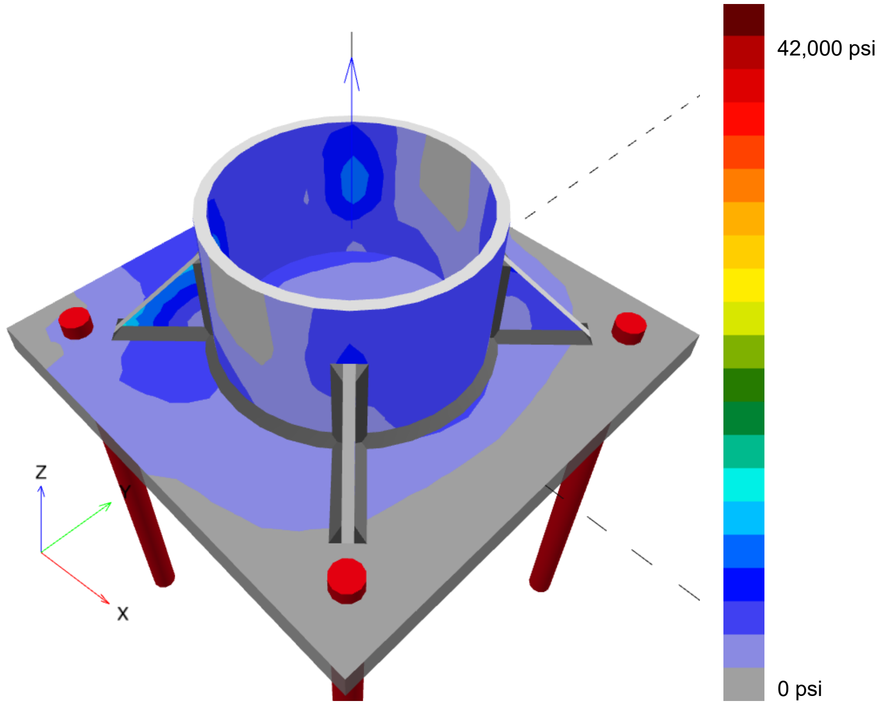
2.4.1.1 Equivalent stress

Results below are displayed for the decisive load combination: 2 - 1.2D+1.6Lr+0.5WA



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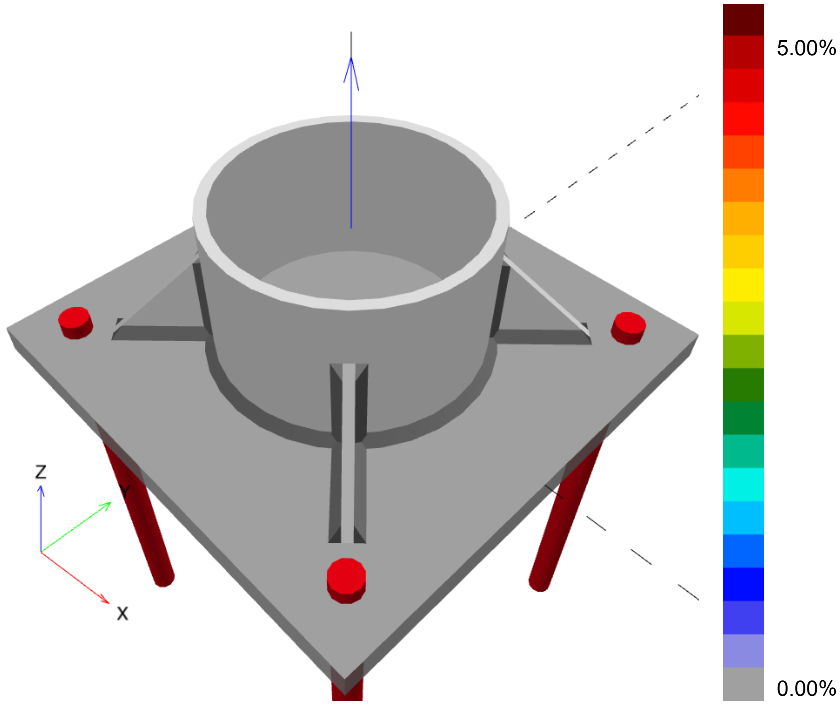
2.4.1.2 Plastic strain

Results below are displayed for the decisive load combination: 1 - 1.4*D



2.4.2 Plate hole bearing resistance, AISC 360-16 Section J3

Decisive load combination: 2 - 1.2D+1.6Lr+0.5WA

Equations

R_n = $\min(1.2\ l_c\ t\ F_u\ ,\ 2.4\ d\ t\ F_u)$ (AISC 360-16 J3-6a, c)

ΦR_n = $0.75\ R_n$

$V \leq \Phi R_n$

Variables

	l_c [in]	t [in]	F_u [psi]	d [in]	R_n [lb]
Anchor 1	1.238	0.750	58,000	0.750	64,623
Anchor 2	11.493	0.750	58,000	0.750	78,300
Anchor 3	1.239	0.750	58,000	0.750	64,697
Anchor 4	11.488	0.750	58,000	0.750	78,300

Results

	V [lb]	ΦR_n [lb]	Utilization [%]	Status
Anchor 1	31	48,467	1	OK
Anchor 2	19	58,725	1	OK
Anchor 3	31	48,523	1	OK

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	V [lb]	ΦR_n [lb]	Utilization [%]	Status
Anchor 4	19	58,725	1	OK

2.5 Welds

Profiles are modeled without taking the corner radius into account. Special rules for welding (e.g. for cold-formed profiles ...) are not taken into account by the software.

2.5.1 Anchor plate to profile

Decisive load combination: 2 - 1.2D+1.6Lr+0.5WA

Equations

$$F_{nw} = 0.6\, F_{EXX}\, (1.0 + 0.5\sin^{1.5} \Theta)$$

$$\Phi R_n = \Phi\, F_{nw}\, A_w$$

$$\text{Utilization} = \frac{F_n}{\Phi\, R_n}$$

Variables

Edge	X_u	T_h [in]	L_s [in]	L [in]	L_c [in]	F_{EXX} [psi]	Θ [°]	A_w [in²]
Member 1	E70xx	0.177◣	0.250	19.901	0.622	70,000	88.4	0.11

Results

Edge	F_n [lb]	ΦR_n [lb]	Utilization [%]	Status
Member 1	934	5,200	18	OK

2.5.2 Stiffeners to profile/anchor plate

Decisive load combination: 2 - 1.2D+1.6Lr+0.5WA

Equations

$$F_{nw} = 0.6\, F_{EXX}\, (1.0 + 0.5\sin^{1.5} \Theta)$$

$$\Phi R_n = \Phi\, F_{nw}\, A_w$$

$$\text{Utilization} = \frac{F_n}{\Phi\, R_n}$$

Variables

Edge	X_u	T_h [in]	L_s [in]	L [in]	L_c [in]	F_{EXX} [psi]	Θ [°]	A_w [in²]
Stiffenera (Anchor plate)	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	38.0	0.07
Stiffenera (Anchor plate) 1	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	37.1	0.07
Stiffenerb (Anchor plate)	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	38.0	0.07
Stiffenerb (Anchor plate) 1	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	38.8	0.07
Stiffenerc (Anchor plate)	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	62.5	0.07
Stiffenerc (Anchor plate) 1	E70xx	◢0.177◣	0.250	2.476	0.413	70,000	24.3	0.07

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Edge	X_u	T_h [in]	L_s [in]	L [in]	L_c [in]	F_{EXX} [psi]	Θ [°]	A_w [in²]
Stiffenerd (Anchor plate)	E70xx	◢0.177◣	0.250	2.476	0.413	70,000	25.6	0.07
Stiffenerd (Anchor plate) 1	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	63.3	0.07
Stiffenera (Member 1-arc 5)	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	44.6	0.07
Stiffenera (Member 1-arc 5) 1	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	36.3	0.07
Stiffenerb (Member 1-arc 13)	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	39.4	0.07
Stiffenerb (Member 1-arc 13) 1	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	39.6	0.07
Stiffenerc (Member 1-arc 21)	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	38.2	0.07
Stiffenerc (Member 1-arc 21) 1	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	32.7	0.07
Stiffenerd (Member 1-arc 29)	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	36.3	0.07
Stiffenerd (Member 1-arc 29) 1	E70xx	◢0.177◣	0.250	2.488	0.415	70,000	34.2	0.07

Results

Edge	F_n [lb]	ΦR_n [lb]	Utilization [%]	Status
Stiffenera (Anchor plate)	500	2,870	18	OK
Stiffenera (Anchor plate) 1	499	2,855	18	OK
Stiffenerb (Anchor plate)	493	2,870	18	OK
Stiffenerb (Anchor plate) 1	490	2,885	17	OK
Stiffenerc (Anchor plate)	148	3,277	5	OK
Stiffenerc (Anchor plate) 1	238	2,605	10	OK
Stiffenerd (Anchor plate)	240	2,627	10	OK
Stiffenerd (Anchor plate) 1	145	3,288	5	OK
Stiffenera (Member 1-arc 5)	447	2,992	15	OK
Stiffenera (Member 1-arc 5) 1	505	2,838	18	OK
Stiffenerb (Member 1-arc 13)	478	2,898	17	OK
Stiffenerb (Member 1-arc 13) 1	464	2,901	16	OK
Stiffenerc (Member 1-arc 21)	295	2,873	11	OK
Stiffenerc (Member 1-arc 21) 1	317	2,770	12	OK
Stiffenerd (Member 1-arc 29)	299	2,839	11	OK
Stiffenerd (Member 1-arc 29) 1	310	2,799	12	OK

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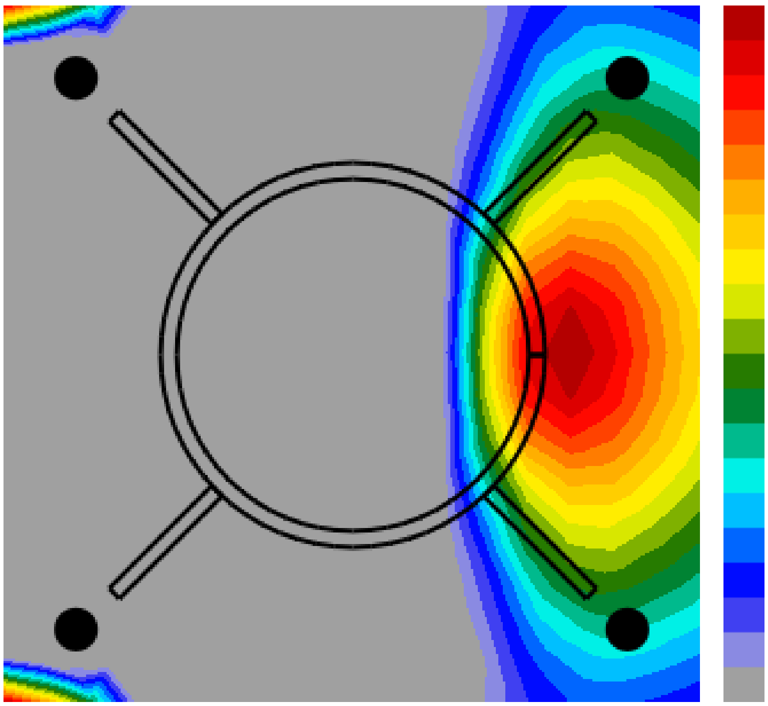
2.6 Concrete

Decisive load combination: 2 - 1.2D+1.6Lr+0.5WA

2.6.1 Compression in concrete under the anchor plate



2.6.2 Concrete block compressive strength resistance check, AISC 360-16 Section J8

Equations

$$F_p = \Phi \, f_{p,max}$$

$$f_{p,max} = 0.85\, f_c' \sqrt{\left(\frac{A_2}{A_1}\right)} \leq 1.7\, f_c; \quad \sqrt{\left(\frac{A_2}{A_1}\right)} \leq 2$$

$$\sigma = \frac{N}{A_1}$$

$$\text{Utilization} = \frac{\sigma}{F_p}$$

Variables

N [lb]	f_c' [psi]	Φ	A_1 [in²]	A_2 [in²]
5,816	2,500	0.65	49.44	894.60

Results

Load combination	F_p [psi]	σ [psi]	Utilization [%]	Status
1.2D+1.6Lr+0.5WA	2,762	118	5	OK

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2.7 Symbol explanation

A_1	Loaded area of concrete
A_2	Supporting area
A_w	Effective area of weld critical element
d	Nominal diameter of the bolt
ε_{lim}	Limit plastic strain
ε_{Pl}	Plastic strain from CBFEM results
f_c	Concrete compressive strength
f_c'	Concrete compressive strength
F_{EXX}	Electrode classification number, i.e. minimum specified tensile strength
F_u	Specified minimum tensile strength of the connected material
F_n	Force in weld critical element
F_{nw}	Nominal stress of the weld material
F_p	Concrete block design bearing strength
$f_{p,max}$	Concrete block design bearing strength maximum
f_y	Yield strength
l_c	Clear distance, in the direction of the force, between the edge of the hole and the edge of the adjacent hole or edge of the material
L	Length of weld
L_c	Length of weld critical element
L_s	Leg size of weld
N	Resulting compression force
σ	Average stress in concrete
σ_{Ed}	Equivalent stress
Φ	Resistance factor
ΦR_n	Factored resistance
R_n	Resistance
t	Thickness of the anchor plate
Θ	Angle of loading measured from the weld longitudinal axis
T_h	Throat thickness of weld
V	Resultant of shear forces Vy, Vz in bolt.
X_u	Filler metal tensile strength

2.8 Warnings

- By using the CBFEM calculation functionality of PROFIS Engineering you may act outside the applicable design codes and your specified anchor plate may not behave rigid. Please, validate the results with a professional designer and/or structural engineer to ensure suitability and adequacy for your specific jurisdiction and project requirements.
- The anchor is modeled considering stiffness values determined from load displacement curves tested in an independent laboratory. Please note that no simple replacement of the anchor is possible as the anchor stiffness has a major impact on the load distribution results.

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3 Summary of results

Design of the anchor plate, anchors, welds and other elements are based on CBFEM (component based finite element method) and AISC.

	Load combination	Max. utilization	Status
Anchors	1.2D+1.6Lr+0.5WA	23%	OK
Anchor plate	1.2D+1.6Lr+0.5WA	16%	OK
Welds	1.2D+1.6Lr+0.5WA	18%	OK
Stiffeners	1.2D+1.6Lr+0.5WA	34%	OK
Concrete	1.2D+1.6Lr+0.5WA	5%	OK
Profile	1.2D+1.6Lr+0.5WA	27%	OK

Fastening meets the design criteria!

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4 Remarks; Your Cooperation Duties

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F rensic Engineers
3600 E. University Dr, Suite1400
Ph enix, AZ 85034
(602) 438-2500

Job. No. 25-0333
6/02/25
By: CS
Check by: JL, SE

Pay Station Canopy Analysis (cont'd)

Pipe Flange Connection

$C_c :=$ Envelope (All Nodes) / Envelope (Per Node) / Load Combo (Per Node)

LC := Envelope / D / D + RLL

NODE := N1 / N29 / N33

Number of Bolts Per Connection	$N_{bolts} := 4$
Flange Bolt Circle	$BC := 7.0in$
Max Tension at Connection	$T = 2327.2 \cdot lb$
Max Moment at Connection	$M = 549.82 \cdot lb \cdot ft$
Max Shear at Connection	$V = 679.1\, lb$
Max Tension per Bolt	$T_{max} := \frac{T}{N_{bolts}} + \frac{4 \cdot M}{BC \cdot N_{bolts}} = 1524\, lb$
Max Shear per Bolt	$V_{max} := \frac{V}{N_{bolts}} = 170\, lb$
Use 5/8" Dia. Grade 5 Bolts:	$T_{all} := 10848lb$ $V_{all} := 5738lb$

Use (4) 5/8" Dia. Grade 5 Bolts at Flange Connections

$$\frac{T_{max}}{T_{all}} + \frac{V_{max}}{V_{all}} = 0.17$$

< 1.0 OK

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3600 E. University Dr, Suite1400
Ph enix, AZ 85034
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By: CS
Check by: JL, SE

Pay Station Canopy Analysis (cont'd)

$LCq = \text{"ENVELOPE"}$

Connection Analysis- HSS Mast Arm Welded to HSS Column

ASTM A500 Grade B $\quad F_y := f_{ya500} = 50 \cdot ksi \quad F_u := f_{ua500} = 62 \cdot ksi \quad E := E_s = 29000 \cdot ksi$

$prop_{4,A} = \text{"HSS 6.625 x 0.280"}$ $\quad pprop_{4,B} = \text{"HSS 3.5 x 0.216"}$

$A := prop_{0,A} \cdot in^2 = 5.2 \cdot in^2$ $\quad A_b := pprop_{0,B} \cdot in^2 = 2.07 \cdot in^2$ $\quad P = 2.38 \cdot k$

$t := prop_{1,A} \cdot in = 0.26 \cdot in$ $\quad t_b := pprop_{1,B} \cdot in = 0.2 \cdot in$ $\quad M_{in} = 0.12 \cdot k \cdot ft$ M1

$D := prop_{2,A} \cdot in = 6.62 \cdot in$ $\quad D_b := pprop_{2,B} \cdot in = 3.5 \cdot in$ $\quad M_{out} = 0.04 \cdot k \cdot ft$

$S := prop_{3,A} \cdot in^3 = 7.96 \cdot in^3$ $\quad S_b := pprop_{3,B} \cdot in^3 = 1.63 \cdot in^3$

AISC Specification Section K4 and Table K4.1A - Limits of Applicability $\quad \theta := 75deg$ > 30 deg

Branch Wall Slenderness

$\frac{D_b}{t_b} = 17.41 < 50$ **OK**

$\frac{D_b}{t_b} = 17.41 < 0.05 \cdot \frac{E}{F_y} = 29$ **OK**

Column Wall Slenderness

$\frac{D}{t} = 25.48 < 50$ **OK**

Width Ratio $\quad 0.2 < \frac{D_b}{D} = 0.53 \quad < \text{or} = 1.0$ **OK**

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Pay Station Canopy Analysis (cont'd)

Connection Analysis- HSS Mast Arm Welded to HSS Column (Cont'd)

AVAILABLE FLEXURAL STRENGTH - AISC TABLE K4.1

Chord Plastification (In-plane bending moment in branch) - AISC table K4.1

Max.Chord (Column) Axial Reaction $P_r = 1.91 \cdot k$

Max. Chord Moment (In Plane) $M_r = 2.4 \cdot k \cdot ft$ M31

$\beta := \frac{D_b}{D} = 0.53$ $\gamma := \frac{D}{2 \cdot t} = 12.74$

$F_c := 0.6 \cdot F_y = 30 \cdot ksi$

$U_T := 1.0$ $U := \left| \frac{P_r}{A \cdot F_c} + \frac{M_r}{S \cdot F_c} \right| = 0.133$

$Q_f := 1.0 - 0.3U \cdot (1 + U) = 0.955$ $\Omega := 1.67$

$$M_{nip} := \frac{5.39 \cdot F_y \cdot t^2 \cdot \gamma^{0.5} \cdot \beta \cdot D_b \cdot Q_f}{\sin(\theta)} = 9905.27\, lb \cdot ft$$

$$\frac{M_{nip}}{\Omega} = 5931.3\, lb \cdot ft$$

Shear Yielding (punching - in plane bending moment in branch) AISC Table K4.1

$D_b = 3.5 \cdot in$ < $(D - 2 \cdot t) = 6.1 \cdot in$ $\Omega_y := 1.58$

$$M_{nip2} := \left[0.6 \cdot F_y \cdot t \cdot D_b^{\,2} \left(\frac{1 + 3 \cdot \sin(\theta)}{4 \cdot \sin(\theta)^2} \right) \right] = 8316.09\, lb \cdot ft$$

$$M_{nip2} \div \Omega_y = 5263.35\, lb \cdot ft$$

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Pay Station Canopy Analysis (cont'd)

Connection Analysis- HSS Mast Arm Welded to HSS Column (Cont'd)

Chord Plastification (Out-of-plane bending moment in branch) - AISC table K4.1

$$M_{nop} := \frac{F_y \cdot t^2 \cdot D_b}{\sin(\theta)} \cdot \left(\frac{3}{1 - 0.81\beta}\right) \cdot Q_f = 5110.6\,\text{lb}\cdot\text{ft} \qquad \Omega = 1.67$$

$$\frac{M_{nop}}{\Omega} = 3060.24\,\text{lb}\cdot\text{ft}$$

Shear Yielding - punching (Out-of-plane bending moment in branch) - AISC table K4.1

$$D_b = 3.5\cdot\text{in} \quad < \quad (D - 2\cdot t) = 6.1\cdot\text{in} \qquad \Omega_y := 1.58$$

$$M_{nop2} := 0.6F_y \cdot t \cdot D_b^{\,2} \cdot \left(\frac{3 + \sin(\theta)}{4\cdot\sin(\theta)^2}\right) = 8461.48\,\text{lb}\cdot\text{ft}$$

$$\frac{M_{nop2}}{\Omega_y} = 5355.37\,\text{lb}\cdot\text{ft}$$

AVAILABLE AXIAL STRENGTH - AISC TABLE K3.1

Shear Yielding - punching - AISC table K3.1

$$D_b = 3.5\cdot\text{in} < (D - 2\cdot t) = 6.1\cdot\text{in}$$

$$P_n := 0.6\cdot F_y \cdot t \cdot \pi \cdot D_b \left(\frac{1 + \sin(\theta)}{2\cdot\sin(\theta)^2}\right) = 90357 \quad \Omega_y := 1.58$$

$$\frac{P_n}{\Omega_y} = 57188.01\,\text{lb}$$

Chord Plastification

$$P_{n2} := \frac{F_y \cdot t^2 \cdot \left(3.1 + 15.6\beta^2\right) \cdot \gamma^{0.2} \cdot Q_f}{\sin(\theta)} = 41432.72\,\text{lb} \qquad \Omega = 1.67$$

$$\frac{P_{n2}}{\Omega} = 24810.01\,\text{lb}$$

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Pay Station Canopy Analysis (cont'd)

Connection Analysis- HSS Mast Arm Welded to HSS Column (Cont'd)

CONNECTION SUMMARY RESULTS $\quad LCq = \text{"ENVELOPE"}$

Allowable In-Plane Bending $\quad M_{ain} := \min\left(\frac{M_{nip}}{\Omega}, \frac{M_{nip2}}{\Omega_y}\right) = 5263.35\,lb\cdot ft$

Allowable Out of Plane Bending $\quad M_{aout} := \min\left(\frac{M_{nop}}{\Omega}, \frac{M_{nop2}}{\Omega_y}\right) = 3060.24\,lb\cdot ft$

Allowable Axial Load $\quad P_a := \min\left(\frac{P_n}{\Omega_y}, \frac{P_{n2}}{\Omega}\right) = 24810.01\,lb$

$$\frac{P}{P_a} + \left(\frac{M_{in}}{M_{ain}}\right)^2 + \frac{M_{out}}{M_{aout}} = 0.11 \qquad \textbf{< 1.0 OK}$$

Weld Check

$d := D_b = 3.5\cdot in \qquad l_w := \pi\cdot d = 11\cdot in \qquad S_w := \frac{\pi\cdot d^2}{4} = 9.62\cdot in^2$

$V = 169.75\,lb \qquad M := M_{in} = 116.71\,lb\cdot ft$

$D := 3in$ 1/16 in. weld $\qquad R_{c\_cs} := 0.928ksi\,D\cdot d \qquad \Omega_{cs} := 2.0 \qquad F_{u\_cs} := 70ksi$

$$\frac{R_{c\_cs}}{d} = 2.78\cdot\frac{k}{in} > \frac{M}{S_w} + \frac{V}{l_w} = 0.16\cdot\frac{k}{in} \qquad \textbf{WELD OK}$$

USE = "3/16 FILLET WELD ALL AROUND"

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Pay Station Canopy Analysis (cont'd)

Connection Analysis- HSS Welded to HSS Mast Arm $LCq = $ "ENVELOPE"

ASTM A500 Grade B $F_y := f_{ya500} = 50 \cdot ksi$ $F_u := f_{ua500} = 62 \cdot ksi$ $E := E_s = 29000 \cdot ksi$

$pprop_{4,B} = $ "HSS 3.5 x 0.216"

$A := pprop_{0,B} \cdot in^2 = 2.07 \cdot in^2$ $A_b := pprop_{0,B} \cdot in^2 = 2.07 \cdot in^2$ $P = 2.25 \cdot k$

$t := pprop_{1,B} \cdot in = 0.2 \cdot in$ $t_b := pprop_{1,B} \cdot in = 0.2 \cdot in$ $M_{in} = 0.76 \cdot k \cdot ft$ M27

$D := pprop_{2,B} \cdot in = 3.5 \cdot in$ $D_b := pprop_{2,B} \cdot in = 3.5 \cdot in$ $M_{out} = 0.01 \cdot k \cdot ft$

$S := pprop_{3,B} \cdot in^3 = 1.63 \cdot in^3$ $S_b := pprop_{3,B} \cdot in^3 = 1.63 \cdot in^3$

AISC Specification Section K4 and Table K4.1A - Limits of Applicability $\theta := 45deg > 30\ deg$

Branch Wall Slenderness

$\frac{D_b}{t_b} = 17.41 < 50$ **OK**

$\frac{D_b}{t_b} = 17.41 < 0.05 \cdot \frac{E}{F_y} = 29$ **OK**

Column Wall Slenderness

$\frac{D}{t} = 17.41 < 50$ **OK**

Width Ratio $0.2 < \frac{D_b}{D} = 1$ < or = 1.0 **OK**

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Pay Station Canopy Analysis (cont'd)

Connection Analysis- HSS Welded to HSS Mast Arm (Cont'd)

AVAILABLE FLEXURAL STRENGTH - AISC TABLE K4.1

Chord Plastification (In-plane bending moment in branch) - AISC table K4.1

Max.Chord Axial Reaction $P_r = 0.0146 \cdot k$ M8

Max. Chord Moment (In Plane) $M_r = 0.82 \cdot k \cdot ft$

$\beta := \frac{D_b}{D} = 1$ $\gamma := \frac{D}{2 \cdot t} = 8.71$

$F_c := 0.6 \cdot F_y = 30 \cdot ksi$

$Q_f := 1.0$ TABLE K4.1
K2 -3 $\Omega := 1.67$

$$M_{nip} := \frac{5.39 \cdot F_y \cdot t^2 \cdot \gamma^{0.5} \cdot \beta \cdot D_b \cdot Q_f}{\sin(\theta)} = 13251.76\, lb \cdot ft$$

Shear Yielding (punching - in plane bending moment in branch) AISC Table K4.1

$D_b = 3.5 \cdot in$ < $(D - 2 \cdot t) = 3.1 \cdot in$ $\Omega_y := 1.58$

If D.b is greater > than (D-2t) Limit State does not need to be checked.

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Pay Station Canopy Analysis (cont'd)

Connection Analysis- HSS Welded to HSS Mast Arm (Cont'd)

Chord Plastification (Out-of-plane bending moment in branch) - AISC table K4.1

$$M_{nop} := \left[\frac{F_y \cdot t^2 \cdot D_b}{\sin(\theta)} \cdot \left(\frac{3}{1 - 0.81\beta}\right) \cdot Q_f\right] = 13156.23\ lb \cdot ft \qquad \Omega = 1.67$$

$M_{nop} \div \Omega = 7877.98\ lb \cdot ft$

Shear Yielding - punching (Out-of-plane bending moment in branch) - AISC table K4.1

$D_b = 3.5 \cdot in \quad < \quad (D - 2 \cdot t) = 3.1 \cdot in \qquad \Omega_y := 1.58$

If D.b is greater > than (D-2t) Limit State does not need to be checked.

AVAILABLE AXIAL STRENGTH - AISC TABLE K3.1

Shear Yielding - punching - AISC table K3.1

$D_b = 3.5 \cdot in < (D - 2 \cdot t) = 3.1 \cdot in \qquad \Omega_y := 1.58$

If D.b is greater > than (D-2t) Limit State does not need to be checked.

Chord Plastification

$$P_{n2} := \frac{F_y \cdot t^2 \cdot \left(3.1 + 15.6\beta^2\right) \cdot \gamma^{0.2} \cdot Q_f}{\sin(\theta)} = 82354.46\ lb \qquad \Omega = 1.67$$

$P_{n2} \div \Omega = 49314.05\ lb$

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Pay Station Canopy Analysis (cont'd)

Connection Analysis- HSS Welded to HSS Mast Arm (Cont'd)

CONNECTION SUMMARY RESULTS

Allowable In-Plane Bending $M_{ain} := \min\left(\frac{M_{nip}}{\Omega}\right) = 7935.19\,lb\cdot ft$

Allowable Out of Plane Bending $M_{aout} := \min\left(\frac{M_{nop}}{\Omega}\right) = 7877.98\,lb\cdot ft$

Allowable Axial Load $P_a := \min\left(\frac{P_{n2}}{\Omega}\right) = 49314.05\,lb$

$\cos(\theta) = 0.71$ $\frac{P}{P_a} + \left(\frac{M_{in}}{M_{ain}}\right)^2 + \frac{M_{out}}{M_{aout}} = 0.06$ **< 1.0 OK**

Weld Check

$d := 2\cdot D_b\cdot \cos(\theta) = 4.9\cdot in$ $l_w := \pi\cdot d = 15.55\cdot in$ $S_w := \frac{\pi\cdot d^2}{4} = 19.24\cdot in^2$

$V = 682.97\,lb$ $M := M_{in} = 758.27\,lb\cdot ft$

$D := 4in$ 1/16 in. weld $R_{c\_cs} := 0.928ksi\,D\cdot d$ $\Omega_{cs} := 2.0$ $F_{u\_cs} := 70ksi$

$\frac{R_{c\_cs}}{d} = 3.71\cdot\frac{k}{in} > \frac{M}{S_w} + \frac{V}{l_w} = 0.52\cdot\frac{k}{in}$ **WELD OK**

USE = "1/4 FILLET WELD ALL AROUND"

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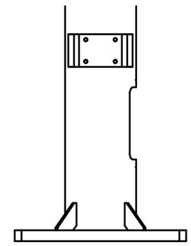
Pay Station Canopy Analysis (cont'd)

Opening in Pole at Base Analysis



A500B Gr 50

Risa-3D Reactions $\qquad LCq = \text{"ENVELOPE"}$

$V_z = 0.026 \cdot k \quad V_y = 0.1 \cdot k \qquad P = 1.91 \cdot k \qquad M_z = 0.23 \cdot k \cdot ft$

$V := \sqrt{V_z^2 + V_y^2} = 101\ lb \qquad T = 0 \cdot k \cdot ft \qquad M_y = 2.4 \cdot k \cdot ft$

Steel Properties $\qquad f_y := f_{ya500} = 50 \cdot ksi$

$E := 29000ksi \quad K := 2.1 \quad L := 10.647ft$

Safety Factors $\quad \Omega_c := 1.67 \quad \Omega_b := 1.67 \quad \Omega_T := 1.67 \quad \Omega_v := 1.67$

Section Properties - HSS Post with Opening $\qquad prop_{4,A} = \text{"HSS 6.625 x 0.280"}$

$A := oprop_{0,A}\ in^2 = 4.15 \cdot in^2 \quad S_z := oprop_{1,A}\ in^3 = 4.24 \cdot in^3 \quad S_y := oprop_{2,A}\ in^3 = 7.56 \cdot in^3$

$r_z := oprop_{3,A}\ in = 1.89 \cdot in \quad r_y := oprop_{4,A}\ in = 2.46 \cdot in \quad t_{des} := prop_{5,A}\ in = 0.26 \cdot in$

Axial Compression

$\frac{K \cdot L}{r_y} = 109.29 > 4.71 \cdot \sqrt{\frac{E}{f_y}} = 113.43 \qquad \frac{K \cdot L}{r_z} = 142.34 > 4.71 \cdot \sqrt{\frac{E}{f_y}} = 113.43$

$F_e := \frac{\pi^2 \cdot E}{\left(\frac{K \cdot L}{\min(r_y, r_z)}\right)^2} = 14.13 \cdot ksi \quad F_{cr} := 0.877 \cdot F_e = 12.39 \cdot ksi$

$P_{all} := \frac{F_{cr} \cdot A}{\Omega_c} = 30.8 \cdot k \qquad r_m := 6.365in$

Shear $\quad C_v := 1$

$V_{all} := \frac{0.6 \cdot f_y \cdot A \cdot C_v}{\Omega_v} = 75 \cdot k \qquad \tau_{app} := \frac{T \cdot (6 \cdot \pi r_m + 1.8t_{des})}{4\pi^2 r_m^2 (t_{des})^2} = 0.01 \cdot ksi$

$\tau_{max} := \frac{0.6 \cdot f_y}{\Omega_v} = 17.96 \cdot ksi \qquad \frac{\tau_{app}}{\tau_{max}} = 0$

Flexural

$M_{zall} := \frac{f_y \cdot S_z}{\Omega_b} = 10.579 \cdot k \cdot ft \qquad M_{yall} := \frac{f_y \cdot S_y}{\Omega_b} = 18.862 \cdot k \cdot ft$

EQ = "H2-1" $\quad$ UNITY = 0.211 $\quad$ **< 1.0 OK, NO STIFFENERS REQUIRED**

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Pay Station Canopy Analysis (cont'd)

Section Properties - HSS Tube with Opening Reinforced

$A := rprop_{0,A}\, in^2 = 5.28 \cdot in^2$ $\quad S_z := rprop_{1,A}\, in^3 = 7.35 \cdot in^3$ $\quad S_y := rprop_{2,A}\, in^3 = 8.53 \cdot in^3$

$r_z := rprop_{3,A}\, in = 2.16 \cdot in$ $\quad r_y := rprop_{4,A}\, in = 2.31 \cdot in$ $\quad I_{zz} := rprop_{5,A}\, in^4 = 24.69 \cdot in^4$

Axial Compression

$$\frac{K \cdot L}{r_y} = 115.95 > 4.71 \cdot \sqrt{\frac{E}{f_y}} = 113.43 \qquad \frac{K \cdot L}{r_z} = 124.04 > 4.71 \cdot \sqrt{\frac{E}{f_y}} = 113.43$$

$$F_e := \frac{\pi^2 \cdot E}{\left(\frac{K \cdot L}{\min(r_y, r_z)}\right)^2} = 18.6 \cdot ksi \qquad F_{cr} := 0.877 \cdot F_e = 16.31 \cdot ksi$$

$$P_{all} := \frac{F_{cr} \cdot A}{\Omega_c} = 51.55 \cdot k$$

Flexural

$$M_{xall} := \frac{f_y \cdot S_z}{\Omega_b} = 18.338 \cdot k \cdot ft \qquad M_{yall} := \frac{f_y \cdot S_y}{\Omega_b} = 21.287 \cdot k \cdot ft$$

EQ = "H2-1" UNITY = 0.162

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Cross Bar Analysis

Cross Bar Geometry

$b := D_{cb} = 2 \cdot in$ $\quad t := t_{cb} = 0.125 \cdot in$ $\quad A_g := A_{cb} = 0.94 \cdot in^2$

Max Length of Bar $\quad B := B \cdot 2 = 17\ ft$

Spacing of Bars $\quad sp = 15.31 \cdot in$

Dead and Live Loads

Dead Load $\quad W_D := w_{sw} = 1.1 \cdot plf$

Roof Live Load $\quad w_{LL} = 5 \cdot psf$ $\quad W_{Lro} := w_{LL} \cdot sp = 6.38 \cdot plf$

Snow Load

$$W_S := \begin{cases} \left[\left(1.37 D_{cbi}{}^2 \div 2\right) \cdot \gamma_s\right] & \text{if } D_{cbi} \le \dfrac{0.73 p_f}{\gamma_s} \\ \dfrac{D_{cbi} + \left(D_{cbi} - 2 \cdot x_s\right)}{2} \cdot p_f & \text{otherwise} \end{cases} = 1.41 \cdot plf$$

Atmospheric Ice Loads $\quad W_{Di} := A_{cbi} \cdot \rho_i = 4.04 \cdot plf$

Wind Load Analysis - Open Bldg, per Fig 27.3-4 & 27.3-5

Full Wind $\quad pWcbA = 20.8 \cdot psf$ $\quad W_{WLA} := pWcbA \cdot D_{cb} = 3.47 \cdot plf$

$pWcbB = -19.07 \cdot psf$ $\quad W_{WLB} := pWcbB \cdot D_{cb} = -3.18 \cdot plf$

Ice Wind $\quad w_{wice} := PWvai \div \left(\alpha_i \cdot B\right) \cdot D_{cbi} = 0.5 \cdot plf$

ASD Factored Loads

1.) DL + RLL $\quad ASD_1 := W_D + W_{Lro} = 7.51 \cdot plf$

2.) DL + SL $\quad ASD_2 := W_D + W_S = 2.54 \cdot plf$

3.) DL + 0.6WLA $\quad ASD_3 := W_D + 0.6 \cdot W_{WLA} = 3.21 \cdot plf$

4.) DL + 0.75(0.6WLA + RLL) $\quad ASD_4 := W_D + 0.75\left(0.6 \cdot W_{WLA} + W_{Lro}\right) = 7.47 \cdot plf$

5.) DL + 0.75(0.6WLA + SL) $\quad ASD_5 := W_D + 0.75\left(0.6 \cdot W_{WLA} + W_S\right) = 3.75 \cdot plf$

6.) 0.6DL + 0.6WLB $\quad ASD_6 := 0.6 \cdot W_D + 0.6 \cdot W_{WLB} = -1.23 \cdot plf$

7.) DL + 0.7Di + 0.7WLi + S

$$ASD_7 := \begin{cases} 0 & \text{if } t_{ice} = 0 \\ W_D + 0.7\left(W_{Di} + w_{wice}\right) + W_S & \text{otherwise} \end{cases} = 5.73 \cdot plf$$

$$ASD_{max} := \max\left(ASD_1, ASD_2, ASD_3, ASD_4, ASD_5, ASD_6, ASD_7\right) = 7.51 \cdot plf$$

Max Applied
Moment and Shear

$$M_a := \frac{ASD_{max} \cdot B^2}{8} = 0.27 \cdot ft \cdot k \qquad V_a := \frac{ASD_{max} \cdot B}{2} = 0.064 \cdot k$$

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By: CS
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2" Sq. x 1/8" Thick Aluminum Tube Trellis Bar (6061-T6) per IBC 1607.7

Maximum Span: $L_b := B = 17\,ft$

Section Properties:

$h := D_{cb}$ $\quad b := D_{cb}$ $\quad t_w := t_{cb}$ $\quad E := E_{al} = 10100 \cdot ksi$ $\quad G := G_{al} = 3800 \cdot ksi$

$$A := b \cdot h - (b - 2 \cdot t_w) \cdot ((h - 2 \cdot t_w)) = 0.938 \cdot in^2$$

$$I_x := \frac{b \cdot h^3 - (b - 2 \cdot t_w) \cdot (h - 2 \cdot t_w)^3}{12} = 0.552 \cdot in^4 \qquad I_y := \frac{h \cdot b^3 - (h - 2 \cdot t_w) \cdot (b - 2 \cdot t_w)^3}{12} = 0.552 \cdot in^4$$

$$S_x := \frac{(b \cdot h^3) - (b - 2 \cdot t_w) \cdot (h - 2 \cdot t_w)^3}{6h} = 0.552 \cdot in^3 \qquad S_y := \frac{(h \cdot b^3) - (h - 2 \cdot t_w) \cdot (b - 2 \cdot t_w)^3}{6b} = 0.552 \cdot i$$

$$Z_x := \frac{b \cdot h^2 - (b - 2 \cdot t_w) \cdot (h - 2 \cdot t_w)^2}{4} = 0.66 \cdot in^3 \qquad Z_y := \frac{b^2 \cdot h - (b - 2 \cdot t_w)^2 \cdot (h - 2 \cdot t_w)}{4} = 0.66 \cdot in^3$$

$$r_x := \sqrt{\frac{I_x}{A}} = 0.767 \cdot in \qquad J := \frac{2 \cdot t_w \cdot t_w \cdot (h - t_w)^2 \cdot (b - t_w)^2}{h \cdot t_w + b \cdot t_w - t_w^2 - t_w^2} = 0.824 \cdot in^4$$

Allowable Welded Stress: (6061-T6 Al.) $\quad \Omega_{br} := 1.95 \quad \Omega_{bo} := 1.65$

ADM 2015 F.2 Gross Yielding

$M_{1cb} := Z_x \cdot F_{cy} \div \Omega_{br} = 987.41\,lb \cdot ft$

$M_{2cb} := 1.5 \cdot S_x \cdot F_{ty} \div \Omega_{bo} = 1462.99\,lb \cdot ft$

$M_{3cb} := 1.5 S_x \cdot F_{cy} \div \Omega_{bo} = 1462.99\,lb \cdot ft$

$M_{np} := \min(M_{1cb}, M_{2cb}, M_{3cb}) = 987.41\,lb \cdot ft \qquad F_{np} := M_{np} \div S_x = 21.47 \cdot ksi$

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Forensic Engineers
3600 E. University Dr, Suite1400
Phoenix, AZ 85034
(602) 438-2500

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2" Sq. x 1/8" Thick Aluminum Tube Trellis Bar (6061-T6) per IBC 1607.7 (cont'd.)

Allowable Welded Stress: (6061-T6 Al.)

ADM 2015 F.4 Lateral-Torsional Buckling

F.4.1 Bending Coefficient C_b

$$M_{max} := M_a = 271.18\,lb \cdot ft$$

$$M_A := \frac{ASD_{max} \cdot (0.25B)}{2} \cdot (B - 0.25B) = 203.39\,lb \cdot ft \qquad M_B := M_{max} \qquad M_C := M_A$$

$$C_b := \frac{12.5 M_{max}}{2.5 M_{max} + 3 \cdot M_A + 4 \cdot M_B + 3 \cdot M_C} = 1.14 \qquad \lambda := 2.3 \cdot \sqrt{\frac{L_b \cdot S_x}{C_b \cdot \sqrt{I_y \cdot J}}} = 27.88$$

Table B.4.2 Buckling Constants

$$B_c := F_{cy} \cdot \left(1 + \frac{\sqrt{F_{cy} \cdot ksi^{-1}}}{2250}\right) = 35.09 \cdot ksi \quad D_c := \frac{B_c}{10} \cdot \sqrt{\frac{B_c}{E}} = 0.21 \cdot ksi \quad C_c := 0.41 \cdot \frac{B_c}{D_c} = 69.56$$

F.4 LTB Equation

$$M_{nmb} := \begin{cases} \left[M_{np} \cdot \left(1 - \frac{\lambda}{C_c}\right) + \frac{\pi^2 \cdot E \cdot \lambda \cdot S_x}{C_c^{\,3}}\right] & \text{if } \lambda < C_c \\ \frac{\pi^2 \cdot E \cdot S_x}{\lambda^2} & \text{if } \lambda \geq C_c \end{cases} = 971.35 \cdot lb \cdot ft$$

$$F_{nmb} := M_{nmb} \div S_x = 21.13 \cdot ksi$$

ADM 2015 Table 2-18 Axial Compression - B.5.4.2 (16)

$$\lambda_{B542} := \frac{b - 2 \cdot t}{t} = 14$$

$$F_{B542} := \begin{cases} 21.2ksi & \text{if } \lambda_{B542} < 20.8 \\ \left[(27.3 - 0.291 \cdot \lambda_{B542})ksi\right] & \text{if } 20.8 \leq \lambda_{B542} < 33 \\ (580 \div \lambda_{B542})ksi & \text{if } \lambda_{B542} \geq 33 \end{cases} = 21.2 \cdot ksi$$

ADM 2015 Table 2-18 Flexural Compression - B.5.5.1 (18)

$$\lambda_{B551} := \frac{b - 2t}{t} = 14$$

$$F_{B551} := \begin{cases} (31.8ksi) & \text{if } \lambda_{B551} < 33.1 \\ \left[(40.5 - 0.262 \cdot \lambda_{B551})ksi\right] & \text{if } 33.1 \leq \lambda_{B551} < 77 \\ (1563 \div \lambda_{B551})ksi & \text{if } \lambda_{B551} \geq 77 \end{cases} = 31.8 \cdot ksi$$

$$F_{bx} := \min(F_{np}, F_{nmb}, F_{B542}, F_{B551}) = 21.13 \cdot ksi$$

Applied Compressive Stress in Extreme Fiber $\quad f_b := (M_a \div S_x) = 5.9 \cdot ksi$

$$\frac{f_b}{F_{bx}} = 0.28$$ **< 1.0 OK**

Use 2" Square x 1/8" Thick
6061-T6 B211 Cross Bar

C nsulting Structural &
F rensic Engineers
3600 E. University Dr, Suite1400
Ph enix, AZ 85034
(602) 438-2500

Job. No. 25-0333
6/02/25
By: CS
Check by: JL, SE

Trellis Bar Connection

Trellis Bar Dimensions (Angle Shape)

$t := 0.1345in$ $b := 2.125in$ $d := 2.125in$

$a := b - t = 1.99 \cdot in$ $c := d - t = 1.99 \cdot in$

$$y := \frac{d^2 + a \cdot t}{2 \cdot (b + c)} = 0.58 \cdot in \qquad \Omega_b := 1.67$$

Moment of Inertia

$$I_x := \frac{1}{3} \cdot \left[t \cdot (d - y)^3 + b \cdot y^3 - a \cdot (y - t)^3\right] = 0.24 \cdot in^4$$

Section Modulus

$$S_x := \frac{I_x}{(d - y)} = 0.16 \cdot in^3 \qquad f_{ya1008} = 41.3 \cdot ksi$$

Allowable Moment

$$M_{all} := \frac{\left(f_{ya1008} \cdot S_x\right)}{\Omega_b} = 326.89\, lb \cdot ft$$

Max Trellis Reaction $P := V_a = 63.81\, lb$

Moment Arm and Moment $M_{arm} := 6in$ $M := 1.5P \cdot M_{arm} = 47.86\, lb \cdot ft$

$$\frac{M}{M_{all}} = 0.15$$ **< 1.0 OK**

Use a 2-1/8"x2-1/8"x0.1345" thick, ASTM A1008 Steel angle

1/2" ϕ SAE Grade 5 Trellis Connector Bolt to 3/4" ϕ Bung

$T_n := 6811lb$

Tension Due to Force Couple $T_a := M \div 0.375in = 1531.37\, lb$

$$\frac{T_a}{T_n} = 0.225$$ **< 1.0 OK**

Use (1) 1/2" ϕ Grade 5 Bolt at Trellis Connector
By inspection, 1/4" weld all around is OK