Future Trac 40 ft Tent Frame with 127 Tube

Structural evaluation of the Future Trac Frame in accordance with IBC 2012 and ASCE 7-10

Evaluated for use in the following conditions:

1. Risk / Occupancy Category I
2. Temporary Structure - (mean recurrence interval ≤ 2 yr = .67)
3. Enclosed or Open structure
4. 20 ft or 15 ft bay spacing
5. Not designed for
   - snow loading,
   - flood hazard areas or,
   - areas subjected to escarpment effects.

STRUCTURAL ONLY
SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER No. 27085 ROBERT V. NANGIA 3/26/14

The professional engineer seal on this cover page refers to the calculation sheets contained within this document and to any Appendix or Table sheets that support this document. Any other drawings and documents may require a separate seal for coverage not provided here.

The professional engineers seal, affixed on this document, signifies a responsibility for the structural adequacy of the design of the structure in the completed project. The content contained within this document does not encompass means, methods and safety of erection.

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1. Summary and Recommendations

This document, based on technical background information as provided by TopTec Products, LLC, covers the structural evaluation of the aluminum frame style structure in accordance with U.S. Building Code requirements. The specifications outlined in the Structural Engineering Institute / American Society of Civil Engineers (SEI/ASCE7) "Minimum Design Loads for Buildings and Other Structures" were followed in determining the integrity of the structure. This document is intended to serve as a basis for the acceptability of this temporary, stand-alone, enclosed structure under standard design wind loads at varying levels of exposure (terrain and wind velocities).

Lightweight Design Inc. compiled this document based on the existing frame tent system with reference to the applicable building codes in the U.S. This report includes the load cases and combinations used in the analysis and gives an indication as to the wind exposure for which the structure is suitable. Certification of this document only shows that the Professional Engineer of that particular state is in agreement with the report's contents. It does not, however, imply that the structure is generally suitable for use within that state, or that every installation is covered by this report.

As this document was compiled based on design information as provided by TopTec Products, LLC, the summary and recommendations for this structure and contained within this document can only be valid if the structure is erected with original TopTec parts and components.

Computer-aided structural frame analysis were involved in the course of the investigation. Different load combinations were considered to identify the critical aspects of the design. Member and detail checks were established to derive the conclusions for the entire report.

For each bay spacing, iteration of calculations were performed to determine the maximum wind speed for each different exposure category. As such, we have arrived at the following conclusions and recommendations;

1.1 Wind Speed Rating

40 ft Tube Frame Tent		
Bay Spacing	Wind Exposure	
	Exposure B	Exposure C
15 ft	125 mph	115 mph
20 ft	110 mph	100 mph
MRI = 2yr, effective velocity = 68%		

For the above mentioned wind speed, exposure category, and return period (or mean recurrence interval, MRI), the structure satisfies the requirements of the "American Society of Civil Engineers Minimum Design Loads for Buildings and Other Structures (ASCE 7), as well as the International Building Code (IBC).

Exposure Categories (IBC)

1609.4.3 Exposure categories. An exposure category shall be determined in accordance with the following:

Exposure B. Exposure B shall apply where the ground surface roughness condition, as defined by Surface Roughness B, prevails in the upwind direction for a distance of at least 2,600 feet (792 m) or 20 times the height of the building, whichever is greater.

Exception: For buildings whose mean roof height is less than or equal to 30 feet (9144 mm), the upwind distance is permitted to be reduced to 1,500 feet (457 m).

Exposure C. Exposure C shall apply for all cases where Exposures B or D do not apply.

Exposure D. Exposure D shall apply where the ground surface roughness, as defined by Surface Roughness D, prevails in the upwind direction for a distance of at least 5,000 feet (1524 m) or 20 times the building, whichever is greater. Exposure D shall extend inland from the shoreline for a distance of 600 feet (183 m) or 20 times the height of the building, whichever is greater.

Surface Roughness Categories (IBC)

1609.4.2 Surface roughness categories. A ground surface roughness within each 45-degree (0.79 rad) sector shall be determined for a distance upwind of the site as defined in Section 1609.4.3 from the categories defined below, for the purpose of assigning an exposure category as defined in Section 1609.4.3.

Surface Roughness B. Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.

Surface Roughness C. Open terrain with scattered obstructions having heights generally less than 30 feet (9144 mm). This category includes flat open country, grasslands, and all water surfaces in hurricane-prone regions.

Surface Roughness D. Flat, unobstructed areas and water surfaces outside hurricane-prone regions. This category includes smooth mud flats, salt flats and unbroken ice.

1.2 Dead Loads

Dead loads are defined as the weights of the materials of construction and fixed service equipment. For this analysis the weight of the frame and fabric have been accounted for.

1.3 Hanging Dead Loads

Hanging dead loads are ancillary loads that typically are hanging from the structure, but not necessarily part of the standard structure. These can be due to electrical and mechanical fixtures (lighting, HVAC, suspended items, etc.). A total load per frame of 500 lb is accounted for in this analysis.

1.4 Live Loads

Live loads are loads produced by the use and occupancy of the building are found on Table 1607.1 (IBC). In the case of this structure, there are no additional live loads.

1.5 Snow Loads

This tent structure is assumed to be erected on a temporary basis, in locations, and during seasons, where snow loading is not expected. No snow loading value has been applied in this analysis (Ps = 0psf).

If a snow event is expected or is likely to occur while the fabric is still in place, then measures should be provided to ensure snow removal or melting. Furthermore, the prescribed gradient of the roof fabric should be maintained to allow for smooth drainage and to prevent the potential for ponding of melt water.

1.6 Seismic Loads

Due to the low mass of the structure, seismic base shear does not control over wind loading shear and thus has not been included in this analysis.

1.7 Base Reactions

The maximum reactions at the foundations/supports due to the factored load and exposure category are given in the table below, per base plate, per frame.

40 ft Tube Frame Tent						
Bay Spacing	Vertical		Horizontal		Guy Strap	
	Uplift	Gravity	Perpendicular to Ridge	Parallel to Ridge	Uplift	Horiz.
15 ft	2249 lb	5172 lb	399 lb	1173 lb	4864 lb	2432 lb
20 ft	2236 lb	6755 lb	520 lb	1300 lb	6484 lb	3242 lb

NOTE: Foundations, by others, are required to support column loads. The structure should be set on firm and unyielding ground. This ground should sufficiently contain the bearing pressures of the base plates as well as the tractive forces of the anchors. A foundations engineer must verify ground conditions on a site-by-site basis and provide appropriate bearing plate sizes to accommodate column loads:

1.8 Installation Requirements

It is understood that the responsibility of proper installation according to the plans rests upon the installation contractor. This includes, but is not limited to, ensuring the following:

- that the cables are always held taut,
- that the fabric is stretched tight enough to prevent the development of pockets and to maintain the prescribed roof gradient,
- that purlins are installed securely against rafters to resist calculated loads,
- that base plates are secured to their foundations using anchors. The manufacturer provides a base plate and anchoring plan for the structure as a base starting point for average soil conditions. It is the installer's responsibility to ensure that the anchorage provided will resist the reaction loads as indicated in the tables found in this document.

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3. Determination of Loads

Dead Load :

The structure dead loads consist of the self weight of the structure's components with addition of uniform distributed loads for fabric roofing, side wall materials, and minor components. Various calculated weights are shown below for reference and use in the static computer model analysis.

Fabric Roof and/or Side : $AreaWt_{fabric} = 24.00 \cdot oz\ per\ sq\ yard$ $UnitWt_{fabric} = 0.278 \cdot pli$

Eaves Purlin, 116mm x 50mm x 2.5mm Alu : $UnitWt_{eave} = 0.181 \cdot pli$ $Wt_{eave} = 43.02 \cdot lbf$

Ridge Purlin 116mm x 50mm x 2.5mm Alu : $UnitWt_{ridge} = 0.181 \cdot pli$ $Wt_{ridge} = 43.02 \cdot lbf$

The structure is designed to support the loads shown in this calculations. It may, or may not, be capable of supporting additional collateral loads. The owner of the structure shall not hand, or otherwise affix, additional loads to this structure without a review by an engineer qualified to make said review. Additionally, prior to adding load to this structure, the owner shall get a written confirmation by the qualified engineer as to the magnitude and location of the load, or loads, being applied.

Live Load :

Live loads loads produced by the use and occupancy of the building are found on Table 1607.1. In the case of this structure, their are no additional live loads.

Roof Live Load :

The electrical and mechanical fixtures (lighting, HVAC, suspended items, etc.) totaling 500 lbs per frame and suspended symmetrically on the structure are accounted for. These hanging loads have been assumed to be 500 lbf at the peak of the structure for this analysis.

Ridge Load hanged at peak : $P_{peak} = 500 \cdot lbf$

Snow Load :

Ground Snow Load :

Ground snow load :	$p_g = 0 \cdot psf$	*[Fig. 7-1, Table 7-1]*

Flat Roof Snow Load :

Exposure Factor :	$C_e = 1$	*[Section 7.3.1]*
Thermal Factor :	$C_t = 1$	*[Section 7.3.2]*
Importance Factor :	$I_s = 0.8$	*[Section 7.3.3]*
$p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g$	$p_f = 0 \cdot psf$	*[Eq. 7.3-1]*

Minimum Snow Load for Low-Slope Roofs :

A minimum roof snow load, p_m, shall only apply to monoslope, hip and gable roofs with slopes less than 15°, and to curved roofs where the vertical angle from the eaves to the crown is less than 10°.). This minimum roof snow load is a separate uniform load case. It need not be used in determining or in combination with drift, sliding, unbalanced, or partial loads.

$p_m := \min(p_g, 20psf) \cdot I_s$	$p_m = 0 \cdot psf$	*[Section 7.3.4]*

Sloped Roof Snow Load :

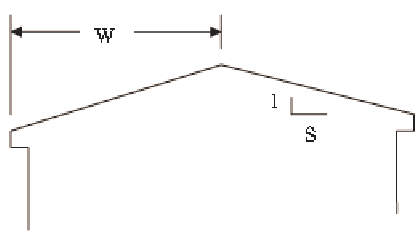
Roof Slope Factor :	$C_s = 0.66$	*[Figure 7-2]*
$p_s := C_s \cdot p_f$	$p_s = 0 \cdot psf$	*[Eq. 7.4-1]*

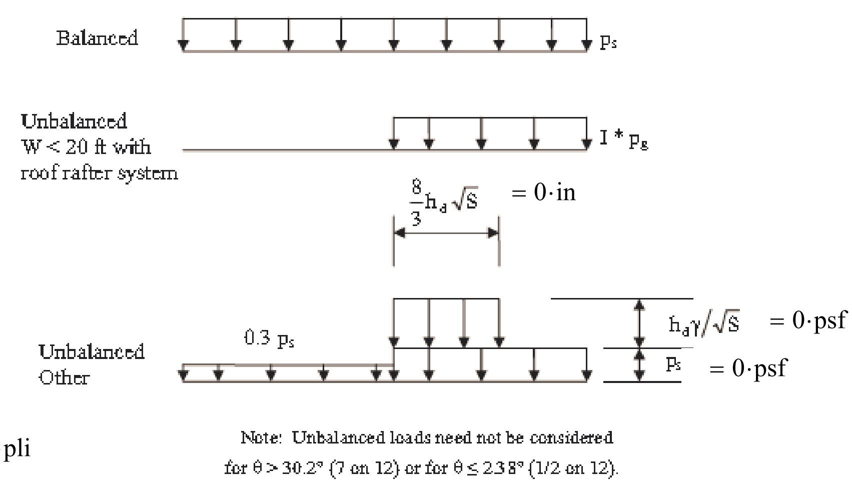
Balanced Snow Load :

$N_1 := p_s \cdot L_{bay}$ $\quad N_1 = 0 \cdot pli$

Un-balanced Snow Load :

$W_{Fig7.5} := \frac{L_{width}}{2}$	*[Figure 7-5]*
$S = 1.95$	*[Section 7.1]*
$\gamma_{snow} = 0 \cdot pcf$	*[Eq. 7-3]*
$h_d = 0 \cdot ft$	*[Figure 7-9]*





$N_{2.windward} = 0.00 \cdot pli$

$N_{2.leeward} = 0.00 \cdot pli$

$N_{2.leeward} + \frac{h_d \cdot \gamma_{snow}}{\sqrt{S}} \cdot L_{bay} = 0 \cdot pli$

Wind Loads.

General Requirements

Risk Category: $Cat = "I"$ *[Table 1.5-1]*

Use of Building(Cat) = "Buildings and other structures that represent a low risk to human life in the event of failure"

Basic wind speed: $V = 100 \cdot mph$ *[Section 26.5.1]*

Basic Wind Speed Map(Cat) = "Use Figure 26.5-1C."

Wind directionality factor: $K_d = 0.85$ *[Section 26.6]*

Exposure category: $Exposure = "C"$ *[Section 26.7]*

Topographic factor: $K_{zt} = 1$ *[Section 26.8]*

Gust effect factor: $G = 0.85$ *[Section 26.9]*

Mean recurrence interval: $MRI = 2 \cdot yr$

Reduction factor for 'other' MRI: $R_n = 0.68$ *[Table C6-3]*

Effective wind speed: $V_r := V \cdot R_n = 68 \cdot mph$

Envelope Procedure

ASCE 7-10 Envelope Procedure for low-rise buildings as specified in Chapter 28 is used in this evaluation.

No reduction to the velocity pressure is taken due to apparent shielding. *[Section 28.1.4]*

Velocity pressure : *[Section 28.3.1]*

$$q_z = 0.00256 \cdot \frac{psf}{mph^2} \cdot K_z \cdot K_{zt} \cdot K_d \cdot V^2$$ where : *[Equation 28.3-1]*

$K_d = 0.85$ wind directionality factor *[Section 26.6, Table 26.6-1]*

$K_{zt} = 1$ topographic factor *[Section 26.8, Fig. 26.8-1]*

$K_z = 2.01 \cdot \left(\frac{z}{z_g}\right)^{\frac{2}{\alpha}}$ for $15ft \le z \le z_g$ $K_z = 2.01 \cdot \left(\frac{15ft}{z_g}\right)^{\frac{2}{\alpha}}$ for $z \le 15ft$ *[Table 28.3-1]*

$K_z = 0.88$ velocity pressure exposure coefficient

$V = 100 \cdot mph$ basic wind speed

$q_z = 8.9 \cdot psf$ velocity pressure evaluated at peak height, z

$q_h = 8.54 \cdot psf$ velocity pressure evaluated at mean roof height, h

The wind load to be used in the design of the MWFRS for an enclosed or partially enclosed building shall not be less than 16 psf multiplied by the wall area of the building and 8 psf multiplied by the roof area of the building projected onto a vertical plane normal to the assumed wind direction. *[Section 28.4.4]*

$Wall\ Case_{windward} = 13.33 \cdot pli$ $Wall\ Case_{leeward} = 13.33 \cdot pli$

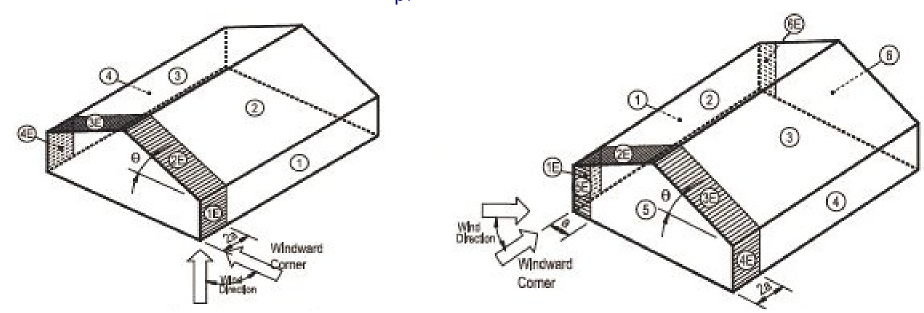
$Roof\ Case_{windward} = 6.67 \cdot pli$ $Roof\ Case_{leeward} = 6.67 \cdot pli$

Internal Pressure Coefficients (GC_{pi})

Openings are considered to be equally distributed around the building. The building qualifies as an enclosed building (see Section 26.10). The value can be both positive (overpressure), and negative (underpressure)

$$GC_{pi} = \begin{pmatrix} 0.18 \\ -0.18 \end{pmatrix}$$ *[Section 26.11]*

External Pressure Coefficients (GC_{pf})



Load Case A
(wind on side)

Load Case B
(wind on end)

$2 \cdot a = 8.00 \cdot ft$

$\frac{2 \cdot a}{L_{bay}} = 40 \cdot \%$

Figure 28.4-1 : External Pressure coefficients (GC_{pf})

Roof Angle θ (degrees)	LOAD CASE A							
	Building Surface							
	1	2	3	4	1E	2E	3E	4E
0-5	0.40	-0.69	-0.37	-0.29	0.61	-1.07	-0.53	-0.43
20	0.53	-0.69	-0.48	-0.43	0.80	-1.07	-0.69	-0.64
30-45	0.56	0.21	-0.43	-0.37	0.69	0.27	-0.53	-0.48
90	0.56	0.56	-0.37	-0.37	0.69	0.69	-0.48	-0.48

Roof Angle θ (degrees)	LOAD CASE B											
	Building Surface											
	1	2	3	4	5	6	1E	2E	3E	4E	5E	6E
0-90	-0.45	-0.69	-0.37	-0.45	0.40	-0.29	-0.48	-1.07	-0.53	-0.48	0.61	-0.43

$GC_{pf.A} =$

"1"	"2"	"3"	"4"	"1E"	"2E"	"3E"	"4E"
0.55	-0.05	-0.44	-0.39	0.72	-0.11	-0.58	-0.53

(interpolated to the roof slope; $\theta_t = 27.14 \cdot deg$)

$GC_{pf.B} =$

"1"	"2"	"3"	"4"	"5"	"6"	"1E"	"2E"	"3E"	"4E"
-0.45	-0.69	-0.37	-0.45	0.4	-0.29	-0.48	-1.07	-0.53	...

Application of Pressures on Building Surfaces 2 and 3

Per note 8 in ASCE 7-10 Fig. 28.4-1, the roof pressure coefficient (GCpf), when negative in Zone 2 and 2E, shall be applied in Zone 2/2E for a distance from the edge of the roof equal to 0.5*horizontal dimension of the building parallel to the direction of the MWFRS being designed or 2.5* the eave height at the windward wall, whichever is less; the remainder of Zone 2/2E extending to the ridge line shall use the pressure coefficient (GCpf) for Zone 3/3E.

$\text{Zone 2/2E distance}_{CaseA} = 20 \cdot ft$

$\text{Zone 2/2E distance}_{CaseB} = 20 \cdot ft$

Design Wind Pressures

$p = q_h \cdot \left[\left(GC_{pf} \right) - \left(GC_{pi} \right) \right]$ *[Equation 28.4-1]*

$p_A =$ (psf)

"1"	"2"	"3"	"4"	"1E"	"2E"	"3E"	"4E"
3.17	-1.95	-5.33	-4.84	4.63	-2.51	-6.46	-6.03
6.25	1.13	-2.26	-1.77	7.70	0.56	-3.38	-2.95

$p_B =$ (psf)

"1"	"2"	"3"	"4"	"5"	"6"	"1E"	"2E"	"3E"	"4E"	"5E"	"6E"
-5.38	-7.43	-4.7	-5.38	1.88	-4.01	-5.64	-10.68	-6.06	-5.64	3.67	-5.21
-2.31	-4.36	-1.62	-2.31	4.95	-0.94	-2.56	-7.6	-2.99	-2.56	6.75	-2.14

top line = overpressure, bottom line = underpressure

Design Wind Loads

The wind pressure on one bay must be supported by one arch. The total wind load per arch equals :

$WL = p \cdot L_{bay}$

$WL_A =$ (pli)

"1"	"2"	"3"	"4"	"1E"	"2E"	"3E"	"4E"
5.29	-3.24	-8.89	-8.07	7.71	-4.18	-10.76	-10.05
10.41	1.88	-3.76	-2.95	12.83	0.94	-5.63	-4.92

$WL_B =$ (pli)

"1"	"2"	"3"	"4"	"5"	"6"	"1E"	"2E"	"3E"	"4E"	"5E"	"6E"
-8.97	-12.38	-7.83	-8.97	3.13	-6.69	-9.4	-17.79	-10.11	-9.4	6.12	-8.68
-3.84	-7.26	-2.7	-3.84	8.26	-1.57	-4.27	-12.67	-4.98	-4.27	11.25	-3.56

top line = overpressure, bottom line = underpressure

Design Wind Loads - First Arch on End with applied load

$WL_{A1} =$ (pli)

"1"	"2"	"3"	"4"
3.61	-2	-5.19	-4.83
6.17	0.56	-2.63	-2.26

$WL_{B1} =$ (pli)

"1"	"2"	"3"	"4"	"5"	"6"
-4.66	-8.36	-4.83	-4.66	2.76	-4.14
-2.09	-5.79	-2.26	-2.09	5.32	-1.58

Design Wind Loads - Second Arch from End with applied load

$WL_{A2} =$ (pli)

"1"	"2"	"3"	"4"
5.29	-3.24	-8.89	-8.07
10.41	1.88	-3.76	-2.95

$WL_{B2} =$ (pli)

"1"	"2"	"3"	"4"	"5"	"6"
-8.97	-12.38	-7.83	-8.97	3.13	-6.69
-3.84	-7.26	-2.7	-3.84	8.26	-1.57

Design Wind Loads - All Other Arches

$WL_{A3} =$ (pli)

"1"	"2"	"3"	"4"
5.29	-3.24	-8.89	-8.07
10.41	1.88	-3.76	-2.95

$WL_{B3} =$ (pli)

"1"	"2"	"3"	"4"	"5"	"6"
-8.97	-12.38	-7.83	-8.97	3.13	-6.69
-3.84	-7.26	-2.7	-3.84	8.26	-1.57

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4. LRFD Load Combinations :

ASCE 7-10 Section 2.2 : SYMBOLS AND NOTATION

D = dead load
D_i = weight of ice
E = earthquake load
F = load due to fluids with well-defined pressures and maximum heights
F_a = flood load
H = load due to lateral earth pressure, ground water pressure, or pressure of bulk materials
L = live load
L_r = roof live load
R = rain load
S = snow load
T = self-straining force
W = wind load
W_i = wind-on-ice determined in accordance with Chapter 10

ASCE Section 2.3 : COMBINING FACTORED LOADS USING STRENGTH DESIGN

Section 2.3.2 : Basic Combinations. Structures, components, and foundations shall be designed so that their design strength equals or exceeds the effects of the factored loads in the following combinations:

1. 1.4D
2. 1.2D + 1.6L + 0.5(L_r or S or R)
3. 1.2D + 1.6(L_r or S or R) + (L or 0.5W)
4. 1.2D + 1.0W + L + 0.5(L_r or S or R)
5. 1.2D + 1.0E + L + 0.2S
6. 0.9D + 1.0W
7. 0.9D + 1.0E

Symbols as used in calculations

D_1	= dead load;	W_1	= lateral wind (perpendicular to ridge line with overpressure)
D_2	= dead load - ancillary;	W_2	= lateral wind (perpendicular to ridge line with underpressure)
L_r	= roof live load;	W_3	= longitudinal wind (parallel to ridge line with overpressure)
S_1	= balanced snow	W_4	= longitudinal wind (parallel to ridge line with underpressure)
S_2	= unbalanced snow	W'	= minimum wind per section 28.4.4 (designated at W_5)

Combinations as applied in calculations :

1 a. $1.4D_1 + 1.4D_2$

4 a. $1.2D_1 + 0.5L_r + 1.0W_1$
b. $1.2D_1 + 0.5L_r + 1.0W_2$
c. $1.2D_1 + 0.5L_r + 1.0W_3$
d. $1.2D_1 + 0.5L_r + 1.0W_4$
e. $1.2D_1 + 0.5L_r + 1.0W'$
f. $1.2D_1 + 0.5S_1 + 1.0W_1$
g. $1.2D_1 + 0.5S_1 + 1.0W_2$
h. $1.2D_1 + 0.5S_1 + 1.0W_3$
i. $1.2D_1 + 0.5S_1 + 1.0W_4$
j. $1.2D_1 + 0.5S_1 + 1.0W'$
k. $1.2D_1 + 0.5S_2 + 1.0W_1$
l. $1.2D_1 + 0.5S_2 + 1.0W_2$
m. $1.2D_1 + 0.5S_2 + 1.0W_3$
n. $1.2D_1 + 0.5S_2 + 1.0W_4$
o. $1.2D_1 + 0.5S_2 + 1.0W'$
p. $1.2D_1 + 1.4D_2 + 0.5L_r + 1.0W_1$
q. $1.2D_1 + 1.4D_2 + 0.5L_r + 1.0W_2$
r. $1.2D_1 + 1.4D_2 + 0.5L_r + 1.0W_3$
s. $1.2D_1 + 1.4D_2 + 0.5L_r + 1.0W_4$
t. $1.2D_1 + 1.4D_2 + 0.5L_r + 1.0W'$
u. $1.2D_1 + 1.4D_2 + 0.5S_1 + 1.0W_1$
v. $1.2D_1 + 1.4D_2 + 0.5S_1 + 1.0W_2$
w. $1.2D_1 + 1.4D_2 + 0.5S_1 + 1.0W_3$
x. $1.2D_1 + 1.4D_2 + 0.5S_1 + 1.0W_4$
y. $1.2D_1 + 1.4D_2 + 0.5S_1 + 1.0W'$
z. $1.2D_1 + 1.4D_2 + 0.5S_2 + 1.0W_1$
aa. $1.2D_1 + 1.4D_2 + 0.5S_2 + 1.0W_2$
ab. $1.2D_1 + 1.4D_2 + 0.5S_2 + 1.0W_3$
ac. $1.2D_1 + 1.4D_2 + 0.5S_2 + 1.0W_4$
ad. $1.2D_1 + 1.4D_2 + 0.5S_2 + 1.0W'$

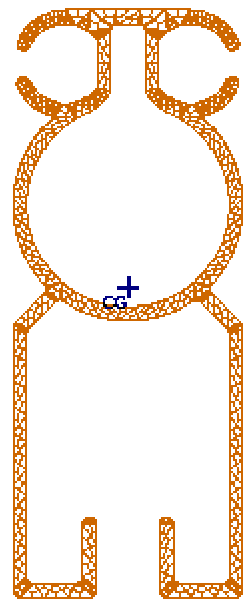
2 a. $1.2D_1 + 0.5L_r$
b. $1.2D_1 + 0.5S_1$
c. $1.2D_1 + 0.5S_2$
d. $1.2D_1 + 1.4D_2 + 0.5L_r$
e. $1.2D_1 + 1.4D_2 + 0.5S_1$
f. $1.2D_1 + 1.4D_2 + 0.5S_2$

6 a. $0.9D_1 + 1.0W_1$
b. $0.9D_1 + 1.0W_2$
c. $0.9D_1 + 1.0W_3$
d. $0.9D_1 + 1.0W_4$
e. $0.9D_1 + 1.0W'$
f. $0.9D_1 + 1.4D_2 + 1.0W_1$
g. $0.9D_1 + 1.4D_2 + 1.0W_2$
h. $0.9D_1 + 1.4D_2 + 1.0W_3$
i. $0.9D_1 + 1.4D_2 + 1.0W_4$
j. $0.9D_1 + 1.4D_2 + 1.0W'$

3 a. $1.2D_1 + 1.6L_r + 0.5W_1$
b. $1.2D_1 + 1.6L_r + 0.5W_2$
c. $1.2D_1 + 1.6L_r + 0.5W_3$
d. $1.2D_1 + 1.6L_r + 0.5W_4$
e. $1.2D_1 + 1.6L_r + 0.5W'$
f. $1.2D_1 + 1.6S_1 + 0.5W_1$
g. $1.2D_1 + 1.6S_1 + 0.5W_2$
h. $1.2D_1 + 1.6S_1 + 0.5W_3$
i. $1.2D_1 + 1.6S_1 + 0.5W_4$
j. $1.2D_1 + 1.6S_1 + 0.5W'$
k. $1.2D_1 + 1.6S_2 + 0.5W_1$
l. $1.2D_1 + 1.6S_2 + 0.5W_2$
m. $1.2D_1 + 1.6S_2 + 0.5W_3$
n. $1.2D_1 + 1.6S_2 + 0.5W_4$
o. $1.2D_1 + 1.6S_2 + 0.5W'$
p. $1.2D_1 + 1.4D_2 + 1.6L_r + 0.5W_1$
q. $1.2D_1 + 1.4D_2 + 1.6L_r + 0.5W_2$
r. $1.2D_1 + 1.4D_2 + 1.6L_r + 0.5W_3$
s. $1.2D_1 + 1.4D_2 + 1.6L_r + 0.5W_4$
t. $1.2D_1 + 1.4D_2 + 1.6L_r + 0.5W'$
u. $1.2D_1 + 1.4D_2 + 1.6S_1 + 0.5W_1$
v. $1.2D_1 + 1.4D_2 + 1.6S_1 + 0.5W_2$
w. $1.2D_1 + 1.4D_2 + 1.6S_1 + 0.5W_3$
x. $1.2D_1 + 1.4D_2 + 1.6S_1 + 0.5W_4$
y. $1.2D_1 + 1.4D_2 + 1.6S_1 + 0.5W'$
z. $1.2D_1 + 1.4D_2 + 1.6S_2 + 0.5W_1$
aa. $1.2D_1 + 1.4D_2 + 1.6S_2 + 0.5W_2$
ab. $1.2D_1 + 1.4D_2 + 1.6S_2 + 0.5W_3$
ac. $1.2D_1 + 1.4D_2 + 1.6S_2 + 0.5W_4$
ad. $1.2D_1 + 1.4D_2 + 1.6S_2 + 0.5W'$

5a. Main Profile Design

Section Properties :



$E = 10100 \cdot ksi$ Table 3.3-1

$n_u = 1.95$ Table 3.4-1

<u>main extrusion</u>

$A_g = 2.069 \cdot in^2$	Cross-sectional area of Shape
$b_w = 5.020 \cdot in$	Web length of Shape
$t_w = 0.118 \cdot in$	Web thickness
$b_f = 1.970 \cdot in$	Flat flange
$t_f = 0.118 \cdot in$	Flange thickness
$I_x = 5.75 \cdot in^4$	Moment of inertia about strong axis
$I_y = 1.04 \cdot in^4$	Moment of inertia about weak axis
$S_x = 2.17 \cdot in^3$	Section Modulus about strong axis
$S_y = 1.05 \cdot in^3$	Section Modulus about weak axis
$r_x = 1.67 \cdot in$	Radius of Gyration about strong axis
$r_y = 0.71 \cdot in$	Radius of Gyration about weak axis
$J = 0.64 \cdot in^4$	Torsional constant
$K_x := 1.0$	For strong axis buckling
$L_x = 96 \cdot in$	Length between Inflection Points for strong axis buckling from computer model
$K_y := 0.7$	For weak axis buckling
$L_y = 96 \cdot in$	Length for weak axis buckling
$L_b := L_y$	Length between Bracing Points (compression flange restrained from twisting or moving laterally)

Selected Ratios :

$\frac{b_w}{t_w} = 42.5$ $\frac{b_f}{t_f} = 16.7$ $\frac{R_b}{t_f} = 0$ $\frac{K_x \cdot L_x}{r_x} = 57.6$ $\frac{K_y \cdot L_y}{r_y} = 94.9$ $\frac{L_b \cdot S_x}{0.5\sqrt{I_y \cdot J}} = 511.1$

The following allowable stresses are based on values from the "2005 Aluminum Design Manual"

Allowable Axial Stress:

Specification 3.4.1 - Tension, axial: $F_{3.4.1} = 32.3 \cdot ksi$ $F_{3.4.1} = 222.7 \cdot MPa$
Any tension member.

Specification 3.4.7 - Compression in Columns: $F_{3.4.7x} = 19.5 \cdot ksi$ $F_{3.4.7x} = 134.4 \cdot MPa$
All columns. $F_{3.4.7y} = 9.18 \cdot ksi$ $F_{3.4.7y} = 63.3 \cdot MPa$

Specification 3.4.9 - Compression in Column Elements: $F_{3.4.9} = 19.14 \cdot ksi$ $F_{3.4.9} = 131.9 \cdot MPa$
Flat elements supported on both edges.

Specification 3.4.10 - Compression in Column Elements: $F_{3.4.10} = 33.25 \cdot ksi$ $F_{3.4.10} = 229.3 \cdot MPa$
Curved elements supported on both edges.

Allowable Axial Stress:
Use in Eq. 4.1.1-1 $F_a = 9.18 \cdot ksi$ $F_a = 63.3 \cdot MPa$
Use in Eq. 4.1.1-2 $F_{ao} = 19.14 \cdot ksi$ $F_{ao} = 131.9 \cdot MPa$
$F_{ex} = 23.24 \cdot ksi$ $F_{ex} = 160.2 \cdot MPa$
$F_{ey} = 9.18 \cdot ksi$ $F_{ey} = 63.3 \cdot MPa$

Allowable Bending Stress:

Specification 3.4.2 - Tension in Beams, extreme fibre, net section: $F_{3.4.2} = 32.3 \cdot ksi$ $F_{3.4.2} = 222.7 \cdot MPa$
Flat elements in uniform tension (flanges).

Specification 3.4.14 - Compression in Beams, gross section.: $F_{3.4.14} = 25.9 \cdot ksi$ $F_{3.4.14} = 178.6 \cdot MPa$
Tubular shapes.

Specification 3.4.16 - Compression in Beams, gross section: $F_{3.4.16} = 31.46 \cdot ksi$ $F_{3.4.16} = 216.9 \cdot MPa$
Flat elements supported on both edges.

Specification 3.4.16.1 - Compression in Beams, gross section: $F_{3.4.16.1} = 38.9 \cdot ksi$ $F_{3.4.16.1} = 268.2 \cdot MPa$
Curved elements supported on both edges.

Specification 3.4.19 - Compression in Beams, elements: $F_{3.4.19} = 43.22 \cdot ksi$ $F_{3.4.19} = 298 \cdot MPa$
Flat elements supported on both edges with longitudinal stiffening.

Allowable Bending Stress:
Use in Eq. 4.1.1-1 & Eq. 4.1.1-2 $F_{bx} = 25.9 \cdot ksi$ $F_{bx} = 178.6 \cdot MPa$
$F_{by} = 25.9 \cdot ksi$ $F_{by} = 178.6 \cdot MPa$

Allowable Shear Stress:

Specification 3.4.20 - Shear in Elements, gross section: $F_{3.4.20} = 17.16 \cdot ksi$ $F_{3.4.20} = 118.3 \cdot MPa$
Unstiffened flat elements supported on both edges.

Actual Stress (un-reinforced extrusion):

Member ID = "M102" $Mx = 51.6 \cdot kip \cdot in$ $My = 0 \cdot kip \cdot in$ $C = -1.83 \cdot kip$

Load Case = "6c - 0.9D1±1.0W3"

$Cmx := 0.85$

$Cmy := 0.85$

$f_{bx} := \left| \frac{Mx}{S_x} \right|$ $f_{by} := \frac{My}{S_y}$ $f_{ac} := \left| \frac{C}{A_g} \right|$

$f_{bx} = 23.7 \cdot ksi$ $f_{by} = 0.0 \cdot ksi$ $f_{ac} = 0.9 \cdot ksi$

$f_{bx} = 163.6 \cdot MPa$ $f_{by} = 0.0 \cdot MPa$ $f_{ac} = 6.1 \cdot MPa$

Eq. 4.1.1-1 :

$$Eq1 := \frac{f_{ac}}{F_a} + \frac{Cmx \cdot f_{bx}}{\left(1 - \frac{f_{ac}}{F_{ex}}\right) \cdot F_{bx}} + \frac{Cmy \cdot f_{by}}{\left(1 - \frac{f_{ac}}{F_{ey}}\right) \cdot F_{by}}$$

$Eq1 = 0.91$

Eq1 is less than or equal to 1.0 = "OK"

Eq. 4.1.1-2 :

$$Eq2 := \frac{f_{ac}}{F_{ao}} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}}$$

$Eq2 = 0.96$

Eq2 is less than or equal to 1.0 = "OK"

Member ID = "M101" $Mx = 51.6 \cdot kip \cdot in$ $My = 0 \cdot kip \cdot in$ $T = 1.91 \cdot kip$

Load Case = "6c - 0.9D1±1.0W3"

$f_{bx} := \left| \frac{Mx}{S_x} \right|$ $f_{by} := \frac{My}{S_y}$ $f_{at} := \frac{T}{A_g}$

$f_{bx} = 23.7 \cdot ksi$ $f_{by} = 0 \cdot ksi$ $f_{at} = 0.9 \cdot ksi$

$f_{bx} = 163.6 \cdot MPa$ $f_{by} = 0 \cdot MPa$ $f_{at} = 6.4 \cdot MPa$

Eq. 4.1.2-1 :

$$Eq3 := \frac{f_{at}}{F_{3.4.1}} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}}$$

$Eq3 = 0.94$

Eq3 is less than or equal to 1.0 = "OK"

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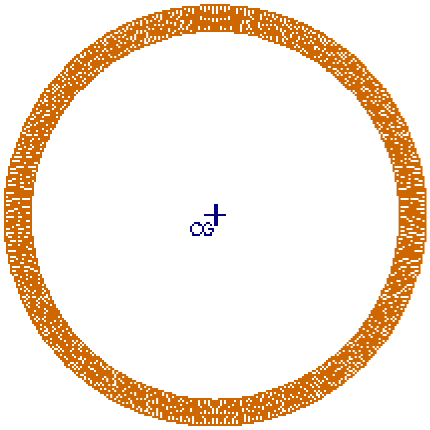
5b. Eave Brace Profile Design

Section Properties :



$E = 10100 \cdot ksi$	Table 3.3-1
$n_u = 1.95$	Table 3.4-1

main extrusion

$A_g = 0.736 \cdot in^2$	Cross-sectional area of Shape
$b_w = 2.000 \cdot in$	Web length of Shape
$t_w = 0.125 \cdot in$	Web thickness
$b_f = 2.000 \cdot in$	Flat flange
$t_f = 0.125 \cdot in$	Flange thickness
$I_x = 0.32 \cdot in^4$	Moment of inertia about strong axis
$I_y = 0.32 \cdot in^4$	Moment of inertia about weak axis
$S_x = 0.32 \cdot in^3$	Section Modulus about strong axis
$S_y = 0.32 \cdot in^3$	Section Modulus about weak axis
$r_x = 0.66 \cdot in$	Radius of Gyration about strong axis
$r_y = 0.66 \cdot in$	Radius of Gyration about weak axis
$J = 0.65 \cdot in^4$	Torsional constant
$K_x := 1.0$	For strong axis buckling
$L_x = 66 \cdot in$	Length between Inflection Points for strong axis buckling from computer model
$K_y := 0.7$	For weak axis buckling
$L_y = 66 \cdot in$	Length for weak axis buckling
$L_b := L_y$	Length between Bracing Points (compression flange restrained from twisting or moving laterally)

Selected Ratios :

$\frac{b_w}{t_w} = 16$ $\quad \frac{b_f}{t_f} = 16$ $\quad \frac{R_b}{t_f} = 0$ $\quad \frac{K_x \cdot L_x}{r_x} = 99.4$ $\quad \frac{K_y \cdot L_y}{r_y} = 69.6$ $\quad \frac{L_b \cdot S_x}{0.5\sqrt{I_y \cdot J}} = 93.3$

The following allowable stresses are based on values from the "2005 Aluminum Design Manual"

Allowable Axial Stress:

Specification 3.4.1 - Tension, axial: Any tension member.		$F_{3.4.1} = 32.3 \cdot ksi$	$F_{3.4.1} = 222.7 \cdot MPa$
Specification 3.4.7 - Compression in Columns: All columns.		$F_{3.4.7x} = 8.49 \cdot ksi$	$F_{3.4.7x} = 58.5 \cdot MPa$
		$F_{3.4.7y} = 15.71 \cdot ksi$	$F_{3.4.7y} = 108.3 \cdot MPa$
Specification 3.4.9 - Compression in Column Elements: Flat elements supported on both edges.		$F_{3.4.9} = 31.74 \cdot ksi$	$F_{3.4.9} = 218.8 \cdot MPa$
Specification 3.4.10 - Compression in Column Elements: Curved elements supported on both edges.		$F_{3.4.10} = 33.25 \cdot ksi$	$F_{3.4.10} = 229.3 \cdot MPa$
Allowable Axial Stress:	Use in Eq. 4.1.1-1	$F_a = 8.49 \cdot ksi$	$F_a = 58.5 \cdot MPa$
	Use in Eq. 4.1.1-2	$F_{ao} = 31.74 \cdot ksi$	$F_{ao} = 218.8 \cdot MPa$
		$F_{ex} = 8.49 \cdot ksi$	$F_{ex} = 58.5 \cdot MPa$
		$F_{ey} = 15.71 \cdot ksi$	$F_{ey} = 108.3 \cdot MPa$

Allowable Bending Stress:

Specification 3.4.2 - Tension in Beams, extreme fibre, net section: Flat elements in uniform tension (flanges).		$F_{3.4.2} = 32.3 \cdot ksi$	$F_{3.4.2} = 222.7 \cdot MPa$
Specification 3.4.14 - Compression in Beams, gross section.: Tubular shapes.		$F_{3.4.14} = 30.23 \cdot ksi$	$F_{3.4.14} = 208.4 \cdot MPa$
Specification 3.4.16 - Compression in Beams, gross section: Flat elements supported on both edges.		$F_{3.4.16} = 31.74 \cdot ksi$	$F_{3.4.16} = 218.8 \cdot MPa$
Specification 3.4.16.1 - Compression in Beams, gross section: Curved elements supported on both edges.		$F_{3.4.16.1} = 38.9 \cdot ksi$	$F_{3.4.16.1} = 268.2 \cdot MPa$
Specification 3.4.19 - Compression in Beams, elements: Flat elements supported on both edges with longitudinal stiffening.		$F_{3.4.19} = 43.22 \cdot ksi$	$F_{3.4.19} = 298 \cdot MPa$
Allowable Bending Stress:	Use in Eq. 4.1.1-1 & Eq. 4.1.1-2	$F_{bx} = 30.23 \cdot ksi$	$F_{bx} = 208.4 \cdot MPa$
		$F_{by} = 30.23 \cdot ksi$	$F_{by} = 208.4 \cdot MPa$

Allowable Shear Stress:

Specification 3.4.20 - Shear in Elements, gross section: Unstiffened flat elements supported on both edges.	$F_{3.4.20} = 19.2 \cdot ksi$	$F_{3.4.20} = 132.4 \cdot MPa$

Actual Stress:

Member ID = "Eb101" $Mx = 0.02 \cdot kip \cdot in$ $My = 0 \cdot kip \cdot in$ $C = -2.21 \cdot kip$

Load Case = "4b - 1.2D1±0.5Lr±1.0W2"

$Cmx := 0.85$

$Cmy := 0.85$

$f_{bx} := \left| \frac{Mx}{S_x} \right|$ $f_{by} := \frac{My}{S_y}$ $f_{ac} := \left| \frac{C}{A_g} \right|$

$f_{bx} = 0.1 \cdot ksi$ $f_{by} = 0.0 \cdot ksi$ $f_{ac} = 3.0 \cdot ksi$

$f_{bx} = 0.5 \cdot MPa$ $f_{by} = 0.0 \cdot MPa$ $f_{ac} = 20.7 \cdot MPa$

Eq. 4.1.1-1 :

$$Eq1 := \frac{f_{ac}}{F_a} + \frac{Cmx \cdot f_{bx}}{\left(1 - \frac{f_{ac}}{F_{ex}}\right) \cdot F_{bx}} + \frac{Cmy \cdot f_{by}}{\left(1 - \frac{f_{ac}}{F_{ey}}\right) \cdot F_{by}}$$

$Eq1 = 0.36$

Eq1 is less than or equal to 1.0 = "OK"

Eq. 4.1.1-2 :

$$Eq2 := \frac{f_{ac}}{F_{ao}} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}}$$

$Eq2 = 0.1$

Eq2 is less than or equal to 1.0 = "OK"

Member ID = "Eb101" $Mx = 0.02 \cdot kip \cdot in$ $My = 0 \cdot kip \cdot in$ $T = 5.42 \cdot kip$

Load Case = "6c - 0.9D1±1.0W3"

$f_{bx} := \left| \frac{Mx}{S_x} \right|$ $f_{by} := \frac{My}{S_y}$ $f_{at} := \frac{T}{A_g}$

$f_{bx} = 0.1 \cdot ksi$ $f_{by} = 0 \cdot ksi$ $f_{at} = 7.4 \cdot ksi$

$f_{bx} = 0.4 \cdot MPa$ $f_{by} = 0 \cdot MPa$ $f_{at} = 50.8 \cdot MPa$

Eq. 4.1.2-1 :

$$Eq3 := \frac{f_{at}}{F_{3.4.1}} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}}$$

$Eq3 = 0.23$

Eq3 is less than or equal to 1.0 = "OK"

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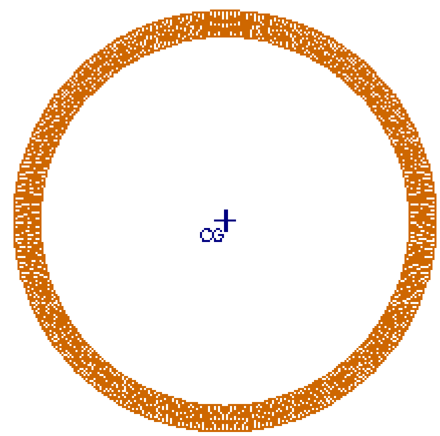
5c. Ridge Brace Profile Design

Section Properties :



$E = 10100 \cdot ksi$	Table 3.3-1
$n_u = 1.95$	Table 3.4-1

<u>main extrusion</u>

$A_g = 0.736 \cdot in^2$	Cross-sectional area of Shape
$b_w = 2.000 \cdot in$	Web length of Shape
$t_w = 0.125 \cdot in$	Web thickness
$b_f = 2.000 \cdot in$	Flat flange
$t_f = 0.125 \cdot in$	Flange thickness
$I_x = 0.32 \cdot in^4$	Moment of inertia about strong axis
$I_y = 0.32 \cdot in^4$	Moment of inertia about weak axis
$S_x = 0.32 \cdot in^3$	Section Modulus about strong axis
$S_y = 0.32 \cdot in^3$	Section Modulus about weak axis
$r_x = 0.66 \cdot in$	Radius of Gyration about strong axis
$r_y = 0.66 \cdot in$	Radius of Gyration about weak axis
$J = 0.65 \cdot in^4$	Torsional constant
$K_x := 1.0$	For strong axis buckling
$L_x = 54.4 \cdot in$	Length between Inflection Points for strong axis buckling from computer model
$K_y := 0.7$	For weak axis buckling
$L_y = 54.4 \cdot in$	Length for weak axis buckling
$L_b := L_y$	Length between Bracing Points (compression flange restrained from twisting or moving laterally)

Selected Ratios :

$\frac{b_w}{t_w} = 16$ $\quad \frac{b_f}{t_f} = 16$ $\quad \frac{R_b}{t_f} = 0$ $\quad \frac{K_x \cdot L_x}{r_x} = 81.9$ $\quad \frac{K_y \cdot L_y}{r_y} = 57.3$ $\quad \frac{L_b \cdot S_x}{0.5\sqrt{I_y \cdot J}} = 76.9$

The following allowable stresses are based on values from the "2005 Aluminum Design Manual"

Allowable Axial Stress:

Specification 3.4.1 - Tension, axial: $F_{3.4.1} = 32.3 \cdot ksi$ $F_{3.4.1} = 222.7 \cdot MPa$
Any tension member.

Specification 3.4.7 - Compression in Columns: $F_{3.4.7x} = 11.81 \cdot ksi$ $F_{3.4.7x} = 81.5 \cdot MPa$
All columns.
$F_{3.4.7y} = 30.28 \cdot ksi$ $F_{3.4.7y} = 208.8 \cdot MPa$

Specification 3.4.9 - Compression in Column Elements: $F_{3.4.9} = 31.74 \cdot ksi$ $F_{3.4.9} = 218.8 \cdot MPa$
Flat elements supported on both edges.

Specification 3.4.10 - Compression in Column Elements: $F_{3.4.10} = 33.25 \cdot ksi$ $F_{3.4.10} = 229.3 \cdot MPa$
Curved elements supported on both edges.

Allowable Axial Stress:

Use in Eq. 4.1.1-1 $F_a = 11.81 \cdot ksi$ $F_a = 81.5 \cdot MPa$

Use in Eq. 4.1.1-2 $F_{ao} = 31.74 \cdot ksi$ $F_{ao} = 218.8 \cdot MPa$

$F_{ex} = 11.81 \cdot ksi$ $F_{ex} = 81.5 \cdot MPa$

$F_{ey} = 23.49 \cdot ksi$ $F_{ey} = 162 \cdot MPa$

Allowable Bending Stress:

Specification 3.4.2 - Tension in Beams, extreme fibre, net section: $F_{3.4.2} = 32.3 \cdot ksi$ $F_{3.4.2} = 222.7 \cdot MPa$
Flat elements in uniform tension (flanges).

Specification 3.4.14 - Compression in Beams, gross section.: $F_{3.4.14} = 30.53 \cdot ksi$ $F_{3.4.14} = 210.5 \cdot MPa$
Tubular shapes.

Specification 3.4.16 - Compression in Beams, gross section: $F_{3.4.16} = 31.74 \cdot ksi$ $F_{3.4.16} = 218.8 \cdot MPa$
Flat elements supported on both edges.

Specification 3.4.16.1 - Compression in Beams, gross section: $F_{3.4.16.1} = 38.9 \cdot ksi$ $F_{3.4.16.1} = 268.2 \cdot MPa$
Curved elements supported on both edges.

Specification 3.4.19 - Compression in Beams, elements: $F_{3.4.19} = 43.22 \cdot ksi$ $F_{3.4.19} = 298 \cdot MPa$
Flat elements supported on both edges with longitudinal stiffening.

Allowable Bending Stress:

Use in Eq. 4.1.1-1 & Eq. 4.1.1-2 $F_{bx} = 30.53 \cdot ksi$ $F_{bx} = 210.5 \cdot MPa$

$F_{by} = 30.53 \cdot ksi$ $F_{by} = 210.5 \cdot MPa$

Allowable Shear Stress:

Specification 3.4.20 - Shear in Elements, gross section: $F_{3.4.20} = 19.2 \cdot ksi$ $F_{3.4.20} = 132.4 \cdot MPa$
Unstiffened flat elements supported on both edges.

Actual Stress:

Member ID = "Pb101" $Mx = 0.04 \cdot kip \cdot in$ $My = 0 \cdot kip \cdot in$ $C = -0.38 \cdot kip$

Load Case = "1a - 1.4D1"

$Cmx := 0.85$

$Cmy := 0.85$

$f_{bx} := \left|\frac{Mx}{S_x}\right|$ $f_{by} := \frac{My}{S_y}$ $f_{ac} := \left|\frac{C}{A_g}\right|$

$f_{bx} = 0.1 \cdot ksi$ $f_{by} = 0.0 \cdot ksi$ $f_{ac} = 0.5 \cdot ksi$

$f_{bx} = 0.8 \cdot MPa$ $f_{by} = 0.0 \cdot MPa$ $f_{ac} = 3.5 \cdot MPa$

Eq. 4.1.1-1 : $Eq1 := \frac{f_{ac}}{F_a} + \frac{Cmx \cdot f_{bx}}{\left(1 - \frac{f_{ac}}{F_{ex}}\right) \cdot F_{bx}} + \frac{Cmy \cdot f_{by}}{\left(1 - \frac{f_{ac}}{F_{ey}}\right) \cdot F_{by}}$

$Eq1 = 0.05$

Eq1 is less than or equal to 1.0 = "OK"

Eq. 4.1.1-2 : $Eq2 := \frac{f_{ac}}{F_{ao}} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}}$

$Eq2 = 0.02$

Eq2 is less than or equal to 1.0 = "OK"

Member ID = "Pb101" $Mx = 0.02 \cdot kip \cdot in$ $My = 0 \cdot kip \cdot in$ $T = 5.85 \cdot kip$

Load Case = "6c - 0.9D1±1.0W3"

$f_{bx} := \left|\frac{Mx}{S_x}\right|$ $f_{by} := \frac{My}{S_y}$ $f_{at} := \frac{T}{A_g}$

$f_{bx} = 0.1 \cdot ksi$ $f_{by} = 0 \cdot ksi$ $f_{at} = 7.9 \cdot ksi$

$f_{bx} = 0.5 \cdot MPa$ $f_{by} = 0 \cdot MPa$ $f_{at} = 54.8 \cdot MPa$

Eq. 4.1.2-1 : $Eq3 := \frac{f_{at}}{F_{3.4.1}} + \frac{f_{bx}}{F_{bx}} + \frac{f_{by}}{F_{by}}$

$Eq3 = 0.25$

Eq3 is less than or equal to 1.0 = "OK"

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6. Cables

Bracing Cables

- The bracing cables are constructed of 1/4" 7x19 Galvanized Improved Plow IWRC wire rope.

Nominal Strength of Cable : $\text{Cable Capacity} = 6800 \cdot \text{lbf}$

Recommended Safety Factor is : $\text{Safety Factor} = 2$

The maximum force in the wind bracing is $T_{max} = 883 \cdot \text{lbf}$.

$$T_{max} \text{ is less than or equal to } \left[\frac{0.75(\text{Cable Capacity})}{\text{Safety Factor}}\right] = \text{"OK"}$$

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APPENDIX A

COMPUTER MODEL INPUT

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Project: Future Trac 40 ft 100C2I0

Table of Contents

Model Summary

Structure Type: Plane Frame
14 Nodes, and 34 Degrees of Freedom
17 Member Elements
The model is non-linear.
The size of the model is:
576 in, in the X direction
219 in, in the Y direction

Nodes

Node	X	Y	Fix DX	Fix DY	Fix RZ
	in	in			
G101	-288.000	0.000	Yes	Yes	No
G102	288.000	0.000	Yes	Yes	No
N101	-240.000	78.000	No	No	No
N102	-240.000	96.000	No	No	No
N103	-199.510	116.800	No	No	No
N104	-32.900	202.264	No	No	No
N105	0.000	219.000	No	No	No
N106	32.900	202.264	No	No	No
N107	199.510	116.800	No	No	No
N108	240.000	96.000	No	No	No
N109	240.000	78.000	No	No	No
N110	-26.456	205.542	No	No	No
S101	-240.000	0.000	Yes	Yes	No
S102	240.000	0.000	Yes	Yes	No

Material Properties

Material	Strength	Elasticity	Poisson	Density	Therm. Coeff.
	psi	psi		lb/in^3	in/in/deg-F
6005-T5-E	35000.0000	10100000.0000	0.330000	0.0970	0.0000
Weightless Steel (Fy = 50ksi)	50000.0000	29000000.0000	0.290000	0.0000	6.3890e-006

OneWay Members

Member	One Way	Section	Material	(1)Node	(2)Node
Cb101	Tension only	Round 0.625	Weightless Steel (Fy = 50ksi)	N102	N108
Gy101	Tension only	Round 0.625	Weightless Steel (Fy = 50ksi)	G101	N102
Gy102	Tension only	Round 0.625	Weightless Steel (Fy = 50ksi)	N108	G102

Nodal Supports

Node	Fix DX	Fix DY	Fix RZ
G101	Yes	Yes	No
G102	Yes	Yes	No
S101	Yes	Yes	No
S102	Yes	Yes	No

Service Load Cases

Load Case	Self Weight
D1	Standard
Lr	None
W1	None
W2	None
W3	None
W4	None
W5	None

Load Cases

Load Case
(1)D1
(17)Lr
(28)W1
(29)W2
(30)W3
(31)W4
(32)W5
(39)1a - 1.4D1
(40)2a - 1.2D1±0.5Lr
(41)2a - 1.2D1±0.5S1
(42)3a - 1.2D1±1.6Lr±0.5W1
(43)3b - 1.2D1±1.6Lr±0.5W2
(44)3c - 1.2D1±1.6Lr±0.5W3
(45)3d - 1.2D1±1.6Lr±0.5W4
(46)3e - 1.2D1±1.6Lr±0.5W5
(47)3f - 1.2D1±0.5W1
(48)3g - 1.2D1±0.5W2
(49)3h - 1.2D1±0.5W3
(50)3i - 1.2D1±0.5W4
(51)3j - 1.2D1±0.5W5
(52)4a - 1.2D1±0.5Lr±1.0W1
(53)4b - 1.2D1±0.5Lr±1.0W2
(54)4c - 1.2D1±0.5Lr±1.0W3
(55)4d - 1.2D1±0.5Lr±1.0W4
(56)4e - 1.2D1±0.5Lr±1.0W5
(57)4p - 1.2D1±1.0W1
(58)4q - 1.2D1±1.0W2
(59)4r - 1.2D1±1.0W3
(60)4s - 1.2D1±1.0W4
(61)4t - 1.2D1±1.0W5
(62)6a - 0.9D±1.0W1
(63)6b - 0.9D1±1.0W2
(64)6c - 0.9D1±1.0W3
(65)6d - 0.9D1±1.0W4
(66)6e - 0.9D1±1.0W5

Load Combination Summary

Factored Combination: 1a - 1.4D1
Scale factor = 1.00
Factor : Service Case
1.40 x D1

Factored Combination: 2a - 1.2D1±0.5Lr
Scale factor = 1.00
Factor : Service Case
1.20 x D1
0.50 x Lr

Factored Combination: 2a - 1.2D1±0.5S1
Scale factor = 1.00
Factor : Service Case

1.20 x D1
Factored Combination: 3a - 1.2D1±1.6Lr±0.5W1
Scale factor = 1.00
Factor : Service Case
1.20 x D1
1.60 x Lr
0.50 x W1
Factored Combination: 3b - 1.2D1±1.6Lr±0.5W2
Scale factor = 1.00
Factor : Service Case
1.20 x D1
1.60 x Lr
0.50 x W2
Factored Combination: 3c - 1.2D1±1.6Lr±0.5W3
Scale factor = 1.00
Factor : Service Case
1.20 x D1
1.60 x Lr
0.50 x W3
Factored Combination: 3d - 1.2D1±1.6Lr±0.5W4
Scale factor = 1.00
Factor : Service Case
1.20 x D1
1.60 x Lr
0.50 x W4
Factored Combination: 3e - 1.2D1±1.6Lr±0.5W5
Scale factor = 1.00
Factor : Service Case
1.20 x D1
1.60 x Lr
0.50 x W5
Factored Combination: 3f - 1.2D1±0.5W1
Scale factor = 1.00
Factor : Service Case
1.20 x D1
0.50 x W1
Factored Combination: 3g - 1.2D1±0.5W2
Scale factor = 1.00
Factor : Service Case
1.20 x D1
0.50 x W2
Factored Combination: 3h - 1.2D1±0.5W3
Scale factor = 1.00
Factor : Service Case
1.20 x D1
0.50 x W3
Factored Combination: 3i - 1.2D1±0.5W4
Scale factor = 1.00
Factor : Service Case
1.20 x D1
0.50 x W4
Factored Combination: 3j - 1.2D1±0.5W5
Scale factor = 1.00
Factor : Service Case
1.20 x D1
0.50 x W5
Factored Combination: 4a - 1.2D1±0.5Lr±1.0W1
Scale factor = 1.00
Factor : Service Case
1.20 x D1
0.50 x Lr
1.00 x W1

Factored Combination: 4b - 1.2D1±0.5Lr±1.0W2
Scale factor = 1.00
Factor : Service Case
1.20 x D1
0.50 x Lr
1.00 x W2
Factored Combination: 4c - 1.2D1±0.5Lr±1.0W3
Scale factor = 1.00
Factor : Service Case
1.20 x D1
0.50 x Lr
1.00 x W3
Factored Combination: 4d - 1.2D1±0.5Lr±1.0W4
Scale factor = 1.00
Factor : Service Case
1.20 x D1
0.50 x Lr
1.00 x W4
Factored Combination: 4e - 1.2D1±0.5Lr±1.0W5
Scale factor = 1.00
Factor : Service Case
1.20 x D1
0.50 x Lr
1.00 x W5
Factored Combination: 4p - 1.2D1±1.0W1
Scale factor = 1.00
Factor : Service Case
1.20 x D1
1.00 x W1
Factored Combination: 4q - 1.2D1±1.0W2
Scale factor = 1.00
Factor : Service Case
1.20 x D1
1.00 x W2
Factored Combination: 4r - 1.2D1±1.0W3
Scale factor = 1.00
Factor : Service Case
1.20 x D1
1.00 x W3
Factored Combination: 4s - 1.2D1±1.0W4
Scale factor = 1.00
Factor : Service Case
1.20 x D1
1.00 x W4
Factored Combination: 4t - 1.2D1±1.0W5
Scale factor = 1.00
Factor : Service Case
1.20 x D1
1.00 x W5
Factored Combination: 6a - 0.9D±1.0W1
Scale factor = 1.00
Factor : Service Case
0.90 x D1
1.00 x W1
Factored Combination: 6b - 0.9D1±1.0W2
Scale factor = 1.00
Factor : Service Case
0.90 x D1
1.00 x W2
Factored Combination: 6c - 0.9D1±1.0W3
Scale factor = 1.00

Factor : Service Case
0.90 x D1
1.00 x W3

Factored Combination: 6d - 0.9D1±1.0W4
Scale factor = 1.00
Factor : Service Case
0.90 x D1
1.00 x W4

Factored Combination: 6e - 0.9D1±1.0W5
Scale factor = 1.00
Factor : Service Case
0.90 x D1
1.00 x W5

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APPENDIX B

COMPUTER MODEL OUTPUT

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Project: Future Trac 40 ft 100C2I0

Table of Contents

Load Cases

Load Case
(1)D1
(17)Lr
(28)W1
(29)W2
(30)W3
(31)W4
(32)W5
(39)1a - 1.4D1
(40)2a - 1.2D1±0.5Lr
(41)2a - 1.2D1±0.5S1
(42)3a - 1.2D1±1.6Lr±0.5W1
(43)3b - 1.2D1±1.6Lr±0.5W2
(44)3c - 1.2D1±1.6Lr±0.5W3
(45)3d - 1.2D1±1.6Lr±0.5W4
(46)3e - 1.2D1±1.6Lr±0.5W5
(47)3f - 1.2D1±0.5W1
(48)3g - 1.2D1±0.5W2
(49)3h - 1.2D1±0.5W3
(50)3i - 1.2D1±0.5W4
(51)3j - 1.2D1±0.5W5
(52)4a - 1.2D1±0.5Lr±1.0W1
(53)4b - 1.2D1±0.5Lr±1.0W2
(54)4c - 1.2D1±0.5Lr±1.0W3
(55)4d - 1.2D1±0.5Lr±1.0W4
(56)4e - 1.2D1±0.5Lr±1.0W5
(57)4p - 1.2D1±1.0W1
(58)4q - 1.2D1±1.0W2
(59)4r - 1.2D1±1.0W3
(60)4s - 1.2D1±1.0W4
(61)4t - 1.2D1±1.0W5
(62)6a - 0.9D±1.0W1
(63)6b - 0.9D1±1.0W2
(64)6c - 0.9D1±1.0W3
(65)6d - 0.9D1±1.0W4
(66)6e - 0.9D1±1.0W5

Member Extreme Results

Member	Fx (lc)	Vy (lc)	Mz (lc)
	lb	lb	lb-in
Cb101	29 (31)	-0 (32)	-0 (32)
Cb101	2023 (56)	0 (31)	0 (31)
Eb101	-2216 (53)	-2 (39)	-0 (53)
Eb101	5579 (30)	2 (39)	28 (39)
Eb102	-238 (39)	-2 (39)	-0 (52)
Eb102	4421 (28)	2 (39)	28 (39)
Gy101	47 (49)	-0 (56)	-0 (56)
Gy101	**7257 (32)**	0 (49)	0 (49)
Gy102	129 (28)	-0 (28)	-0 (28)
Gy102	2972 (30)	0 (30)	0 (30)
M101	**-6761 (56)**	-604 (56)	-15235 (53)
M101	2284 (54)	1033 (30)	53289 (30)

M102	-5648 (56)	**-2995 (30)**	-15235 (53)
M102	-81 (1)	998 (53)	**53289 (30)**
M103	-2992 (54)	-293 (53)	-9805 (53)
M103	2359 (29)	529 (30)	12092 (30)
M104	-995 (46)	-1065 (30)	**-33738 (30)**
M104	2652 (30)	1253 (30)	29664 (30)
M105-2	-2442 (54)	-1218 (30)	-2192 (39)
M105-2	153 (61)	85 (39)	29664 (30)
M105-3	-2440 (54)	-1129 (30)	-8880 (30)
M105-3	135 (61)	81 (39)	21850 (28)
M106	-2269 (54)	-189 (58)	-8880 (30)
M106	58 (39)	1526 (30)	42125 (30)
M107	-1464 (46)	-946 (30)	-26009 (28)
M107	2827 (30)	815 (28)	42125 (30)
M108	-2580 (52)	-448 (28)	-2141 (55)
M108	1028 (31)	171 (54)	11327 (28)
M109	-2309 (30)	-206 (46)	-2480 (39)
M109	-81 (1)	**2350 (28)**	41121 (28)
M110	-1386 (55)	-842 (28)	-10099 (56)
M110	1792 (28)	518 (56)	41121 (28)
Pb101	-339 (39)	-3 (39)	-0 (65)
Pb101	5431 (30)	3 (39)	54 (39)

Nodal Extreme Reactions

Node	FX	FY	MZ
	lb	lb	lb-in
G101	**-3245.2384 (32)**	**-6490.4768 (32)**	**-NA-**
G101	0.0000 (1)	0.0000 (1)	-NA-
G102	0.0000 (1)	-2658.5650 (30)	-NA-
G102	**1329.2825 (30)**	0.0000 (1)	-NA-
S101	-464.4330 (32)	-2239.5017 (54)	-NA-
S101	31.7994 (39)	**6760.8125 (56)**	-NA-
S102	-518.3043 (56)	-1791.6044 (28)	-NA-
S102	212.4661 (28)	1385.6386 (55)	-NA-

Nodal Extreme Displacements

Node	DX	DY
	in	in
G101	-NA-	-NA-
G101	-NA-	-NA-
G102	-NA-	-NA-
G102	-NA-	-NA-
N101	-0.0280 (40)	-0.0252 (56)
N101	0.3975 (30)	0.0084 (54)
N102	-0.0919 (55)	-0.0300 (56)
N102	0.2556 (56)	0.0072 (54)
N103	**-0.5205 (54)**	-0.2967 (53)
N103	0.3160 (56)	**1.0142 (30)**
N104	-0.3544 (55)	**-0.6771 (53)**
N104	0.4934 (53)	0.6973 (30)
N105	-0.0845 (55)	-0.1346 (56)
N105	0.3134 (56)	0.1538 (28)
N106	-0.3328 (55)	-0.5038 (55)
N106	0.4968 (53)	0.7502 (28)
N107	-0.1037 (55)	-0.0741 (55)
N107	**0.5499 (52)**	0.7829 (28)
N108	-0.0885 (30)	-0.0063 (55)
N108	0.3648 (56)	0.0056 (28)
N109	-0.2846 (28)	-0.0051 (55)
N109	0.3624 (56)	0.0067 (28)

N110	-0.2981 (55)	-0.5693 (53)
N110	0.4384 (53)	0.5666 (30)
S101	-NA-	-NA-
S101	-NA-	-NA-
S102	-NA-	-NA-
S102	-NA-	-NA-

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