CLARK REDER
ENGINEERING

7/25/2022

Christie Lites
9479 Eunice Avenue
Orlando, FL 32808
Attn: Paul Elkin

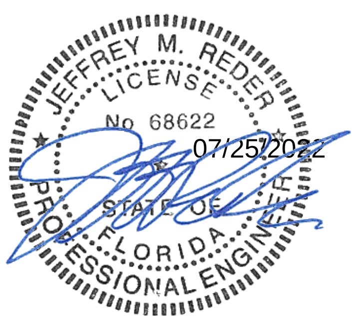
RE: Christie Lites Type B Truss
CRE Project No.: 22.915.01

Dear Paul:

Clark Reder Engineering Inc. has completed our structural review of the Christie Lites Type B aluminum box truss. Clark Reder Engineering Inc. created load tables for spans of 8’ up to 48’ per the requirements set forth in the 2020 Aluminum Design Manual, ANSI E1.2-2021, Entertainment Technology, Design, Manufacture and Use of Aluminum Truss and Towers as well as Eurocode 9. Attached please find the allowable loading tables for your use.

We trust this information is sufficient for your needs at this time. Please do not hesitate to contact our office should you have any questions or require additional information.

Regards,
Clark-Reder Engineering, Inc.



Jeffrey M. Reder, P.E.
FL Registration #:68622

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Daniel J. Clark, P.E. P.E. # 14355	Daniel J. Clark, S.E. P.E. # S5317	Jeffrey M. Reder, P.E. P.E. # PE0051394
Connecticut	**Delaware**	**District of Columbia**
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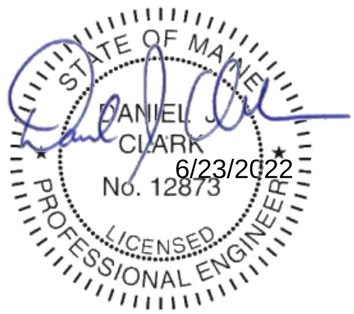
Idaho	**Illinois**	**Indiana**
6/23/2022	6/23/2022 Clark Reder Engineering, Inc. is a professional design firm registered in Illinois #184.006693	6/23/2022
Daniel J. Clark, P.E. P.E. # 14947	Jeffrey M. Reder, S.E. P.E. # 81006866	Jeffrey M. Reder, P.E. P.E. # PE11600603
Iowa	**Kansas**	**Kentucky**
6/23/2022	6/23/2022	6/23/2022
Jeffrey M. Reder, P.E. P.E. # 19998	Daniel J. Clark, P.E. P.E. # 21809	Jeffrey M. Reder, P.E. P.E. # 23597

Louisiana

Jeffrey M. Reder, P.E.
P.E. # 30304

Maine



Daniel J. Clark, P.E.
P.E. # 12873

Maryland

Professional Certification: I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland.
License # 38421 Expiration Date: 01/29/2022

Jeffrey M. Reder, P.E.
P.E. # 38421

Massachusetts

Jeffrey M. Reder, P.E.
P.E. # 48535

Michigan

Jeffrey M. Reder, P.E.
P.E. # 6201056952

Minnesota

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Minnesota.

Signature: ____________
Typed or Printed Name: JEFFREY M. REDER
Date: 6/23/2022 License #: 56104

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New Jersey

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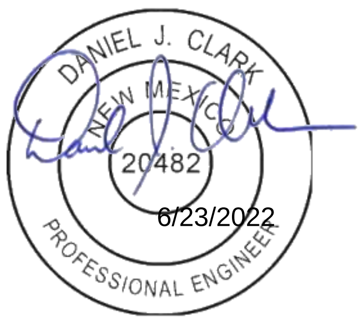
New Mexico



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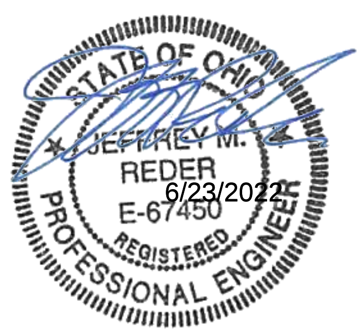

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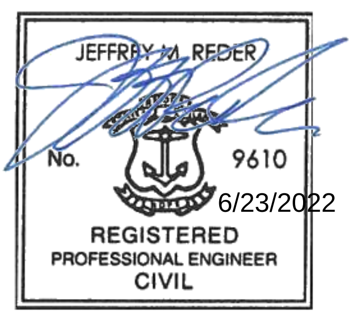

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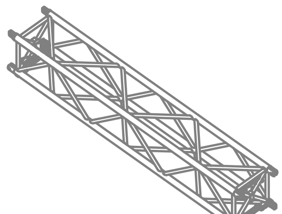
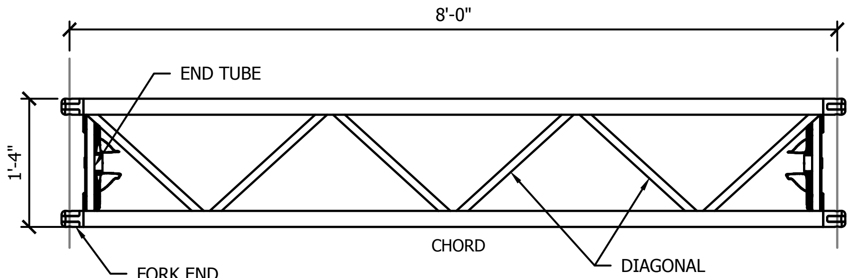
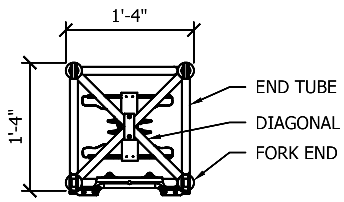


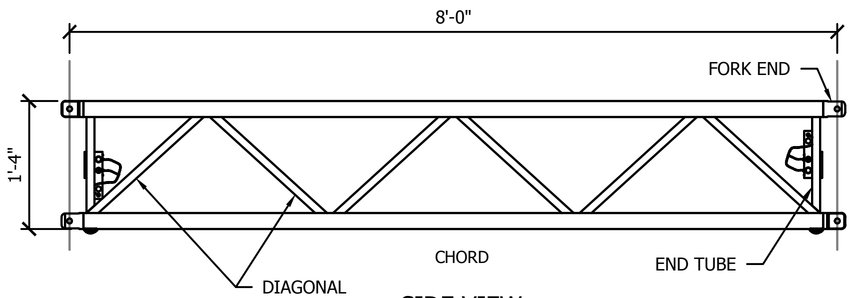
3D VIEW



TOP VIEW



END VIEW



SIDE VIEW

CHRISTIE LITES B-TYPE TRUSS TABLE

TRUSS SPAN	UNIFORMLY DISTRIBUTED LOAD			CENTER POINT LOAD		THIRD POINT LOAD		QUARTER POINT LOAD	
	LOAD	TOTAL LOAD	DEFLECTION	LOAD	DEFLECTION	LOAD	DEFLECTION	LOAD	DEFLECTION
8'-0"	1,028 lb/ft	8,224 lbs	0.065 in	6,884 lbs	0.087 in	4,113 lbs	0.090 in	3,442 lbs	0.104 in
16-0"	424 lb/ft	6,784 lbs	0.433 in	3,395 lbs	0.351 in	2,547 lbs	0.449 in	1,698 lbs	0.416 in
24-0"	184 lb/ft	4,416 lbs	0.975 in	2,212 lbs	0.794 in	1,659 lbs	1.009 in	1,106 lbs	0.938 in
32-0"	100 lb/ft	3,200 lbs	1.733 in	1,605 lbs	1.422 in	1,204 lbs	1.792 in	802 lbs	1.669 in
40'-0"	60 lb/ft	2,400 lbs	2.671 in	1,228 lbs	2.243 in	868 lbs	2.654 in	614 lbs	2.612 in
48'-0"	32 lb/ft	1,536 lbs	3.205 in	942 lbs	3.200 in	547 lbs	3.186 in	396 lbs	3.200 in

PARTS LIST

DIAGONALS	1"øx1/8" TUBE
CHORDS	2"øx1/8" TUBE
END TUBE	1"øx1/8" TUBE
FORK ENDS	ALUMINUM

NOTES:
1. ALL ALUMINUM IS 6082-T6 OR 6061-T6
2. ALL WELD FILLER IS 4043

TABLE USAGE NOTES:
1. THE TRUSS IS SUPPORTING VERTICAL LOADS ONLY, I.E. THE TRUSS LADDERS ARE ORIENTED VERTICALLY AND NO LATERAL LOADS ARE APPLIED TO THE TRUSS.
2. THE TRUSS WAS ANALYZED AS A SIMPLE SPAN BEAM WITH SUPPORTS AT TRUSS ENDS ONLY.
3. THE TRUSS HAS BEEN ANALYZED FOR STATIC LOADS ONLY.
4. ALL LOADS ARE APPLIED CENTERED BETWEEN THE LADDERS.
5. ALL LOADS AND SUPPORTS ARE TO BE LOCATED AT THE PANEL POINTS OF THE TRUSS ONLY.
6. SELF WEIGHT HAS BEEN CONSIDERED IN THE ANALYSIS OF THE TRUSS.
7. MAXIMUM DEFLECTION LIMITED TO SPAN/180.
8. ALLOWABLE LOADS BASED ON 2020 ALUMINUM DESIGN MANUAL.

CHRISTIE LITES B-TYPE TRUSS

SINGLE USE

CLARK REDER ENGINEERING
10091 Mosteller Lane
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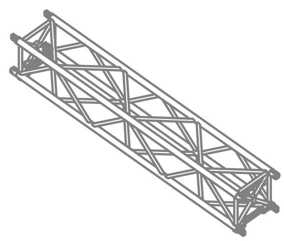
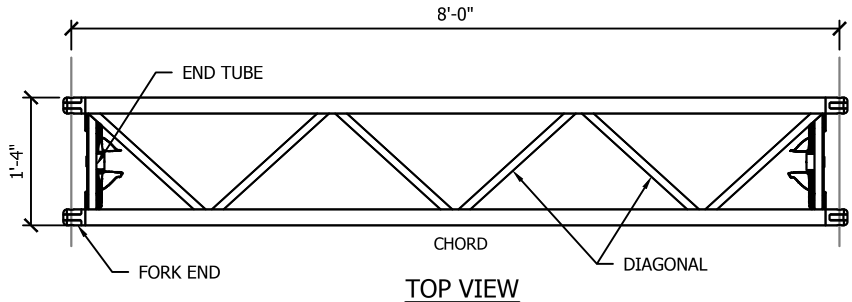
513 851 1223

TRUSS TABLE

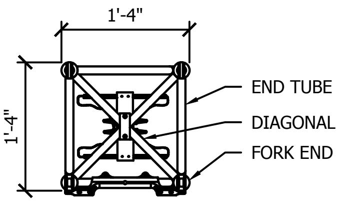
DATE: 6/23/2022
CRE PROJECT NO: 22.915.01
DRAWN BY: DBG/DDL



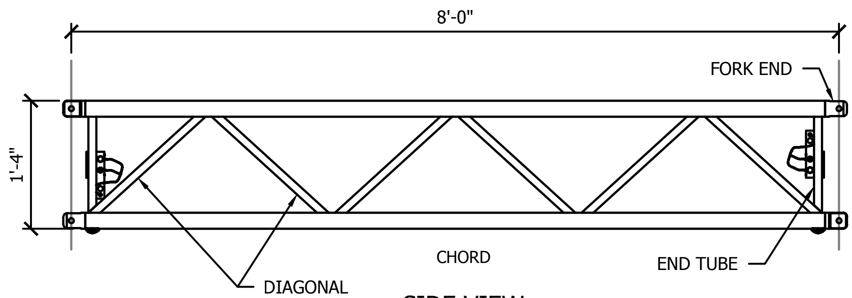
3D VIEW



TOP VIEW



END VIEW



SIDE VIEW

CHRISTIE LITES B-TYPE TRUSS TABLE

TRUSS SPAN	UNIFORMLY DISTRIBUTED LOAD			CENTER POINT LOAD		THIRD POINT LOAD		QUARTER POINT LOAD	
	LOAD	TOTAL LOAD	DEFLECTION	LOAD	DEFLECTION	LOAD	DEFLECTION	LOAD	DEFLECTION
8'-0"	874 lb/ft	6,992 lbs	0.055 in	5,851 lbs	0.074 in	3,496 lbs	0.076 in	2,926 lbs	0.088 in
16'-0"	361 lb/ft	5,776 lbs	0.369 in	2,886 lbs	0.299 in	2,165 lbs	0.383 in	1,443 lbs	0.355 in
24'-0"	157 lb/ft	3,768 lbs	0.835 in	1,880 lbs	0.681 in	1,410 lbs	0.864 in	940 lbs	0.803 in
32'-0"	85 lb/ft	2,720 lbs	1.492 in	1,364 lbs	1.227 in	1,023 lbs	1.542 in	682 lbs	1.437 in
40'-0"	52 lb/ft	2,080 lbs	2.347 in	1,044 lbs	1.952 in	783 lbs	2.423 in	522 lbs	2.266 in
48'-0"	32 lb/ft	1,536 lbs	3.205 in	822 lbs	2.871 in	547 lbs	3.186 in	336 lbs	2.814 in

PARTS LIST

PARTS LIST	
DIAGONALS	1"φx1/8" TUBE
CHORDS	2"φx1/8" TUBE
END TUBE	1"φx1/8" TUBE
FORK ENDS	ALUMINUM

NOTES:
1. ALL ALUMINUM IS 6082-T6 OR 6061-T6
2. ALL WELD FILLER IS 4043

TABLE USAGE NOTES:
1. THE TRUSS IS SUPPORTING VERTICAL LOADS ONLY, I.E. THE TRUSS LADDERS ARE ORIENTED VERTICALLY AND NO LATERAL LOADS ARE APPLIED TO THE TRUSS.
2. THE TRUSS WAS ANALYZED AS A SIMPLE SPAN BEAM WITH SUPPORTS AT TRUSS ENDS ONLY.
3. THE TRUSS HAS BEEN ANALYZED FOR STATIC LOADS ONLY.
4. ALL LOADS ARE APPLIED CENTERED BETWEEN THE LADDERS.
5. ALL LOADS AND SUPPORTS ARE TO BE LOCATED AT THE PANEL POINTS OF THE TRUSS ONLY.
6. SELF WEIGHT HAS BEEN CONSIDERED IN THE ANALYSIS OF THE TRUSS.
7. MAXIMUM DEFLECTION LIMITED TO SPAN/180.
8. ALLOWABLE LOADS BASED ON 2020 ALUMINUM DESIGN MANUAL. ALL CAPACITIES ARE REDUCED TO 0.85 PER ANSI E1.2-2020 FOR REPETITIVE USE MEMBERS

CHRISTIE LITES B-TYPE TRUSS

REPETITIVE USE

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TRUSS TABLE

DATE: 6/23/2022
CRE PROJECT NO: 22.915.01
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ST1.2

APPENDIX A

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Christie Lites Type B Truss

Design Codes and Standards

- Aluminum Design Manual, 2020 ed.
- Eurocode 9: Design of Aluminum Structures - EN 1999-1-1
- American Institute of Steel Construction, Steel Construction Manual 15th Edition
- ANSI E 1.2-2021 *"Manufacture and Use of Aluminum Trusses and Towers"*

Truss Description

The truss is a box truss fabricated from 6061-T6 aluminum members. The truss is 406mm deep x 406mm wide (16" deep x 16" wide.) The ladder chords will be composed of 2" x 1/8" thick pipes. The ladder diagonals, horizontals, and verticals will be composed of 1" x 1/8" thick pipes. The end members are composed of forked ends. The truss will be reviewed for lengths of 8'-0", up to 48'.

Analysis Assumptions

- The truss is supporting vertical loads only, i.e. the truss diagonals are oriented vertically and no lateral loads are applied to the truss.
- The truss is analyzed as a simple span beam. Truss support points are located at truss panel points.
- The truss will be analyzed for static loads only.
- All loads are applied at the centroid of the truss between the two ladder trusses below the truss.
- All loads are applied at the panel points of the truss as to not induce local bending stresses in the chords.

Conclusions and Recommendations

The truss load capacities are outlined in the truss tables in the front of this submittal. The load capacities listed are based on the assumptions listed above and included in the charts. Values are give both for single use and repetitive use which includes a factor of 0.85 per ANSI E1.2 - 2021. The truss capacities are based on the lowest values due to truss diagonal capacity, truss chord capacity and truss connection capacity.

6061-T6 Mechanical Properties

	Unwelded	Welded
Tension Yield Stress:	$F_{ty} := 35ksi$	$F_{tyw} := 15ksi$
Ultimate Tensile Stress:	$F_{tu} := 38ksi$	$F_{tuw} := 24ksi$
Compression Yield Stress:	$F_{cy} := 35ksi$	$F_{cyw} := 15ksi$
Shear yield stress:	$F_{sy} := 0.6 \cdot F_{ty} = 21 \cdot ksi$	$F_{syw} := 0.6 \cdot F_{tyw} = 9 \cdot ksi$
Ultimate shear stress:	$F_{su} := 24ksi$	$F_{suw} := 15ksi$
Tension coefficient:	$k_t := 1.0$	

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Truss Properties

Chords - 2"x1/8"

Outer diameter: $D_c := 2 \cdot in$ Wall thickness: $t_c := 0.125 \cdot in$

Inner diameter: $ID_c := D_c - 2 \cdot t_c = 0.146\,ft$

Area of tube: $A_c := \frac{\pi \cdot \left(D_c^{\,2} - ID_c^{\,2}\right)}{4} = 0.7363 \cdot in^2$

Polar moment: $J_c := \frac{\pi \cdot \left[\left(\frac{D_c}{2}\right)^4 - \left(\frac{ID_c}{2}\right)^4\right]}{2} = 0.65 \cdot in^4$

Moment of inertia: $I_c := \frac{\pi \cdot \left(D_c^{\,4} - ID_c^{\,4}\right)}{64} = 0.325 \cdot in^4$

Rb over t: $R\_t_c := \frac{\frac{D_c - t_c}{2}}{t_c} = 7.5$

Elastic section modulus: $S_c := \frac{\pi \cdot \left(D_c^{\,4} - ID_c^{\,4}\right)}{32 \cdot D_c} = 0.325 \cdot in^3$

Selfweight: $wt_c := A_c \cdot \gamma_a = 0.864 \cdot plf$

Radius of gyration: $r_c := \frac{\sqrt{D_c^{\,2} + ID_c^{\,2}}}{4} = 0.664 \cdot in$

Diagonals - 1"x1/8"

Outer diameter: $D_d := 1 \cdot in$ Wall thickness: $t_d := 0.125 \cdot in$

Inner diameter: $ID_d := D_d - 2 \cdot t_d = 0.063\,ft$

Area of tube: $A_d := \frac{\pi \cdot \left(D_d^{\,2} - ID_d^{\,2}\right)}{4} = 0.3436 \cdot in^2$

Polar moment: $J_d := \frac{\pi \cdot \left[\left(\frac{D_d}{2}\right)^4 - \left(\frac{ID_d}{2}\right)^4\right]}{2} = 0.067 \cdot in^4$

Moment of inertia: $I_d := \frac{\pi \cdot \left(D_d^{\,4} - ID_d^{\,4}\right)}{64} = 0.034 \cdot in^4$

Rb over t: $R\_t_d := \frac{\frac{D_d - t_d}{2}}{t_d} = 3.5$

Elastic section modulus: $S_d := \frac{\pi \cdot \left(D_d^{\,4} - ID_d^{\,4}\right)}{32 \cdot D_d} = 0.067 \cdot in^3$

Selfweight: $wt_d := A_d \cdot \gamma_a = 0.403 \cdot plf$

Radius of gyration: $r_d := \frac{\sqrt{D_d^{\,2} + ID_d^{\,2}}}{4} = 0.313 \cdot in$

Horizontals - 2"x1/8"

Outer diameter: $hv_d := 1 \cdot in$ Wall thickness: $t_{hv} := 0.125 \cdot in$

Inner diameter: $Ihv_d := hv_d - 2 \cdot t_{hv} = 0.063\,ft$

Area of tube: $A_{hv} := \dfrac{\pi \cdot \left(hv_d^{\,2} - Ihv_d^{\,2}\right)}{4} = 0.3436 \cdot in^2$

Polar moment: $J_{hv} := \dfrac{\pi \cdot \left[\left(\dfrac{hv_d}{2}\right)^4 - \left(\dfrac{Ihv_d}{2}\right)^4\right]}{2} = 0.067 \cdot in^4$

Moment of inertia: $I_{hv} := \dfrac{\pi \cdot \left(hv_d^{\,4} - Ihv_d^{\,4}\right)}{64} = 0.034 \cdot in^4$

Rb over t: $R\_t_{hv} := \dfrac{\dfrac{hv_d - t_{hv}}{2}}{t_{hv}} = 3.5$

Elastic section modulus: $S_{hv} := \dfrac{\pi \cdot \left(hv_d^{\,4} - Ihv_d^{\,4}\right)}{32 \cdot hv_d} = 0.067 \cdot in^3$

Selfweight: $wt_{hv} := A_{hv} \cdot \gamma_a = 0.403 \cdot plf$

Radius of gyration: $r_{hv} := \dfrac{\sqrt{hv_d^{\,2} + Ihv_d^{\,2}}}{4} = 0.313 \cdot in$

Global Truss Properties

Truss center of chord to center of chord depth: $d_{tr} := 16 \cdot in - D_c = 14 \cdot in$

Truss center of chord to center of chord width: $b_{tr} := 16in - D_c = 14 \cdot in$

Area of truss: $A_{tr} := 4 \cdot A_c$ $A_{tr} = 2.945 \cdot in^2$

Moment of inertia of truss: $I_{tr} := 4 \cdot \left[I_c + A_c \cdot \left(\dfrac{d_{tr}}{2}\right)^2\right]$ $I_{tr} = 145.617 \cdot in^4$ *strong axis*

Radius of gyration of truss: $r_{tr} := \sqrt{\dfrac{I_{tr}}{A_{tr}}}$ $r_{tr} = 7.031 \cdot in$

Modulus of Elasticity of truss: $E_{tr} := 10100 \cdot ksi$

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Diagonals

Axial Capacity

The vertical diagonals are 6061-T6 aluminum. Since no weld occurs outside of 5% of the member length the diag will be treated as non weld affected for compression buckling checks

Length of diagonals: $L_d := 17.795 \cdot in$ *distance between brace points.*

Axial tension - D.2a/b

Allowable stress on gross area (weld affected): $F_{t\_D2a\_w} := 9.1 \cdot ksi$

Allowable stress on net area(weld affected): $F_{t\_D2b\_net\_w} := 12.3 \cdot ksi$

Compression in diagonal - E.2

Slenderness: $S_{E2} := \frac{1.0 \cdot L_d}{r_d}$ $S_{E2} = 56.944$

Allowable stress:

$$F_{c\_E2\_d} := \begin{cases} 21.2ksi & \text{if } S_{E2} \le 17.8 \\ \left(.00047S_{E2}^{2} - 0.232S_{E2} + 25.2\right)ksi & \text{if } 17.8 < S_{E2} \le 66 \\ \frac{51352ksi}{S_{E2}^{2}} & \text{otherwise} \end{cases}$$

$F_{c\_E2\_d} = 13.513 \cdot ksi$

Compression in diagonal - B5.4.5 - WELD AFFECTED

Slenderness: $S_{B545} := \sqrt{R\_t_d}$ $S_{B545} = 1.871$

Allowable stress:

$$\left(F_{c\_B545\_d\_w}\right) := ksi \cdot \begin{cases} 9.1 & \text{if } S_{B545} \le 6.8 \\ \left(11.8 - 0.396 \cdot S_{B545}\right) & \text{if } 6.8 < S_{B545} < 20 \\ \frac{3776}{\left[S_{B545}^{2}\left(1 + \frac{S_{B545}}{35}\right)^{2}\right]} & \text{otherwise} \end{cases} = 9.1 \cdot ksi$$

$F_{c\_B545\_d\_w} = 9.1 \cdot ksi$

Diag tension stress (gross area): $F_t := F_{t\_D2a\_w} = 9.1 \cdot ksi$ $F_t = 9.1 \cdot ksi$

Diag compression stress: $F_c := \min\left(F_{c\_E2\_d}, F_{c\_B545\_d\_w}\right)$ $F_c = 9.1 \cdot ksi$

Diag tension capacity: $T_d := A_d \cdot F_t$ $T_d = 3.127 \cdot kip$

Diag compression capacity: $C_d := A_d \cdot F_c$ $C_d = 3.127 \cdot kip$

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Weld of Diagonal to Chord

Nominal stress of base metal corresponding to its welded ultimate strength, A3.3: $F_{nBM} := 15ksi$ Table A3.3

Nominal stress of weld metal corresponding to it ultimate strength, A3.6: $F_{nw} := 24ksi$ Table A3.6

Safety factor $n_u := 1.95$

Angle of diagonal to horizontal: $\theta_d := 41.5 \cdot deg$

Length of weld $L_{weld} := \pi \sqrt{2 \cdot \left[\left(\frac{D_d}{\sin(\theta_d)} \cdot 0.5 \right)^2 + (D_d \cdot 0.5)^2 \right]}$ *ellipse* $L_{weld} = 4.022 \cdot in$

Size of weld $S_w := \frac{3}{16} in$

Weld section modulus: $S_{weld} := (0.5 \cdot D_d)^2 \cdot \pi$ $S_{weld} = 0.785 \cdot \frac{in^3}{in}$ *assuming weld is round*

Effective throat of fillet weld $S_{we} := S_w \frac{\sqrt{2}}{2}$ $S_{we} = 0.1326 \cdot in$

Nominal weld stress: $F_{sw} := \min(0.6 \cdot F_{nBM} \cdot S_w \cdot L_{weld}, 0.6 \cdot 0.85 \cdot F_{nw} \cdot S_{we} \cdot L_{weld}) = 6.526 \cdot kip$

Allowable weld strength: $F_{weld} := \frac{F_{sw}}{n_u}$ $F_{weld} = 3.347 \cdot kip$

Capacity of diagonal: $P_{diag} := \min(T_d, C_d, F_{weld}) = 3.127 \cdot kip$

Chords

Axial Capacity

The chords are 6061-T6 aluminum. Diagonals are welded between brace points, treat chord as weld affected for compression buckling.

Length of chord $L_c := 28.58 \cdot in$ *distance between horizontals; top chord is weld affected at midspan due to diagonals*

Axial tension - D.2a/b

Allowable stress on gross area (weld affected): $F_{t\_D2a\_wc} := 9.1 \cdot ksi$

Allowable stress on net area(weld affected): $F_{t\_D2b\_net\_wc} := 12.3 \cdot ksi$

Compression in Chord - E.2 - WELD AFFECTED

Slenderness: $S_{E2c} := \frac{0.9 \cdot L_c}{r_c}$ $S_{E2c} = 38.716$

Allowable stress:

$$F_{c\_E2\_c\_wc} := \begin{cases} (9.1 \cdot ksi) & \text{if } S_{E2c} \le 21.8 \\ \left(0.00007 \cdot S_{E2c}^{2} - 0.066 \cdot S_{E2c} + 10.5\right) \cdot ksi & \text{if } 21.8 < S_{E2c} < 133 \\ \left(\dfrac{51352}{S_{E2c}^{2}}\right) \cdot ksi & \text{if } S_{E2c} \ge 133 \end{cases}$$

$F_{c\_E2\_c\_wc} = 8.05 \cdot ksi$

Compression in Chord - B5.4.5 - WELD AFFECTED

Slenderness: $S_{B545c} := \sqrt{R\_t_{c}}$ $S_{B545c} = 2.739$

Allowable stress:

$$F_{c\_B545\_c\_wc} := ksi \cdot \begin{cases} 9.1 & \text{if } S_{B545} \le 6.8 \\ (11.8 - 0.396 \cdot S_{B545}) & \text{if } 6.8 < S_{B545} < 20 \\ \dfrac{3776}{\left[S_{B545}^{2}\left(1 + \dfrac{S_{B545}}{35}\right)^{2}\right]} & \text{otherwise} \end{cases}$$

$F_{c\_B545\_c\_wc} = 9.1 \cdot ksi$

Chord tension stress: $F_{tc} := F_{t\_D2a\_wc} = 9.1 \cdot ksi$ $F_{tc} = 9.1 \cdot ksi$

Chord compression stress: $F_{cc} := \min(F_{c\_E2\_c\_wc}, F_{c\_B545\_c\_wc})$ $F_{cc} = 8.05 \cdot ksi$

Chord tension capacity: $T_{c} := A_{c} \cdot F_{tc}$ $T_{c} = 6.7 \cdot kip$

Chord compression capacity: $C_{c} := A_{c} \cdot F_{cc}$ $C_{c} = 5.927 \cdot kip$

Aluminum Forked End

6061-T6 Extrusion Mechanical Properties

	Unwelded	Welded
Tension Yield Stress:	$F_{ty} := 35ksi$	$F_{tyw} := 15ksi$
Ultimate Tensile Stress:	$F_{tu} := 38ksi$	$F_{tuw} := 24ksi$
Compression Yield Stress:	$F_{cy} := 35ksi$	$F_{cyw} := 15ksi$
Shear yield stress:	$F_{sy} := 0.6 \cdot F_{ty} = 21 \cdot ksi$	$F_{syw} := 0.6 \cdot F_{tyw} = 9 \cdot ksi$
Ultimate shear stress:	$F_{su} := 24ksi$	$F_{suw} := 15ksi$
Tension coefficient:	$k_t := 1.0$	
Thickness of fork:	$t_m := .69 \cdot in$	
Center of hole to edge:	$L_m := 1in$	
Center of hole to end:	$L_{m\_end} := 1.732 \cdot in$	
Height of plate:	$h_m := 2 \cdot in$	
Diameter of hole:	$d_{m\_hole} := .625 \cdot in$	

Axial tension - D.2a/b

Allowable stress gross section: $F_{t\_D.2\_a} := 21.2 \cdot ksi$

Allowable gross tension: $P_{m\_gross} := F_{t\_D.2\_a} \cdot t_m \cdot h_m$ $\quad P_{m\_gross} = 29.256 \cdot kip$

Allowable stress net section: $F_{t\_D.2\_b} := 19.5 \cdot ksi$

Allowable net tension: $P_{m\_net} := F_{t\_D.2\_b} \cdot t_m \cdot \left(h_m - d_{m\_hole} + \frac{1}{32} \cdot in\right)$ $\quad P_{m\_net} = 18.921 \cdot kip$

Bearing - J.6.5

Allowable stress bearing: $F_{t\_J.3.7} := 25.9 \cdot ksi$

Allowable bearing: $P_{m\_brg} := \frac{L_m \cdot t_m \cdot F_{tu}}{1.5} = 17480\ lbf$ $P_{m\_brg} = 17.48 \cdot kip$

Allowable Bearing Check $Limit := 1.33 \cdot d_{m\_hole} \cdot t_m \cdot F_{tu} = 21795.375\ lbf$

Check to see if J.6.5 Conditions are met

$$Check := \begin{cases} \text{"VALID"} & \text{if } P_{m\_brg} < Limit \\ \text{"NOT VALID"} & \text{otherwise} \end{cases} = \text{"VALID"}$$

Compression - E.3:

Unbraced length: $L := L_{m\_end}$

Plate moment of inertia: $Iy_m := \frac{1}{12} \cdot h_m \cdot t_m^3$ $\quad Iy_m = 0.055 \cdot in^4$

Area of plate: $A_m := t_m \cdot h_m$ $\quad A_m = 1.38 \cdot in^2$

Radius of gyration: $ry_m := \sqrt{\frac{Iy_m}{A_m}}$ $\quad ry_m = 0.199 \cdot in$

Slenderness: $S_{E.3} := \frac{2.1 \cdot L_{m\_end}}{ry_m}$ $\quad S_{E.3} = 18.26$

Allowable stress:

$$F_{vert\_E.3} := \begin{cases} (21.2 \cdot ksi) & \text{if } S_{E.3} \le 17.8 \\ \left(0.00047 \cdot S_{E.3}^2 - 0.232 \cdot S_{E.3} + 25.2\right) \cdot ksi & \text{if } (0 < S_{E.3}) \wedge (66 > S_{E.3}) \\ \left(\frac{51352}{S_{E.3}^2}\right) \cdot ksi & \text{if } 66 < S_{E.3} \end{cases}$$

$F_{vert\_E.3} = 21.1 \cdot ksi$

Allowable compression: $P_{m\_comp} := F_{vert\_E.3} \cdot t_m \cdot h_m$ $\quad P_{m\_comp} = 29.146 \cdot kip$

Allowable axial force in fork: $P_{allow\_fork} := \min\left(P_{m\_gross}, P_{m\_net}, P_{m\_brg}, P_{m\_comp}\right)$

$P_{allow\_fork} = 17.48 \cdot kip$

Diameter of pin: $d_{pin} := .625 \cdot in$

Pin yield strength: $Fy_{pin} := 50 \cdot ksi$

Pin tensile strength: $Fu_{pin} := 65 \cdot ksi$

Pin shear capacity:

The pin will be in double shear. Use Table J3.2 for nominal stress of fasteners.

Nominal shear stress: $F_{nv\_pin} := 0.5 \cdot Fu_{pin}$ $\quad F_{nv\_pin} = 32.5 \cdot ksi$

Area of pin: $A_{pin} := \frac{\pi \cdot d_{pin}^2}{4}$ $\quad A_{pin} = 0.307 \cdot in^2$

Available double shear capacity of pin: $V_{a\_pin} := \frac{F_{nv\_pin} \cdot A_{pin}}{2} \cdot 2$ $\quad V_{a\_pin} = 9.971 \cdot kip$

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Split Pins

The forks are connected to the aluminum with Split Pins. The Spirol pins are coiled 3/8" diameter pins Use a factor of safety of 2 on the coil pins.

Capacity of coiled spirol pin in double shear: $P_{allow\_split\_pin} := 16 \cdot kip$

There are two pins therefore allowable load is: $P_{allow\_split} := \dfrac{(2 \cdot P_{allow\_split\_pin})}{2}$ $P_{allow\_split} = 16 \cdot kip$

Aluminum Bearing

The aluminum chord to split pin bearing shall be checked. There are (4) bearing surfaces.

Thickness of truss chord: $t_{chord} := t_c$

Diameter of coil pin: $d_{split\_pin} := 0.375 \cdot in$

Allowable pin bearing strength in aluminum: $P_{brg\_al} := 4 \cdot t_{chord} \cdot d_{split\_pin} \cdot 39 \cdot ksi$ $P_{brg\_al} = 7.312 \cdot kip$

assumes non-weld affected areas

Truss Allowable Capacity

The allowable moment and shear capacity of the truss will be determined from the capacities determined above.

Minimum axial force in chord: $P_{chord\_min} := \min(T_c, C_c, P_{brg\_al}, P_{allow\_fork})$ $P_{chord\_min} = 5.927 \cdot kip$

Allowable truss moment capacity: $M_{truss} := \min(2 \cdot d_{tr} \cdot P_{chord\_min})$ $M_{truss} = 13.83 \cdot ft \cdot kip$

Minimum axial force in diagonal: $P_{diag\_min} := P_{diag}$ $P_{diag\_min} = 3.127 \cdot kip$

Allowable truss shear capacity: $V_{truss} := 2 \cdot \sin(\theta_d) \cdot P_{diag\_min}$ $V_{truss} = 4.144 \cdot kip$

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Weight of Truss Calculation

Truss selfweight:

$$wt_{truss} := \frac{62lbf}{8ft} = 7.75 \cdot plf$$

$$wt_{truss} = 7.75 \cdot plf$$

Allowable Loads Due to Moment

Uniform Load:

$$w_{mUDL}(L) := -\frac{L^2 \cdot wt_{truss} - 8 \cdot M_{truss}}{L^2}$$

Center Point Load:

$$P_{mCPL}(L) := \frac{4 \cdot \left(M_{truss} - \frac{L^2 \cdot wt_{truss}}{8}\right)}{L}$$

Third Point Loads:

$$P_{m3p}(L) := \frac{3 \cdot \left(M_{truss} - \frac{L^2 \cdot wt_{truss}}{8}\right)}{L}$$

Quarter Point Loads:

$$P_{mQp}(L) := \frac{2 \cdot \left(M_{truss} - \frac{L^2 \cdot wt_{truss}}{8}\right)}{L}$$

Allowable Loads Due to Shear

Uniform Load:

$$w_{vUDL}(L) := \frac{2 \cdot V_{truss} - L \cdot wt_{truss}}{L}$$

Center Point Load:

$$P_{vCPL}(L) := 2 \cdot V_{truss} - L \cdot wt_{truss}$$

Third Point Loads:

$$P_{v3p}(L) := V_{truss} - \frac{1}{2} \cdot wt_{truss} \cdot L$$

Quarter Point Loads:

$$P_{vQp}(L) := \frac{2 \cdot \left(M_{truss} - \frac{L^2 \cdot wt_{truss}}{8}\right)}{L}$$

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Allowable Loads Due to Deflection

The deflection will be limited to L/180.

Uniform Load: $$w_{\Delta UDL}(L) := -\frac{1.0e\text{-}41 \cdot \left(1.0e41 \cdot L^4 \cdot wt_{truss} - 7.769308e46 \cdot I_{tr} \cdot ksi \cdot \Delta(L)\right)}{L^4}$$

Center Point Load: $$P_{\Delta CPL}(L) := \frac{4.29730473043047e\text{-}22 \cdot \left(6.217e24 \cdot I_{tr} \cdot ksi - 1.4428e21 \cdot L^3 \cdot wt_{truss}\right)}{L^2}$$

Third Point Loads: $$P_{\Delta 3p}(L) := \frac{1.71e\text{-}21 \cdot \left(9.067e23 \cdot I_{tr} \cdot ksi - 2.10416e20 \cdot L^3 \cdot wt_{truss}\right)}{L^2}$$

Quarter Point Loads: $$P_{\Delta Qp}(L) := \frac{0.0034722 \cdot \left(323200.0 \cdot I_{tr} \cdot ksi - 75.0 \cdot L^3 \cdot wt_{truss}\right)}{L^2}$$

Allowable Loads Based on Minimum Allowable Values

$L := 8 \cdot ft, 16 \cdot ft .. 48 \cdot ft$

Uniform load: $$w_{UDL}(L) := \min\left(w_{mUDL}(L), w_{vUDL}(L), w_{\Delta UDL}(L)\right)$$

Center point load: $$P_{CPL}(L) := \min\left(P_{mCPL}(L), P_{vCPL}(L), P_{\Delta CPL}(L)\right)$$

3rd point load: $$P_{3rd}(L) := \min\left(P_{m3p}(L), P_{v3p}(L), P_{\Delta 3p}(L)\right)$$

Quarter point load: $$P_{4th}(L) := \min\left(P_{mQp}(L), P_{vQp}(L), P_{\Delta Qp}(L)\right)$$

Corresponding deflections:

Uniform load: $$\Delta_{UDL}(L) := \frac{5 \cdot wt_{truss} \cdot L^4}{384 \cdot E_a \cdot I_{tr}} + \frac{5 \cdot w_{UDL}(L) \cdot L^4}{384 \cdot E_a \cdot I_{tr}}$$

Center point load: $$\Delta_{CPL}(L) := \frac{5 \cdot wt_{truss} \cdot L^4}{384 \cdot E_a \cdot I_{tr}} + \frac{0.021 \cdot P_{CPL}(L) \cdot L^3}{E_a \cdot I_{tr}}$$

3rd point load: $$\Delta_{3rd}(L) := \frac{5 \cdot wt_{truss} \cdot L^4}{384 \cdot E_a \cdot I_{tr}} + \frac{0.036 \cdot P_{3rd}(L) \cdot L^3}{E_a \cdot I_{tr}}$$

Quarter point load: $$\Delta_{4th}(L) := \frac{5 \cdot wt_{truss} \cdot L^4}{384 \cdot E_a \cdot I_{tr}} + \frac{0.05 \cdot P_{4th}(L) \cdot L^3}{E_a \cdot I_{tr}}$$

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Allowable Loads

L = (ft)	$\Delta_{UDL}(L) =$ (in)	$\Delta_{CPL}(L) =$ (in)	$\Delta_{3rd}(L) =$ (in)	$\Delta_{4th}(L) =$ (in)
8	0.065	0.087	0.09	0.104
16	0.433	0.351	0.449	0.416
24	0.975	0.794	1.009	0.938
32	1.733	1.422	1.792	1.669
40	2.671	2.243	2.654	2.612
48	3.205	3.2	3.186	3.2

L = (ft)	$w_{UDL}(L) =$ (plf)	$P_{CPL}(L) =$ (kip)	$P_{3rd}(L) =$ (kip)	$P_{4th}(L) =$ (kip)
8	1028	6.884	4.113	3.442
16	424	3.395	2.547	1.698
24	184	2.212	1.659	1.106
32	100	1.605	1.204	0.802
40	60	1.228	0.868	0.614
48	32	0.942	0.547	0.396

Allowable Loads Based on Minimum Allowable Values

Reduction per ANSI E1.21: $red := 0.85$

Uniform load: $w_{UDL}(L) := \min(red \cdot w_{mUDL}(L), red \cdot w_{vUDL}(L), w_{\Delta UDL}(L))$

Center point load: $P_{CPL}(L) := \min(red \cdot P_{mCPL}(L), red \cdot P_{vCPL}(L), P_{\Delta CPL}(L))$

3rd point load: $P_{3rd}(L) := \min(red \cdot P_{m3p}(L), red \cdot P_{v3p}(L), P_{\Delta 3p}(L))$

Quarter point load: $P_{4th}(L) := \min(red \cdot P_{mQp}(L), red \cdot P_{vQp}(L), red \cdot P_{\Delta Qp}(L))$

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Corresponding deflections:

Uniform load: $\Delta_{UDL}(L) := \frac{5 \cdot wt_{truss} \cdot L^4}{384 \cdot E_a \cdot I_{tr}} + \frac{5 \cdot w_{UDL}(L) \cdot L^4}{384 \cdot E_a \cdot I_{tr}}$

Center point load: $\Delta_{CPL}(L) := \frac{5 \cdot wt_{truss} \cdot L^4}{384 \cdot E_a \cdot I_{tr}} + \frac{0.021 \cdot P_{CPL}(L) \cdot L^3}{E_a \cdot I_{tr}}$

3rd point load: $\Delta_{3rd}(L) := \frac{5 \cdot wt_{truss} \cdot L^4}{384 \cdot E_a \cdot I_{tr}} + \frac{0.036 \cdot P_{3rd}(L) \cdot L^3}{E_a \cdot I_{tr}}$

Quarter point load: $\Delta_{4th}(L) := \frac{5 \cdot wt_{truss} \cdot L^4}{384 \cdot E_a \cdot I_{tr}} + \frac{0.05 \cdot P_{4th}(L) \cdot L^3}{E_a \cdot I_{tr}}$

Allowable Loads

L = (ft)	$\Delta_{UDL}(L)$ = (in)	$\Delta_{CPL}(L)$ = (in)	$\Delta_{3rd}(L)$ = (in)	$\Delta_{4th}(L)$ = (in)
8	0.055	0.074	0.076	0.088
16	0.369	0.299	0.383	0.355
24	0.835	0.681	0.864	0.803
32	1.492	1.227	1.542	1.437
40	2.347	1.952	2.423	2.266
48	3.205	2.871	3.186	2.814

L = (ft)	$w_{UDL}(L)$ = (plf)	$P_{CPL}(L)$ = (kip)	$P_{3rd}(L)$ = (kip)	$P_{4th}(L)$ = (kip)
8	874	5.851	3.496	2.926
16	361	2.886	2.165	1.443
24	157	1.88	1.41	0.94
32	85	1.364	1.023	0.682
40	52	1.044	0.783	0.522
48	32	0.822	0.547	0.336