STRUCTURAL SUBMITTAL PACKAGE

for

Christie Lites

Christie Lites Light Ladders

Project Location: All 50 States

Event Dates: Various

Submittal Date: 7/22/2022

Clark Reder Project Number: 22.915.03

Reviewed by:

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07/28/2022

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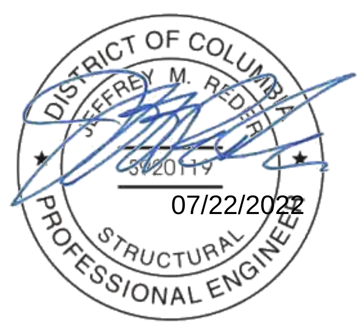

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CRE Project #: 22.915.03
Project: Christie Lites Light Ladders
Date: 0722/2022
Client: Christie Lites
Engineer: DBG

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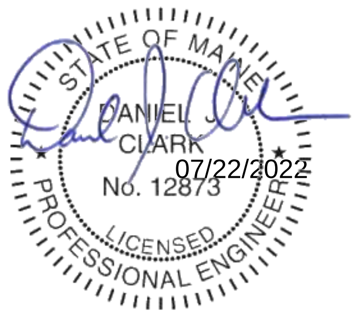
Louisiana  Jeffrey M. Reder, P.E. P.E. # 30304	**Maine**  Daniel J. Clark, P.E. P.E. # 12873	**Maryland**  Professional Certification: I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland. License # 38421 Expiration Date: 01/29/2022 Jeffrey M. Reder, P.E. P.E. # 38421
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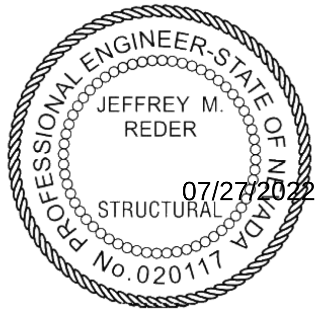

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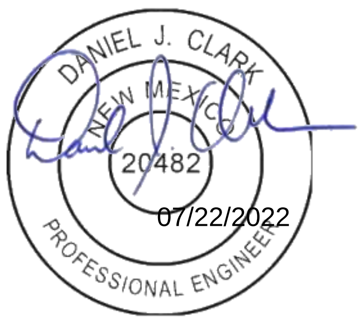

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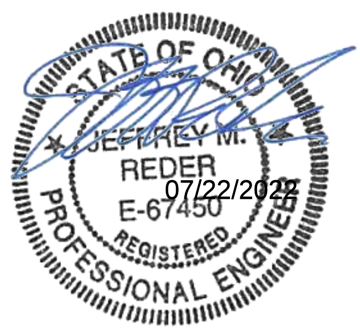

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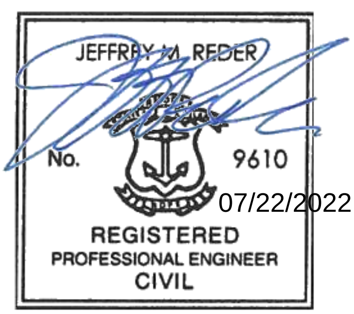

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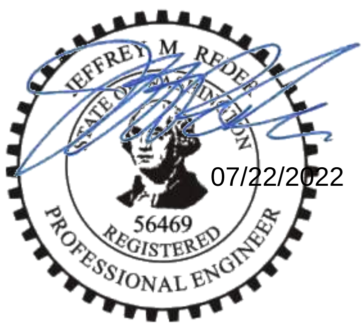

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Project Information

Project Summary

The project referenced by this submittal consists of the analysis of a series of light ladders. The light ladders consisted of 42"/84" with 13"/26" Barreau Amovible members running between the two vertical members. All documents were provided by Christie Lites and are included for reference.

Scope of Review

Clark Reder Engineering reviewed the light ladders for the predetermined loads on the rungs, as well as the overall vertical loads on the ladder verticals. The analysis was run in order to determine whether the members in the light ladder had sufficient capacity for the expected loads.

The fixture that the system attaches to is by others. The ladder has been evaluated for indoor use only, the light ladder has not been evaluated for exterior applications or exposure to wind loads.

Conclusions

Our review has concluded that the Christie Lites Light Ladders meets the structural requirements of the 2018 International Building Code, ASCE 7-16, ASCE 37-14, and Eurocode 9.

Limitations and Exceptions

The scope of review for this submittal is limited to the items listed above. All other temporary or permanent structures on site not specifically referenced above under "Scope of Review" are the responsibility of others.

Where the items covered by this submittal are attached to existing structures, it is the responsibility of the engineer of record for those existing structures to review the impact of the elements referenced in this submittal.

GENERAL STRUCTURAL NOTES

EVENT DATE & LOCATION

1. EVENT DATE: VARIOUS
2. EVENT LOCATION: ALL 50 STATES

CODES

1. 2018 INTERNATIONAL BUILDING CODE
2. ASCE 7-16: MINIMUM DESIGN LOADS AND ASSOCIATED CRITERIA FOR BUILDINGS AND OTHER STRUCTURES
3. ASCE 37-14: DESIGN LOADS ON STRUCTURES DURING CONSTRUCTION
4. 2015 ALUMINUM DESIGN MANUAL
5. AISC 360-16: SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS
6. EUROCODE 9

REFERENCES

1. ANSI E1.2-2021 ENTERTAINMENT TECHNOLOGY, "DESIGN, MANUFACTURE AND USE OF ALUMINUM TRUSSES AND TOWERS"

DESIGN LOADS

1. DEAD LOAD: SELF-WEIGHT OF STRUCTURE
2. ALLOWABLE LOADS:
    - A. LADDER VERTICALS EVALUATED WITH LOAD OF 2200#
    - B. LADDER RUNGS EVALUATED WITH LOAD OF 200#

ALUMINUM

1. ALUMINUM SHALL CONFORM TO THE FOLLOWING UNLESS NOTED OTHERWISE ON THE DRAWINGS:
    - A. MEMBER ALLOY: 6061-T6
    - B. WELD FILLER ALLOY: 4043
2. ALL DETAILING, FABRICATION AND ERECTION SHALL CONFORM TO THE ALUMINUM ASSOCIATION ALUMINUM DESIGN MANUAL, CURRENT EDITION.
3. WELDING SHALL BE IN ACCORDANCE WITH THE AMERICAN WELDING SOCIETY LATEST EDITION.
4. FIELD CONNECTIONS SHALL BE BOLTED UNLESS SPECIFIED OTHERWISE ON THE DRAWINGS.
5. WHERE THE CONTACT OF DISSIMILAR METALS MAY CAUSE ELECTROLYSIS, MEANS SHALL BE PROVIDED TO SEPARATE THE DISSIMILAR METALS WITH A NON-CONDUCTIVE MATERIAL.

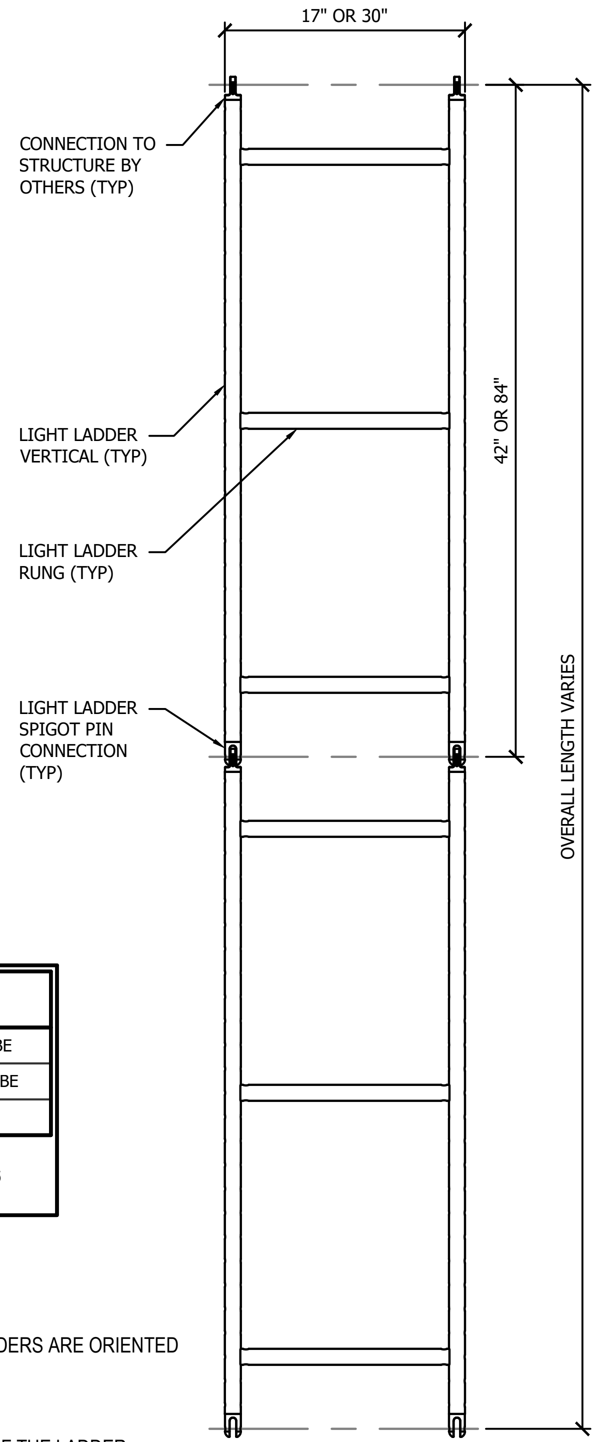
INSPECTIONS

1. ALL LADDER UNITS AND/OR OTHER EQUIPMENT SHALL BE VISUALLY INSPECTED PRIOR TO ERECTION. DAMAGED OR CORRODED EQUIPMENT SHALL NOT BE USED. FIELD MODIFICATIONS SHALL BE APPROVED BY THE ENGINEER OF RECORD PRIOR TO INSTALLATION.

INSPECTIONS

1. ALL UNITS AND/OR OTHER RIGGING EQUIPMENT SHALL BE VISUALLY INSPECTED PRIOR TO ERECTION. DAMAGED OR CORRODED EQUIPMENT SHALL NOT BE USED. FIELD MODIFICATIONS SHALL BE APPROVED BY THE ENGINEER OF RECORD PRIOR TO INSTALLATION.

APPENDIX A



FRONT VIEW

COMPONENT WEIGHTS	
ITEM	WEIGHT
84" LADDER VERTICAL	12 LBS
42" LADDER VERTICAL	8 LBS
13" LADDER RUNG	2 LBS
26" LADDER RUNG	3 LBS

PARTS LIST	
LADDER RUNGS	2"ϕx$\frac{1}{8}$" TUBE
CHORDS	2"ϕx$\frac{3}{16}$" 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 LIGHT LADDER SHALL SUPPORT VERTICAL LOADS ONLY, I.E. THE LIGHT LADDERS ARE ORIENTED VERTICALLY AND NO LATERAL LOADS ARE APPLIED TO THE TRUSS.
2. THE LIGHT LADDER SHALL SUPPORT STATIC LOADS ONLY.
3. MAXIMUM TOTAL WEIGHT OF LADDER AND APPLIED LOADS = 2,200 LBS.
4. MAXIMUM ALLOWABLE LOAD ON LIGHT LADDER IS 2,200 LBS LESS THE WEIGHT OF THE LADDER COMPONENTS.
5. MAX ALLOWABLE LOAD PER RUNG IS 200 LBS.
6. ALLOWABLE LOADS BASED ON 2020 ALUMINUM DESIGN MANUAL.
7. MAXIMUM LENGTH OF LIGHT LADDER IS 50'-0".

CHRISTIE LITES
LIGHT LADDER

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LIGHT LADDER
LAYOUT AND ALLOWABLE LOADING

DATE: 6/29/2022
CRE PROJECT NO: 22.915.03
DRAWN BY: DBG/DDL

ST1.1

APPENDIX B

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Light Ladders

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 ladderes and Towers"*

Description

The ladder is a light ladder fabricated from 6061-T6 aluminum members. The ladder chords are composed of 2" x 3/16" thick pipes. The ladder rungs will be made from Barreau Amovibile 13" and 26" Interieur members. The end members are composed of forked ends. The ladder will be reviewed for lengths of 7'-0".

Analysis Assumptions

- The ladder is supporting vertical loads only,.
- The ladder will be analyzed for static loads only.
- All loads are applied at the centroid of the horizontal member between the two ladder verticals.
- All loads are applied at the panel points of the ladder as to not induce local bending stresses in the chords.
- Maximum expected load on each ladder rung is 200#
- Maximum expected load from each ladder is 2200#

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Conclusions and Recommendations

The ladder load capacities are outlined 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 ladder capacities are based on the lowest values due to ladder diagonal capacity, ladder chord capacity and ladder 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:	$k_t := 1.0$	

Grade 8 Bolt Mechanical Properties

Tensile Strength of Bolt: $F_{u.bolt} := 150ksi$

General Design - Applies To All Assemblies

Steel/Aluminum Factors of Safety

Note: The following factors/design criteria applies to all assemblies and will be used throughout design package (U.N.O).

AISC Typical Factors of Safety (U.N.O.): $\Omega_{y.AISC} := 1.67$ $\Omega_{r.AISC} := 2.0$

ADM Typical Factors of Safety (U.N.O.): $\Omega_{y.ADM} := 1.65$ $\Omega_{r.ADM} := 1.95$

Member Properties

Vericals - 2"x3/16"

Outer diameter: $D_c := 2 \cdot in$ Wall thickness: $t_c := \frac{3}{16} \cdot in$

Inner diameter: $ID_c := D_c - 2 \cdot t_c = 0.135\,ft$

Area of tube: $A_c := \frac{\pi \cdot \left(D_c^{\,2} - ID_c^{\,2}\right)}{4} = 1.0677 \cdot in^2$

Polar moment: $J_c := \frac{\pi \cdot \left[\left(\frac{D_c}{2}\right)^4 - \left(\frac{ID_c}{2}\right)^4\right]}{2} = 0.886 \cdot in^4$

Moment of inertia: $I_c := \frac{\pi \cdot \left(D_c^{\,4} - ID_c^{\,4}\right)}{64} = 0.443 \cdot in^4$

Rb over t: $R\_t_c := \frac{\frac{D_c - t_c}{2}}{t_c} = 4.833$

Elastic section modulus: $S_c := \frac{\pi \cdot \left(D_c^{\,4} - ID_c^{\,4}\right)}{32 \cdot D_c} = 0.443 \cdot in^3$

Selfweight: $wt_c := A_c \cdot \gamma_a = 1.253 \cdot plf$

Radius of gyration: $r_c := \frac{\sqrt{D_c^{\,2} + ID_c^{\,2}}}{4} = 0.644 \cdot in$

Horizontal Rungs - 2"x1/8"

Outer diameter: $hv_d := 2 \cdot in$ Wall thickness: $t_{hv} := 0.125 \cdot in$

Inner diameter: $Ihv_d := hv_d - 2 \cdot t_{hv} = 0.146\,ft$

Area of tube: $A_{hv} := \frac{\pi \cdot \left(hv_d^{\,2} - Ihv_d^{\,2}\right)}{4} = 0.7363 \cdot in^2$

Polar moment: $J_{hv} := \frac{\pi \cdot \left[\left(\frac{hv_d}{2}\right)^4 - \left(\frac{Ihv_d}{2}\right)^4\right]}{2} = 0.65 \cdot in^4$

Moment of inertia: $I_{hv} := \frac{\pi \cdot \left(hv_d^{\,4} - Ihv_d^{\,4}\right)}{64} = 0.325 \cdot in^4$

Rb over t: $R\_t_{hv} := \frac{\frac{hv_d - t_{hv}}{2}}{t_{hv}} = 7.5$

Elastic section modulus: $S_{hv} := \frac{\pi \cdot \left(hv_d^{\,4} - Ihv_d^{\,4}\right)}{32 \cdot hv_d} = 0.325 \cdot in^3$

Plastic Section Modulus: $Z_{hv} := \left(\frac{hv_d^{\,3}}{6}\right) - \left(\frac{Ihv_d^{\,3}}{6}\right) = 0.44 \cdot in^3$

Radius of gyration: $r_{hv} := \frac{\sqrt{hv_d^{\,2} + Ihv_d^{\,2}}}{4} = 0.664 \cdot in$

Selfweight: $wt_{hv} := A_{hv} \cdot \gamma_a = 0.864 \cdot plf$

Distances Between Chords $D_{13} := 15in$ $D_{26} := 28in$

Global Properties

Area of Chords $A_{tr} := 2 \cdot A_c$ $A_{tr} = 2.135 \cdot in^2$

Moment of inertia $I_{tr} := 2 \cdot (I_c) + A_{tr} \cdot \left(\frac{D_{13}}{2}\right)^2$ $I_{tr} = 120.997 \cdot in^4$ strong axis

Radius of gyration $r_{tr} := \sqrt{\frac{I_{tr}}{A_{tr}}}$ $r_{tr} = 7.528 \cdot in$

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

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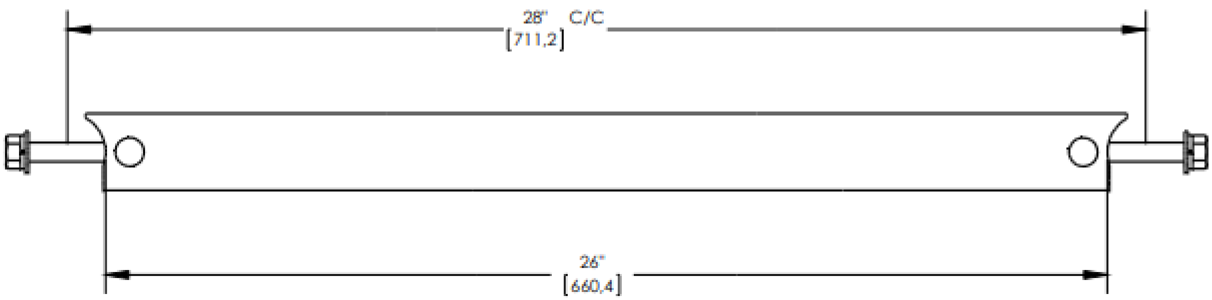
Ladder Rungs - Checked for a 200# Max Load

Capacity

The calculation is for the Barreau Amovible 26" Member

Length of chord $L_c := 26 \cdot in$ *distance between welds*



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: $S_{E2c} := \dfrac{0.9 \cdot L_c}{r_{hv}}$ $S_{E2c} = 35.221$

Allowable stress:

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

$F_{c\_E2\_c\_wc} = 8.262 \cdot ksi$

Compression in Chord - B5.4.5 - WELD AFFECTED

Slenderness: $S_{B545c} := R\_t_{hv}^{\,0.5}$ $S_{B545c} = 2.739$

Allowable stress:

$$F_{c\_B545\_c\_wc} := \begin{cases} (9.1 \cdot ksi) & \text{if } S_{B545c} \le 6.8 \\ \left(11.8 - 0.396 \cdot \sqrt{S_{B545c}}\right) \cdot ksi & \text{if } 6.8 < S_{B545c} < 20 \\ \left[\dfrac{3776}{S_{B545c} \cdot \left(1 + \dfrac{\sqrt{S_{B545c}}}{35}\right)^2}\right] \cdot ksi & \text{if } 20 \le S_{B545c} \end{cases}$$

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

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

Chord compression stress: $F_{cc} := \min\left(F_{c\_E2\_c\_wc}, F_{c\_B545\_c\_wc}\right)$ $F_{cc} = 8.262 \cdot ksi$

Chord tension capacity: $T_c := A_c \cdot F_{tc}$ $T_c = 9.716 \cdot kip$

Chord compression capacity: $C_c := A_c \cdot F_{cc}$ $C_c = 8.821 \cdot kip$

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Rung Checks: Bending Check For Center Point Load

Plastic Section Modulus: $Z_x := Z_{hv}$

Allowable Bending Moment: $M_{ladder} := \min\left(\frac{1.5 \cdot S_{hv} \cdot F_{cy}}{1.65}, \frac{Z_{hv} \cdot F_{cy}}{1.65}\right) = 0.778 \cdot kip \cdot ft$

Centerpoint Load: $P_{CPL} := 200 lbf$

Moment due to CPL: $M_{Load} := \frac{P_{CPL} \cdot L_c}{4} = 0.108\, kip \cdot ft$

Utilization of Moment Capacity in Rung: $util := \frac{M_{Load}}{M_{ladder}} = 13.925\,\%$

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Shear/Bearing Check: Worst Case Is Load on End of Rung

Properties of Bolt $D_B := .5in$

End Load $P_{EL} := 200lbf$

Set up a and b values for equation $a := 0in$ $\quad b := 26in$

Calculation of Shear at Ends $Shear := \dfrac{P_{EL} \cdot b}{L_c} = 200\ lbf$

Bolts Checks In Shear

Ultimate Tensile Strength: $F_{u.bolt} := F_{u.bolt}$

Rupture Factor of Safety: $\Omega_{r.AISC} = 2$

Tensile Strength of Bolt: $F_{t.bolt} := 0.75 \cdot F_{u.bolt} = 112.5 \cdot ksi$

Shear Strength of Bolt: $F_{s.bolt} := 0.45 \cdot F_{u.bolt} = 67.5 \cdot ksi$

Area of bolt: $A_{bolt} := \left(\dfrac{D_B}{2}\right)^2 \cdot \pi = 0.196 \cdot in^2$

Allowable Shear Load: $R_{n.bolt.shear} := \dfrac{A_{bolt} \cdot F_{s.bolt}}{\Omega_{r.AISC}} = 6.627 \cdot kip$

Maximum Shear Load $V_{Max} := Shear$

Utilization of Shear Load $\%Util := \dfrac{V_{Max}}{R_{n.bolt.shear}} = 3.018 \cdot \%$

Bearing Check: Worst Case Is Load on End of Rung - Contact With 3/16" Tubes

Thickness of Pipes $t := \dfrac{3}{16} in$

Max Allowable Bearing Force $F_{D.Bolt} := \dfrac{\left(D_B \cdot t \cdot F_{tuw}\right)}{\Omega_{r.ADM}} = 1153.846\ lbf$

Utilization of Moment Capacity in Rung $util := \dfrac{Shear}{F_{D.Bolt}} = 17.333\ \%$

The shear at the ends is less than the maximum allowable bearing force. By inspection of the 26" rung the 13" rung is deemed to be sufficient.

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Ladder Vertical Check

Axial Capacity

The Verticals are 6061-T6 aluminum.

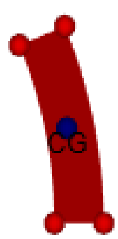
Length of Vertical $L_c := 84in$

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): $F_{t\_D2b\_net\_wc} := 12.3 \cdot ksi$

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



Geometric Properties

Area	0.1358 in²
Ix	0.0057 in⁴
Iy	0.0006 in⁴
Ixy	-0.0011 in⁴
rx	0.2047 in
ry	0.0674 in
Sx+	0.0148 in³
Sx-	0.0159 in³
Sy+	0.0044 in³
Sy-	0.0034 in³
Xc	4.174 in
Yc	1.013 in

Area of Vertical $a_c := A_c - 2 \cdot .1358in^2 = 0.796 \cdot in^2$

Determine Governing Load
$$F_{Load} := \begin{cases} F_{t\_D2a\_wc} \cdot a_c & \text{if } F_{t\_D2a\_wc} \cdot a_c < F_{t\_D2b\_net\_wc} \cdot a_c \\ F_{t\_D2b\_net\_wc} \cdot a_c & \text{otherwise} \end{cases}$$

Vertical tension capacity: $T_c := F_{Load}$ $\qquad T_c = 7.244 \cdot kip$

Aluminum Forked End

6061-T6 Extrusion Mechanical Properties

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

Thickness of fork: $t_m := .75 \cdot \text{in}$

Center of hole to edge: $L_m := 1\text{in}$

Center of hole to end: $L_{m\_end} := 1.732 \cdot \text{in}$

Height of plate: $h_m := 2 \cdot \text{in}$

Diameter of hole: $d_{m\_hole} := .625 \cdot \text{in}$

Axial Capacity of Plate

Axial tension - D.2a/b

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

Allowable gross tension: $P_{m\_gross} := F_{t\_D.2\_a} \cdot t_m \cdot h_m$ $\quad P_{m\_gross} = 31.8 \cdot \text{kip}$

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

Allowable net tension: $P_{m\_net} := F_{t\_D.2\_b} \cdot t_m \cdot \left(h_m - d_{m\_hole} + \frac{1}{32} \cdot \text{in}\right)$ $\quad P_{m\_net} = 20.566 \cdot \text{kip}$

Bearing - J.3.7

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

Allowable bearing: $P_{m\_brg} := \left(L_m \cdot t_m \cdot F_{t\_J.3.7}\right)$ $\quad P_{m\_brg} = 19.425 \cdot \text{kip}$

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

$P_{allow\_fork} = 19.425 \cdot kip$

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: $A_{pin} := \dfrac{\pi \cdot d_{pin}^{\,2}}{4}$ $\quad A_{pin} = 0.307 \cdot in^2$

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

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: $P_{allow\_split\_pin} := 27 \cdot kip$

There is a single pins therefore allowable load is: $P_{allow\_split} := \dfrac{2P_{allow\_split\_pin}}{2}$ $\quad P_{allow\_split} = 27 \cdot kip$

Aluminum Bearing

The aluminum chord to split pin bearing shall be checked. There are (2) bearing surfaces.

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

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

Allowable pin bearing strength in aluminum: $P_{brg\_al} := 4 \cdot t_{chord} \cdot d_{split\_pin} \cdot 39 \cdot ksi$ $\quad P_{brg\_al} = 10.969 \cdot kip$

assumes non-weld affected areas

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Worst Case Scenario Check

Identify Worst Case Situation - All 2200 lbf load placed on Single Ladder Vertical

Load on single chord $P_{Load} := 2200\text{lbf}$

Check utilization of member $Util := \dfrac{P_{Load}}{\min(T_c, P_{allow\_fork}, P_{brg\_al})} = 30.37\,\%$

By observation, the chord is sufficient to handle worst case situation.

Weight of Single Ladder with Two Verticals and Three Rungs

Weight of Verticals $W_{84} := 12.14\text{lbf}$ $W_{42} := 7.89\text{lbf}$

Weight of Rungs $W_{13} := 1.9\text{lbf}$ $W_{26} := 2.8\text{lbf}$

Weight of single 84" vertical w/a 13" rung ladder $W_{84.13} := 2 \cdot W_{84} + 3 \cdot W_{13} = 29.98\,\text{lbf}$

Weight of single 84" vertical w/a 26" rung ladder $W_{84.26} := 2 \cdot W_{84} + 3 \cdot W_{26} = 32.68\,\text{lbf}$

Weight of single 42" vertical w/a 13" rung ladder $W_{42.13} := 2 \cdot W_{42} + 3 \cdot W_{13} = 21.48\,\text{lbf}$

Weight of single 42" vertical w/a 26" rung ladder $W_{42.26} := 2 \cdot W_{42} + 3 \cdot W_{26} = 24.18\,\text{lbf}$