Appendix F. Truss Design

All members are equal leg double angles, A36 steel with $E := 29000\ ksi$, $F_y := 36\ ksi$, $F_u := 58\ ksi$, and Pin-Pin connection ($k := 1.0$).

Top Chord (Compression Member)

$Pu_{max} := 284.52\ kip$ $\qquad$ $L_T := 8\ ft$

$L_C := L_T \cdot k = 8\ ft$

Table 1. Determined using Table 4-8 from the Steel Construction Manual (SCM).

Selection	Wt (plf)	ϕPnx (kip)	ϕPny (kip)	Conn
"2L6x6x7/16"	34.4	287	253	2
"2L6x6x1/2"	39.2	324	302	2
"2L5x5x5/8"	40	310	336	3

While 2L6x6x7/16 is the lightest, the ϕPny is not greater than Pu_{max}, thus the next member, 2L6x6x1/2 is selected.

Check Self Weight:

$W := L_T \cdot Wt(1) = 0.314\ kip$

$D := 1.2 \cdot W = 0.376\ kip$

$NEWPu := D + Pu_{max} = 284.896\ kip$ $<$ $\phi Pny(1) = 302\ kip$ $\qquad$ OK

Spacing:

$$a := \frac{L_T}{Conn(1)+1} = 32\ in$$

Slenderness (E2): $r_{min} := 2.63\ in$

$\dfrac{L_T}{r_{min}} = 36.502$ < 200 $\qquad$ OK

$\therefore$ **Top Chord Member Selected: 2L6x6x1/2**

Bottom Chord (Tension Member)

$Pu_{max} := 303.51\ kip$ $\quad\quad L_B := 8\ ft$

$MIN_{Ag} := \dfrac{Pu_{max}}{0.9 \cdot F_y} = 9.368\ in^2$ $\quad\quad \dfrac{MIN_{Ag}}{2} = 4.684\ in^2$

Using Table 1-15 and knowing the area of the double angle must be greater than the minumum gross area, a 2L4x4x3/4 was selected with an $Ag := 10.9\ in^2$

<u>TM Yielding (D2-1):</u>

$\phi Pn_y := 0.9 \cdot F_y \cdot Ag = 353.16\ kip$ $\;>\; Pu_{max} = 303.51\ kip$ OK

<u>TM Rupture (D2-2):</u>

$Ae := Ag \cdot 0.75 = 8.175\ in^2$

$\phi Pn_r := 0.75 \cdot F_u \cdot Ae = 355.613\ kip$ $\;>\; Pu_{max} = 303.51\ kip$ OK

<u>Slenderness (E2):</u> $r_{min} := 1.8\ in$

$\dfrac{L_B}{r_{min}} = 53.333$ < 300 OK

$\therefore$ **Bottom Chord Member Selected: 2L4x4x3/4**

Vertical Chord (Compression Member)

$Pu_{max} := 18.196\ kip$ $L_V := 4\ ft$

$L_C := L_V \cdot k = 4\ ft$

Table 2. Determined using Table 4-8 from the Steel Construction Manual (SCM).

$Selection$	Wt (plf)	ϕPnx (kip)	ϕPny (kip)	$Conn$
"2L2x2x1/8"	3.3	22.4	21.5	3

Since 2L2x2x1/8 is the lightest double angle member which still has a greater ϕPn than Pu_{max}, it is selected.

Check Self Weight:

$W := L_V \cdot Wt = 0.013\ kip$

$D := 1.2 \cdot W = 0.016\ kip$

$NEWPu := D + Pu_{max} = 18.212\ kip$ < $\phi Pny = 21.5\ kip$ OK

Spacing:

$$a := \frac{L_V}{Conn + 1} = 12\ in$$

Slenderness (E2): $r_{min} := .961\ in$

$$\frac{L_V}{r_{min}} = 49.948 < 200$$ OK

$\therefore$ **Vertical Chord Member Selected: 2L2x2x1/8**

Diagonal Chord

Since there are both compression and tension members in this chord, both are designed and and redesigned using the opposites selected member.

$$L_D := 8.9443\ ft$$

Tension Member

$$Pu_{max} := 148.32\ kip$$

$$MIN_{Ag} := \frac{Pu_{max}}{0.9 \cdot F_y} = 4.578\ in^2$$

Using Table 1-15 and knowing the area of the double angle must be greater than the minumum gross area, a 2L4x4x5/16 was selected with an $Ag := 4.8\ in^2$

TM Yielding (D2-1):

$\phi Pn_y := 0.9 \cdot F_y \cdot Ag = 155.52\ kip$ > $Pu_{max} = 148.32\ kip$ OK

TM Rupture (D2-2):

$Ae := Ag \cdot 0.75 = 3.6\ in^2$

$\phi Pn_r := 0.75 \cdot F_u \cdot Ae = 156.6\ kip$ > $Pu_{max} = 148.32\ kip$ OK

Slenderness (E2): $r_{min} := 1.79\ in$

$\frac{L_D}{r_{min}} = 59.962$ < 300 OK

∴ Diagonal Tension Member Selected: 2L4x4x5/16

Compression Member

$$Pu_{max} := 106.27 \ kip$$

$$L_C := L_D \cdot k = 8.944 \ ft$$

Table 3. Determined using Table 4-8 from the Steel Construction Manual (SCM).

Selection	Wt (plf)	ϕPnx (kip)	ϕPny (kip)	Conn
"2L4x4x3.8"	19.6	123	155	3
"2L3.5x3.5x7/16"	19.6	108	143	3

Since both weigh the same, 2L3.5x3.5x7/16 is selected.

Check self weight:

$$W := L_D \cdot Wt(1) = 0.175 \ kip$$

$$D := 1.2 \cdot W = 0.21 \ kip$$

$NEWPu := D + Pu_{max} = 106.48 \ kip \ < \ \phi Pnx(1) = 108 \ kip$ OK

Spacing:

$$a := \frac{L_D}{Conn(1) + 1} = 26.833 \ in$$

Slenderness (E2): $r_{min} := 1.61 \ in$,

$\frac{L_D}{r_{min}} = 66.666 < 200$ OK

$\therefore$ Diagonal Compression Member Selected: 2L3.5x3.5x7/16

Redesign Compression Member With Selected Tension Member

Diagonal Tension Member Selected: 2L4x4x5/16

$$Pu_{max} := 106.27 \; kip$$

$$L_C := L_D \cdot k = 8.944 \; ft$$

Using Table 4-8 from the SCM with member 2L4x4x5/16 and an $L_C = 9 \; ft$, the $\phi Pnx := 104 \; kip$ and $\phi Pny := 116 \; kip$. Since $\phi Pnx \leq Pu_{max}$, this member cannot support the critical compression load needed and will fail.

Redesign Tension Member With Selected Compression Member

Diagonal Compression Member Selected: 2L3.5x3.5x7/16

$$Pu_{max} := 148.32 \; kip$$

$$MIN_{Ag} := \frac{Pu_{max}}{0.9 \cdot F_y} = 4.578 \; in^2$$

Using Table 1-15, the gross area of the 2L3.5x3.5x7/16 member is $Ag := 5.78 \; in^2$. Since $Ag \geq MIN_{Ag}$, this member will be adequate for supporting the critical tension load. OK

∴ Diagonal Chord Member Selected: 2L3.5x3.5x7/16

Deflections

The truss may not exceed a snow load deflection of greater than L/240.

$L := 64\ ft$

$Def_{snow} := 0.99294\ in$

$\frac{L}{240} = 3.2\ in \quad > \quad Def_{snow} = 0.99294\ in$ OK

Table 2 - Truss Member Schedule

Member ID	Governing LLC	Member Length (ft)	Type (Tens/ Comp)	P_u (kips)	Member Selected	ϕP_n (kips)	# Int Conn. (if any)	Supplier
T1	3. 1.2D+1.6S	8	C	-129.7	2L6x6x1/2	302	2	GERDAU AMERISTEEL
T2	3. 1.2D+1.6S		C	-129.7		302	2	GERDAU AMERISTEEL
T3	3. 1.2D+1.6S		C	-278.3		302	2	GERDAU AMERISTEEL
T4	3. 1.2D+1.6S		C	-278.3		302	2	GERDAU AMERISTEEL
T5	3. 1.2D+1.6S		C	-278.3		302	2	GERDAU AMERISTEEL
T6	3. 1.2D+1.6S		C	-278.3		302	2	GERDAU AMERISTEEL
T7	3. 1.2D+1.6S		C	-129.7		302	2	GERDAU AMERISTEEL
T8	3. 1.2D+1.6S		C	-129.7		302	2	GERDAU AMERISTEEL
D1	3. 1.2D+1.6S	8.9443	T	145	2L3.5x3.5x7/16	108	3	GERDAU AMERISTEEL
D2	3. 1.2D+1.6S		C	-103.9		108	3	GERDAU AMERISTEEL
D3	3. 1.2D+1.6S		T	62.4		108	3	GERDAU AMERISTEEL
D4	3. 1.2D+1.6S		C	-20.8		108	3	GERDAU AMERISTEEL
D5	3. 1.2D+1.6S		C	-20.8		108	3	GERDAU AMERISTEEL
D6	3. 1.2D+1.6S		T	62.4		108	3	GERDAU AMERISTEEL
D7	3. 1.2D+1.6S		C	-103.9		108	3	GERDAU AMERISTEEL
D8	3. 1.2D+1.6S		T	145		108	3	GERDAU AMERISTEEL
V1	3. 1.2D+1.6S	4	C	-18	2L2x2x1/8	21.5	3	GERDAU AMERISTEEL
V2	3. 1.2D+1.6S		C	-0.37		21.5	3	GERDAU AMERISTEEL
V3	3. 1.2D+1.6S		C	-18		21.5	3	GERDAU AMERISTEEL
V4	3. 1.2D+1.6S		C	-0.37		21.5	3	GERDAU AMERISTEEL
V5	3. 1.2D+1.6S		C	-18		21.5	3	GERDAU AMERISTEEL
V6	3. 1.2D+1.6S		C	-0.37		21.5	3	GERDAU AMERISTEEL
V7	3. 1.2D+1.6S		C	-18		21.5	3	GERDAU AMERISTEEL
B1	3. 1.2D+1.6S	8	T	222.6	2L4x4x3/4	353.16	N/A	GERDAU AMERISTEEL
B2	3. 1.2D+1.6S		T	222.6		353.16	N/A	GERDAU AMERISTEEL
B3	3. 1.2D+1.6S		T	296.9		353.16	N/A	GERDAU AMERISTEEL
B4	3. 1.2D+1.6S		T	296.9		353.16	N/A	GERDAU AMERISTEEL
B5	3. 1.2D+1.6S		T	222.6		353.16	N/A	GERDAU AMERISTEEL
B6	3. 1.2D+1.6S		T	222.6		353.16	N/A	GERDAU AMERISTEEL