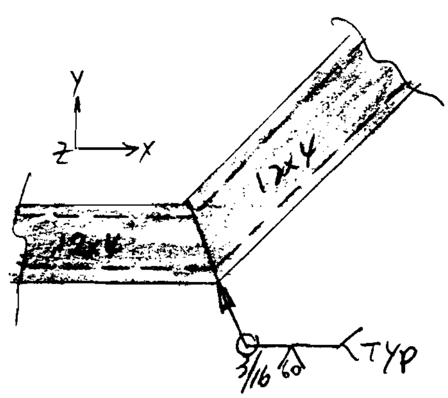
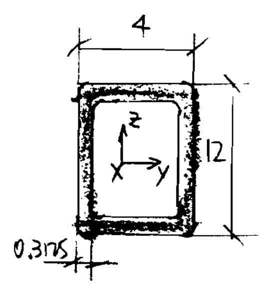
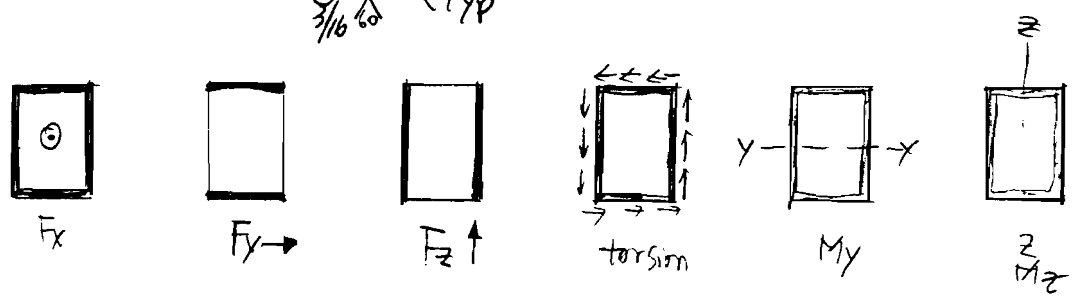
DESIGN CONNECTIONS AT POINT AA, CC, HH, MM, PP, NN, II & DD.

From the ansys results, knowing the worst combination loadings at points mentioned above are:

ELEMENT 114-0°	F_x = 2545.5 lb	(Tension)
ELEMENT 12-0°	F_y = 1745.5 lb	(shear)
ELEMENT 12-90°	F_z = 1088.2 lb	(shear)
ELEMENT 12-90°	M_x = 12575 lb-in	(Torsion)
ELEMENT 75-90°	M_y = 23657 lb-in	(Bending in strong axis)
ELEMENT 114-0°	M_z = 20115 lb-in	(Bending in weak axis)







According to "Design of welded structures" BLODGETT, Section 7.4-7, page 7.4-7, Table 5 – "properties of weld treated as Line", knowing:

Bending $S_y = bd + \frac{d^2}{3}$ where $b = 4$ $d = 12$

$S_y = 4 \times 12 + \frac{12^2}{3} = 96 \ in^2$

Bending $S_z = bd + \frac{d^2}{3}$ where $b = 12$ $d = 4$

$S_z = 12 \times 4 + \frac{4^2}{3} = 53.33 \ in^2$

Twisting $J = \frac{(b+d)^3}{6}$ where $b = 4$, $d = 12$

$J = \frac{(4+12)^3}{6} = 682.67 \ in^3$

O DETERMINE THE FORCE ON WELD

Tension $f_x = \frac{P}{A_W}$ where $P = 2545.5 \ lb$

$A_W = 4 \times 2 + 12 \times 2 = 32 \ in$

$f_x = \frac{2545.5}{32} = 79.54 \ lb/in$

shear $f_y = \frac{V}{A_W}$ where $V = 1745.5 \ lb$

$A_W = 4 + 4 = 8 \ in$

$f_y = \frac{1745.5}{8} = 218.18 \ lb/in$

shear $f_z = \frac{V}{A_W}$ where $V = 1888.2 \ lb$

$A_W = 12 + 12 = 24 \ in$

$f_z = \frac{1888.2}{24} = 78.68 \ lb/in$

twisting $f_{\tau x} = \frac{T C_y}{J}$ where $T = M_x = 12575$ lb-in $C_y = \frac{12}{2} = 6$ in

$J = 682.67$ in^3

$$f_{\tau x} = \frac{12575 \times 6}{682.67} = 110.52 \text{ lb/in}$$

twisting $f_{\tau y} = \frac{T C_x}{J}$ where $T = M_x = 12575$ lb-in $C_x = \frac{4}{2} = 2$ in

$J = 682.67$ in^3

$$f_{\tau y} = \frac{12575 \times 2}{682.67} = 36.84 \text{ lb/in}$$

Bending

$f_x' = \frac{M}{S_y}$ where $M = M_y = 23657$ lb-in

$S_y = S_y = 96$ in^2

$$f_x' = \frac{23657}{96} = 246.43 \text{ lb/in}$$

Bending

$f_x'' = \frac{M}{S_z}$ where $M = M_z = 20115$ lb-in

$S_z = 53.33$ in^2

$$f_x'' = \frac{20115}{53.33} = 377.18 \text{ lb/in}$$

o DETERMINE WELD SIZE BY USING ALLOWABLES:

According to "Design of welded structures" Blodget, Section 7.4, page 7.4-7, knowing:

The resultant force is equal to the square root of the sum of the squares of these three forces.

$$f_r = \sqrt{f_1^2 + f_2^2 + f_3^2}$$

Therefore:

$$f_r = \sqrt{(f_x + f_{x'} + f_{x''})^2 + (f_y + f_{Tx})^2 + (f_z + f_{Ty})^2}$$

$$= \sqrt{(79.54 + 246.43 + 377.18)^2 + (218.18 + 110.52)^2 + (78.68 + 36.84)^2}$$

$$= 784.73 \text{ lb/in}$$

$$= 0.785 \text{ kips/in}$$

According to AISC, ASD, page 4-168, knowing, the single V-groove welds is acceptable.

According to AISC, ASD, Table J2.1 & Table J2.3, page 5-66, knowing: the effective throat thickness is 3/16".

According to AISC, ASD, Table J2.5, page 5-70, knowing the allowable stress on welds is the same as base metal.

According to ANSI/ASME, B30.20-1993, Below the Hook Lifting Devices, knowing, the allowable stress is equal to $\frac{1}{3} F_y$.

where $F_y = 36$ ksi for A36.

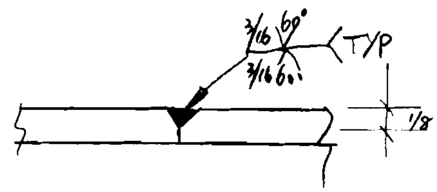
$$\frac{1}{3} F_y = \frac{1}{3} \times 36 = 12 \text{ ksi}$$

Therefore, the allowable loads in kips/in is equal to

$$12 \times 0.707 \times 3/16 = 1.59 \text{ Kips/in}.$$

use the continues weld.

$$SF = \frac{1.59}{0.785} = 2.0$$



WELDS: E70XX

In conclusion, design as sketched is adequate to carry the load.

STRONGBACK CONNECTION WEIGHT

$$\text{Total weight} = W_{plate+Angle} + W_{Bolts+nuts}$$

where $W_{plate+angle} = 1543\ lb$

$W_{Bolts+nuts} = 108.672\ lb$

$$\text{Total weight} = 1543 + 108.672$$

$$= 1652\ lb$$

[redacted] LIST: (CONNECTING PLATES & ANGLES)

1). 0.25" x 1.5" x 4" → 16 (each)

2). 0.375 x 4" x 7" → 12 (each)

3). ∠4 x 4 x 8½ x 3/8" → 24 (each)

4). ∠4 x 7 x 8½ x 3/8" → 18 (each)

5). 0.5" x 5" x 10" → 18 (each)

6). 0.875" x 11 7/8" x 11 7/8" → 2 (each)

7). 0.875" x 11 7/8 x 8½" → 7 (each)

8). 0.625 x 11 7/16 x 65 → 4 (each)

9). 1.25 x 11 7/16 x 30 → 2 (each)

10). 0.5 x 10.5 x 12 → 2 (each)

— Weight

1). 0.425 x 16 = 6.8 lb

2). 1.488 x 12 = 17.86 lb

3). 9.8 lb/ft x 17 ft = 166.6 lb

4). 13.6 lb/ft x 12.75 ft = 173.4 lb

5). 7.08 x 18 = 127.60 lb

6). 34.985 x 2 = 69.97 lb

7). 25.04 x 7 = 175.31 lb

8). 131.75 x 4 = 527 lb

9). 121.62 x 2 = 243.25 lb

10). 17.5 x 2 = 35 lb

total: 1543 lb

— A325 Bolt & Nut list:

1). 3/4" — 2 1/4 long — 68 (ea)

2). 3/4" — 5 long — 4 (ea)

3). 3/4" — 5 1/2 long — 16 (ea)

4). 3/4" — 7 long — 36 (ea)

— A325 Bolt & Nuts Weight

1). 3/4" x 2 1/4 → 0.648 x 68 = 44 lb
2). 3/4" x 5 → 0.958 x 4 = 3.832 lb
3). 3/4" x 5 1/2 → 1.08 x 16 = 17.28 lb
4). 3/4" x 7 → 1.21 x 36 = 43.56 lb

— Total Bolt & Nut Weight

108.672 lb