A LAYER MDT OCTANT SUPPORT ANALYSIS

BY: Tony Levand March 23, 2000

CHECKED: [Signature]
A Layer Supports

Support Weldment

Loads:

\[
\frac{\text{Seat Weight}}{2} = 400 \text{ lbs}
\]

\[
\begin{array}{c}
\text{Fy} = 36 \text{ksi} \\
F_{\text{allow}} = \frac{36}{3} = 12 \text{ksi} \\
F_s = \frac{F_{\text{allow}}}{2} = 6 \text{ksi}
\end{array}
\]

Material: ASTM A36 HR FLAT

Weld Analysis:

\[
M = 900 \times 5.16 = 2064 \text{ in lbs}
\]

1/4 weld, assume outside welds only, parent material

\[
I = 3.25 \times \frac{25}{\sqrt{2}} \times 2 = 1.1 \times 10^4
\]

\[
S_b = \frac{\text{Mc}}{I} = \frac{2064 \times 3.25}{1.1} = 3.4 \text{ ksi} \geq 12 \text{ ksi}
\]

Shear = \[
\frac{400}{3.25 \times 2 \times \frac{25}{\sqrt{2}}} = 348 \text{ psi}
\]

Bolt Tension:

\[
P_{\text{bolt}} = \frac{M}{D} = \frac{2064}{2.5 \times 2} = 413 \text{ lbs}
\]

3/8 bolts: \[
P_{\text{allow}} = F_{\text{allow}}A = 12 \times 0.0775 = 920 \text{ lbs} > 413 \text{ lbs}
\]

Shear = \[
P_{\text{allow}}/2 = 465 \text{ lbs} > \frac{400}{4} \]
A Layer supports

**BOLT PULL-OUT**

**SHEAR**

\[ \text{SLOT: } \quad P = 120 \text{ lbs} \]

\[ M = \frac{P}{8} = \frac{120 \times 1.06}{8} = 13.2 \text{ in. lbs} \]

\[ \sigma_b = \frac{6M}{B + 2} = \frac{6 \times 13.2}{0.375 \times 2.97} = 2.3 \text{ ksi} \leq 12 \text{ ksi} \]

**TENSION**

\[ T = 1.205 \]

\[ P = 413 \text{ lbs} \]

**ASSUME:**

1) Flange effective in bending
2) Toe action of flange results moment

\[ M = \frac{Pc}{2} = \frac{413 \times 1.205}{2} = 24.9 \text{ in. lbs} \]

\[ \sigma_b = \frac{6M}{B + 2} = \frac{6 \times 24.9}{1.297 + 1.06 \times 0.375^2} = 7.8 \text{ ksi} \leq 12 \text{ ksi} \]
CLEVIS BOLT BENDING

1/2 shoulder bolt \[ F_{uy} = 160 \text{ ksi} \]

\[ W = 400 \text{ lbs} \]

\[ d \text{ Allowable} = \frac{F_{uy}}{3} = \frac{160}{3 \times 1.5} = 35.5 \text{ ksi} \]

\[ M = \frac{P L}{4} = \frac{400 \times 1}{4} = 100 \text{ in} \cdot \text{lbs} \]

\[ I = \frac{4 \pi}{64} = 3.07 \times 10^{-3} \text{ in}^4 \]

\[ f_b = \frac{M c}{L} = \frac{100 \times 1.25}{3.067 \times 10^{-5}} = 9.14 \text{ ksi} < 35 \text{ ksi} \]

Ref:
D Unbrako engineers guide p2
SUBJECT: A LAER SUPPORTS

DATE: 1/12/00

WELD:
$\phi_b = 3.4 \times \frac{2}{3} = 5.1 \text{ ksi} < 12 \text{ ksi}$

Shear: 417 psi

BOLT TENSION

$P_{bolt} = 620 \text{ lbs} < 930 \text{ lbs}$

BOLT PULL-OUT

Shear:
$\phi_a = 3.5 \text{ ksi} < 12 \text{ ksi}$

Tension:
$\phi_t = 11.7 \text{ ksi} > 12 \text{ ksi}$

CLEVIS BOLT

5/8 bolt in double shear (shoulder bolt).

Shear strength: $27,450 \text{ lbs} > 600 \text{ lbs}$

(From ANABAT engineering guide p 13)
DRG 3923.130-MC-373937

This block is welded to the bevel along the vertical corners of the ef aperture, between the coils. It supports the weight of the octants 0, 3, 4, 7.

Support Weight = Octant Weight \( \div 2 \) = 400 lbs

This is a solid block of steel, thus the welds only are critical.

Moment applied to welds = 325.61 in lbs (M_x)

Natural to welds:
2301 Torsion (My')
2301 Bending (M_x')

400 lbs shear

Weld Properties:

1/4" Weld

\[ J_w = \frac{bh^3}{12} \times 2 = 2 \times \frac{3.25}{\sqrt{2}} \times \frac{3.25}{2} = 1.26 \text{ in}^4 \]

\[ J = \frac{2A_d^2}{12} \]

\[ J = \left[ \frac{z^2 + \left( \frac{z^2(3.25)}{2} \right)}{2} \right] \left[ \frac{3.25}{2} \times 4 \times \frac{3125}{12} \right] = 7.63 \text{ in}^4 \]
DNG  3823.130 - MC-373937 (cont.)

WELD ANALYSIS (cont.)

\[
f_m = \frac{m_c}{t} = \frac{2301 \times 3.25}{1.26} = 63 \text{ ksi}
\]

\[
\gamma = \frac{T_c}{J} = \frac{2301 \left( \frac{2^2 + 3.25^2}{2} \right)^{1/2}}{17.63} = 1.45 \text{ ksi}
\]

\[
\sigma_s = \frac{P}{A} = \frac{400}{\frac{2115}{12} \times 3.25 \times 2} = 278 \text{ psi}
\]

Weld stress =

\[
\sqrt{3^2 + 1.15^2 + 0.27^2} = 3.22 \text{ ksi}
\]

Using allowable for the parent material (EF is 100)

\[
F + \gamma = 25 \text{ ksi}
\]

\[
F_s = \frac{F + \gamma}{2} = 12.5 \text{ ksi}
\]

\[
F_{34} = \frac{F_s}{3} = \frac{12.5}{3} = 4.17 \text{ ksi}
\]

\[
3.22 < 4.17 \quad \text{WELD IS OK}
\]
A-42" SUPPORTS

DRG 3923.130-MB-373936

This pad supports octants 1, 2 and 5, 6 in the Z direction (beam line) around the EE aperture. There is no weight on this mount, it will be analyzed for handling loads.

Section A-A

Material: HR flat
ASTM A 36
Fty = 36 ksi
Fallow = \( \frac{36}{3} = 12 \text{ ksi} \)

Force = 100 lbs
\[ M = 100 \times 1.25 = 125 \text{ in lb} \]
\[ \sigma_b = \frac{6M}{bL^2} = \frac{6 \times 125}{2 \times .25^2} = 6 \text{ ksi} \approx 12 \text{ ksi} \]

DRG 3923.130-MB-373973

Refer to 373555 weld analysis.
Weld is 5/16.
<table>
<thead>
<tr>
<th>SUBJEC T</th>
<th>A LATER SUPPORTS</th>
</tr>
</thead>
</table>

**D04G 3823.130-MC-373609 373974**

**LINE 48/3**

373609

Loading is identical to 373936 1715 bolted to 373974 with 2 - 3/8 bolts. Good by inspection

373974

Good by inspection
MODIFY BRACKETS FOR COLL CLEARANCE

BOLT TENSION:

CENTER OF Y = \frac{2 \times 138}{4} = 69\text{ in}

E Y^2 = 2(.77)^2 + (2.5 - .97)^2 + (1.38 - .97)^2 = 4.39\text{ in}^2

EA Y^2 = 0.775 \times 0.39 = 0.340\text{ in}^4

Critical bolt:

M = 600 \times 5.16 = 3096 \text{ in lbs}

f = \frac{3096 \times (2.5 - .97)}{.340} = 14\text{ KSI} < 15\text{ KSI}

STUD MATERIAL:

AISI C-1008 - C-1022

SBS KSI MIN Tensile

F_t = 40000\text{ psi}

F_y = \frac{9}{3} = 15\text{ KSI}

WELD ANALYSIS:

WELD ALONG ONE SIDE AND T3A

SHIM THICKNESS = 1.5

M = 600 \times (5.16 + 1.5) = 4000 \text{ in lbs}

\frac{c_{\text{MIN}}}{c} = \frac{\frac{3.5}{2}}{3.5 + 4.83} = .731

J = \frac{3.5 \times 2.5}{12.12} + \frac{3.5 \times 2.5 \times (3.5 - .731)^2}{4} + \frac{4.98 \times 2.5 \times .731^2}{4} + \frac{4.89 \times 2.5^3}{12}

= 5.84\text{ in}^4

\frac{f_{\text{w},a}}{5.84} = \frac{4000 \times (3.5 - .731)}{5.84} = 1.9\text{ KSI} \leq 12\text{ KSI}

\text{McMaster-Carr page 2796}
<table>
<thead>
<tr>
<th>MOUNT</th>
<th>LOAD</th>
<th>DIRECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>D, E, L, M</td>
<td>750 lbs</td>
<td>DOWN</td>
</tr>
<tr>
<td>A, D, E, F, H, C, F, K, U</td>
<td>150 lbs</td>
<td>DOWN</td>
</tr>
</tbody>
</table>

**LOAD BOLT ON MOUNT WELDMENT BRACKET**

**MOUNTS (1½)**

**MOUNT BRACKET**

**LOAD** = 750 lbs

**MOUNTS (3)**

**LOAD** = 150 lbs