Engineering Note 3823.130-EN-522

A LAYER MDT OCTANT SUPPORT ANALYSIS

BY: Tony Levand March 23, 2000

CHECKED: Rt12Lo

ENGINEERING NOTE

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SUBJECT

A Layer Supports

NAME

Tony Levan

DATE

1/11/00

REVISION DATE

DR4 3923.130-MC-373555

SUPPORT IS BOLTED
TO 373937 OR 373973

SUPPORT WELDMENT

MATERIAL: ASTM A-36 HR FLAT

LOADS:

$$\frac{\text{OCTANT WEIGHT}}{2} = 400 \text{ lbs}$$

$$F_{Ty} = 36 \text{ KSI}$$

$$F_{allow} = \frac{36}{3} = 12 \text{ KSI} \quad \text{Tensile Allowable}$$

$$F_s = \frac{F_{allow}}{2} = 6 \text{ KSI} \quad \text{Shear Allowable}$$

WELD ANALYSIS:

$$M = 400 \times 5.16 = 2064 \text{ in lbs}$$

1/4" weld, ASSUME OUTSIDE WELDS ONLY, PARENT MATERIAL

$$I = \frac{3.25^3 \times .25}{12} \times 2 = 1.1 \text{ in}^4$$

$$\sigma_b = \frac{Mc}{I} = \frac{2064 \times 3.25}{1.1 \times 2} = 3.4 \text{ KSI} < 12 \text{ KSI}$$

$$\text{Shear} = \frac{400}{3.25 \times 2 \times \frac{.25}{\sqrt{2}}} = 348 \text{ PSI}$$

BOLT TENSION:

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

3/8 BOLTS: $P_{allow} = F_{allow} A = 12 \times .0775 = 930 \text{ lbs} > 413 \text{ lbs}$
 shear: $P_{allow/2} = 465 \text{ lbs} > \frac{400}{4}$

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DR4 3323.130-MC-373535 (cont)

BOLT PULL-OUT

SHFAR

SLOT:

$$M = \frac{PL}{8} = \frac{100 \times 1.06}{8} = 13.2 \text{ in lbs}$$

$$f_b = \frac{6M}{B^2} = \frac{6 \times 13.2}{.375 \times .297^2} = 2.3 \text{ KSI} < 12 \text{ KSI}$$

TENSION:

$P_{\text{bolt}} = 413 \text{ lbs}$

ASSUME 1) $\frac{1}{2}$ FLANGE EFFECTIVE IN BEARING

2) TOE ACTION OF FLANGE REACTS MOMENT

$$M = \frac{PL}{2} = \frac{413 \times 1.205}{2} = 249 \text{ in lbs}$$

$$f_b = \frac{6M}{B^2} = \frac{6 \times 249}{[.297 + 1.06] \cdot .375^2} = 7.8 \text{ KSI} < 12 \text{ KSI}$$

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CLEVIS BOLT BENDING $\frac{1}{2}$ shoulder bolt

$$F_{ty} = 160 \text{ KSI} \text{ ①}$$

$$\sigma_{\text{Allowable}} = \frac{F_{ty}}{3} = \frac{160}{3 \times 1.5} = \underline{35.5 \text{ KSI}}$$

$$M = \frac{PL}{4} = \frac{400 \times 1}{4} = 100 \text{ in-lbs}$$

$$I = .5 \frac{\pi^4}{64} = 3.07 \times 10^{-3} \text{ in}^4$$

$$f_b = \frac{Mc}{I} = \frac{100 \times .25}{3.067 \times 10^{-3}} = \underline{8.14 \text{ KSI}} < 35 \text{ KSI}$$

Ref:

① Uni-bolts engineering guide p2

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DRG 3823.130-MC-373332

SUPPORT BRACKET - SIDE OCTANTS OUTBOARD

THE FLANGE IS IDENTICAL TO
373555, LOADS ARE 600 lbs vs 400 lbs

$P = \frac{2}{3} \text{OCTANT} = 600 \text{ lbs}$

WELD:

$$f_b = 3.4 \times \frac{3}{2} = 5.1 \text{ KSI} < 12 \text{ KSI}$$

$$\text{shear} = 417 \text{ PSI}$$

BOLT TENSION

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

BOLT PULL-OUTSHEAR:

$$f_{bA} = 3.5 \text{ KSI} < 12 \text{ KSI}$$

TENSION:

$$f_b = 11.7 \text{ KSI} < 12 \text{ KSI}$$

CLEVIS BOLT

5/8 BOLT IN DOUBLE SHEAR (shoulder bolt)

$$\text{shear strength} = 29,450 \text{ lbs} \gg 600 \text{ lbs}$$

DUNBROOK engineering guide p 13

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ALAYER SUPPORTS

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DRG 3923.130-MC-373937

THIS BLOCK IS WELDED TO THE BEVEL ALONG THE VERTICAL CORNERS OF THE EF APCTURE, BETWEEN THE COILS. IT SUPPORTS THE WEIGHT OF THE OCTANTS 0, 3, 4, 7.

$$\text{SUPPORT WEIGHT} = \frac{\text{OCTANT WEIGHT}}{2} = 400 \text{ lbs}$$

THIS IS A SOLID BLOCK OF STEEL, THUS THE WELDS ONLY ARE CRITICAL.

$$\text{MOMENT APPLIED TO WELDS} = 32549 \text{ in lbs (Mx)}$$

$$\text{NATURAL TO WELDS: } 2301 \text{ TORSION (MY')}$$

$$2301 \text{ BENDING (MX')}$$

$$+ 400 \text{ lbs shear}$$

WELD PROPERTIES:

1/4" WELD

3.25" weld length

$$I_{xx} = \frac{Bh^3}{12} \times 2 = 2 \times \frac{3.25^3}{12} \times \frac{3.25}{12} = 1.26 \text{ in}^4$$

$$J = \sum A d^2$$

$$J = \left[\frac{2^2 + (2^2 + (3.25^2))}{2} \right] \left[\frac{3.25}{2} \times 4 \times \frac{3.25}{12} \right] = 7.63 \text{ in}^4$$

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A LAYER SUPPORTS

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DRG 3823.130 - MC-373937 (cont.)

WELD ANALYSIS (cont.)

$$f_b = \frac{M_c}{I} = \frac{2301 \times \frac{3.25}{2}}{1.26} = 23 \text{ KSI}$$

$$\gamma = \frac{T_c}{J} = \frac{2301 (2^2 + 3.25^2)^{1/2}}{17.63} = 1.45 \text{ KSI}$$

$$f_s = \frac{P}{A} = \frac{400}{\frac{.3125}{\sqrt{2}} \times 3.25 \times 2} = 278 \text{ PSI}$$

Weld stress =

$$\sqrt{3^2 + 1.45^2 + .278^2} = 3.22 \text{ KSI}$$

USING ALLOWABLES FOR THE PARENT MATERIAL (EF IS 100%)

$$F_{ty} = 25 \text{ KSI}$$

$$F_s = \frac{F_{ty}}{2} = 12.5 \text{ KSI}$$

$$F_{s1} = \frac{F_s}{3} = \frac{12.5}{3} = 4.17 \text{ KSI}$$

$$\underline{3.22 < 4.17} \quad \underline{\text{WELD IS OK}}$$

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A LAYER SUPPORTS

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DRG 3823.130-MB-373936-2

THIS PAD SUPPORTS OCTANTS 1, 2 and 5, 6 IN THE Z DIRECTION (BEAM LINE) AROUND THE EF APERTURE. THERE IS NO WEIGHT ON THIS MOUNT. IT WILL BE ANALYZED FOR HANDLING LOADS.

MATERIAL: HR FLAT
ASTM A 36

$F_{TY} = 36 \text{ KSI}$

$F_{allow} = \frac{36}{3} = 12 \text{ KSI}$

FORCE = 100 lbs

$M = 100 \times 1.25 = 125 \text{ in lbs}$

$$f_b = \frac{6M}{bt^2} = \frac{6 \times 125}{2 \times .25^2} = 6 \text{ KSI} < 12 \text{ KSI}$$

DRG 3823.130-MB-373973

Refer to 373555 weld analysis.
weld is 5/16

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DRG 3823.130-MC-373609, 373974

LINK ANGLE

373609

LOADING IS IDENTICAL TO 373936 IT IS

BOLTED TO 373974 WITH 2- $\frac{3}{8}$ BOLTS,GOOD BY INSPECTION373974GOOD BY INSPECTION

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A LAYER SUPPORTS

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2/29/00

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MODIFY BRACKETS FOR COIL CLEARANCE

BOLT TENSION:

CENTROID $\bar{y} = \frac{2.5 + 1.33}{4} = .97$

$\Sigma \bar{y}^2 = 2(.97)^2 + (2.5 - .97)^2 + (1.33 - .97)^2 = 4.319 \text{ in}^2$

$\Sigma A \bar{y}^2 = .0775 \times 4.319 = .340 \text{ in}^4$

critical bolt:

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

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

STEEL MATERIAL: ①

AISI C-1006-C-1022

58 KSI MIN Tensile

$F_y = 46 \text{ KSI}$

$F_u = \frac{46}{3} = 15 \text{ KSI}$

$\frac{1.5 \text{ in} \times 1 \text{ in}}{1 \text{ in}^2} = \frac{1.5}{1 \text{ in}^2}$

WELD ANALYSIS:

WELD ALONG ONE SIDE AND TOP
SHIM THICKNESS = 1.5

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

Centroid @ $\frac{3.5}{2} (3.5) = .731$

$I = \frac{3.5 \times 2.5^3}{12} + 3.5 \times 2.5 \times (3.5 - .731)^2 + \frac{4.93 \times 2.5^3}{12} + 4.93 \times 2.5 \times .731^2$

$= 5.84 \text{ in}^4$

$f_w = \frac{4000 \times (3.5 - .731)}{5.84} = \underline{1.9 \text{ KSI}} < 12 \text{ KSI}$

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A LAYER MDT MOUNT TEST LOADS

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MOUNT	LOAD	DIRECTION
1) A, B, G, H, I, J, O, P BB, CC, FF, GG	750 lbs	DOWN
2) D, E, L, M,	750 lbs	DOWN
3) AA, DD, EE, HH, C, F, K, N	150 lbs	DOWN

LOAD BOLT ON MOUNT WELDMENT BRACKET

MOUNTS (1 & 2)

MOUNT BRACKET

LOAD = 750 lbs

MOUNTS (3)