PROJECT: Western Flyer Crane repair (Allied Sysetms crane)

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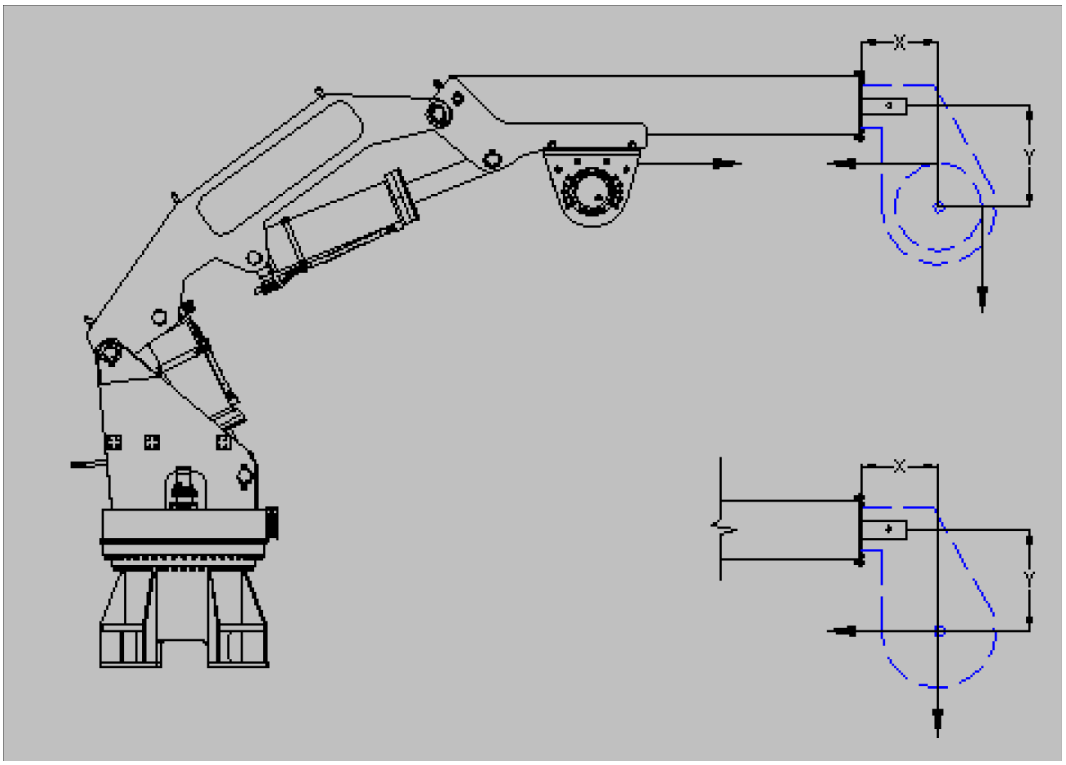
REFERENCE:

Roark's Formulas for Stress and Strain 6th edition

Mechanical Engineering Design: Shigley 5th ed.

Title: Static & Dynamic analysis

PROPERTIES & ASSUMPTIONS:



$X := 11.75 \cdot in$ **HEAD_WEIGHT** $:= 2300 \cdot lbf$

$Y := 29 \cdot in$ **LINE_TENSION** $:= 23780 \cdot lbf$

$\mathbf{MOMENT\_FLANGE} := \mathbf{LINE\_TENSION} \cdot \mathbf{Y} + (\mathbf{LINE\_TENSION} + \mathbf{HEAD\_WEIGHT}) \cdot \mathbf{X}$

$\mathbf{MOMENT\_FLANGE} = 996060\ \mathbf{in} \cdot \mathbf{lbf}$

$\mathbf{b} := 9 \cdot \mathbf{in}$

$\mathbf{d} := 12 \cdot \mathbf{in}$

$\mathbf{INERTIA\_WELD} := (.375 \cdot \mathbf{in}) \cdot (.707) \cdot \left[\frac{(12 \cdot \mathbf{in})^2}{6} \cdot ((3 \cdot 9 \cdot \mathbf{in} + 12 \cdot \mathbf{in})) \right]$

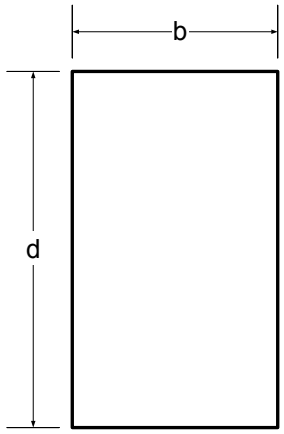
$\mathbf{INERTIA\_WELD} = 248\ \mathbf{in}^4$

$\mathbf{WELD\_STRESS} := \frac{\mathbf{MOMENT\_FLANGE} \cdot 6 \cdot \mathbf{in}}{\mathbf{INERTIA\_WELD}}$

$\mathbf{WELD\_STRESS} = 24083\ \mathbf{psi}$

$\mathbf{FACTOR\_OF\_SAFETY\_WELD} := \frac{70000 \cdot \mathbf{psi}}{\mathbf{WELD\_STRESS}}$

$\mathbf{FACTOR\_OF\_SAFETY\_WELD} = 2.91$



Boom extension
Rectangular Tube

For each Gusset, compute the Inertia:

$\mathbf{INERTIA\_GUSSET} := \frac{.707 \cdot .375 \cdot \mathbf{in} (1.75 \cdot \mathbf{in})^3}{12}$ $\mathbf{INERTIA\_GUSSET} = 0.118409\ \mathbf{in}^4$

$\mathbf{Area\_GUSSET} := .707 \cdot .375 \cdot \mathbf{in} \cdot 1.75 \cdot \mathbf{in}$ $\mathbf{Area\_GUSSET} = 0.464\ \mathbf{in}^2$

$\mathbf{d} := 6.875 \cdot \mathbf{in}$

parallel Axis Th.

$\mathbf{I'} := \mathbf{INERTIA\_GUSSET} + (\mathbf{Area\_GUSSET} \cdot \mathbf{d}^2)$ $\mathbf{I'} = 22.048\ \mathbf{in}^4$

For 4ea Gussets there are 8 welds. Therefore the total Inertia of the Gussets is:

$\mathbf{GUSSET\_INERTIA_T} := 8 \cdot \mathbf{I'}$ $\mathbf{GUSSET\_INERTIA_T} = 176.385\ \mathbf{in}^4$

$\text{Total\_Weld\_Inertia} := \text{INERTIA\_WELD} + \text{GUSSET\_INERTIA}_T$ $\text{Total\_Weld\_Inertia} = 424.542\,\text{in}^4$

Maximum Weld Stress @ end of Gusset:

$\text{Total\_Weld\_Stress} := \frac{\text{MOMENT\_FLANGE} \cdot 7.75 \cdot \text{in}}{\text{Total\_Weld\_Inertia}}$ $\text{Total\_Weld\_Stress} = 1.818 \times 10^4\ \text{psi}$

$\text{Total\_FS\_Weld} := \frac{70000 \cdot \text{psi}}{\text{Total\_Weld\_Stress}}$ $\text{Total\_FS\_Weld} = 3.85$

Looks like we can't get over 4 here but we feel there is plenty of safety factor anyhow.

Below: Jon took a look at trying to plug weld to the existing verticals to see if we gained anything (not much)

Calc Inertia for each Plug Weld:

$\text{INERTIA\_PLUG\_WELD} := \frac{.707 \cdot .375 \cdot \text{in} \cdot (.750 \cdot \text{in})^3}{12}$ $\text{INERTIA\_PLUG\_WELD} = 9.321 \times 10^{-3}\,\text{in}^4$

$\text{Area\_Plug\_Weld} := .707 \cdot .375 \cdot \text{in} \cdot .75 \cdot \text{in}$ $\text{Area\_Plug\_Weld} = 0.199\,\text{in}^2$

$\text{dd} := 5.375 \cdot \text{in}$

parallel axis th.

$I_{pw} := \text{INERTIA\_PLUG\_WELD} + (\text{Area\_Plug\_Weld} \cdot \text{dd}^2)$ $I_{pw} = 5.754\,\text{in}^4$

For 4 plug welds there are 8 weld sides:

$\text{PW\_INERTIA}_T := 8 \cdot I_{pw}$ $\text{PW\_INERTIA}_T = 46.032\,\text{in}^4$