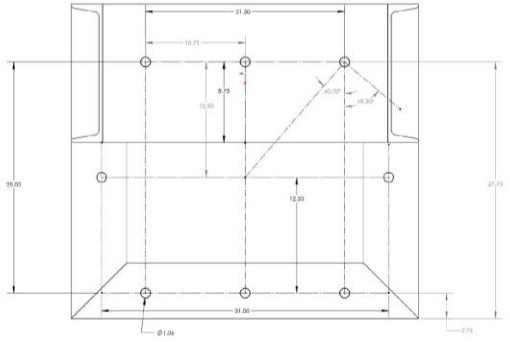
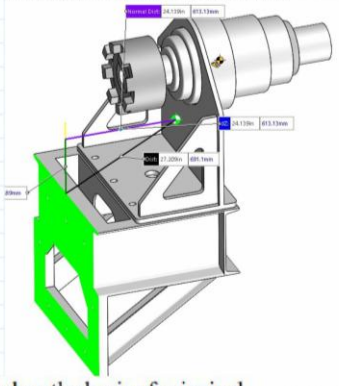
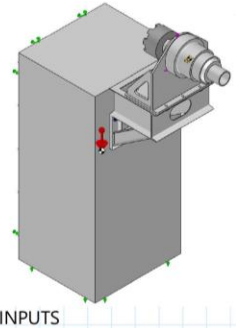
Bolt Stress Calc & Design of Inching Drive for M/C Shop

WO# 50281-Bolted bracket calculation JUL-27-2025

Referece: Machine Design-Bhandari Pg. 247







The bolts can be designed on the basis of principal stress theory or principal shear stress theory.

The principal stress σ_1 is given by,

$$\sigma_1 = \frac{\sigma_t}{2} + \sqrt{\left(\frac{\sigma_t}{2}\right)^2 + \tau^2} \qquad (7.13)$$

The principal shear stress is given by,

$$\tau_{max} = \sqrt{\left(\frac{\sigma_t}{2}\right)^2 + \tau^2} \qquad (7.14)$$

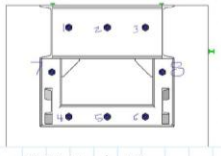
Note: bolts 7 & 8 not considered

INPUTS

$V := 2800 \cdot lb$ Weight including base, reducer, reducer bracket and male coupling

$P := V$

$T := 1052688 \cdot in \cdot lb$ Maximum output torque



$B_{TSA} := .472\ in^2$ Bolt tensile stress area

$N_B := 6$ Number of bolts

$Y_s := 60000 \cdot \frac{lb}{in^2}$ Anchor bolt Yield Strength, considering A354-Grade BD

CALCULATION

Primary Shear Forces, P'=P'1, P'2, P'3, P'4, P'5, P'6,

$$P' := \frac{V}{N_B} = 466.67\ lb$$

$P'_3 := P'$

Obtaining distances from center of bolt pattern to center of bolts r1=r4=r3=r6 and r2=r5

$$r_1 := \sqrt[2]{(10.75 \cdot in)^2 + (12.5 \cdot in)^2} = 16.49\ in$$

$r_2 := 12.5 \cdot in$ $r_7 := 15.5 \cdot in$

From fig.1 we can deduct that bolts 3, 6, 1 and 4 would be under max. shear forces

$$P''_3 := \frac{T \cdot r_1}{4 \cdot (r_1^2) + 2 \cdot (r_2^2) + 2 \cdot (r_7^2)} = 9230.363\ lb$$

Resultant shear force on bolt 3 (Ps)

$$\Sigma Fy := P'_3 + (\langle P''_3 \rangle \cdot \cos(49 \cdot deg)) = 6522.33\ lb$$

$$\Sigma Fx := P''_3 \cdot \sin(49 \cdot deg) = 6966.24\ lb$$

$$P_s := \sqrt[2]{(\Sigma Fy)^2 + (\Sigma Fx)^2} = 9543.03\ lb$$

Hydraulic motor w/ CB valve for metered rotation

STRESS DUE TO TENSION CALCULATION

The moment V x e tends to tilt the bracket about the lower edge, this way the top bolt row is taking maximum forces

$e := 24.25 \cdot in$ base, reducer, reducer bracket and male coupling COG to mounting face

$l_1 := 27.75 \cdot in$ Lower edge to upper bolt row distance

$l_2 := 15.25 \cdot in$ Lower edge to lower bolt row distance

$l_3 := 2.75 \cdot in$

$$P_3 := \frac{P \cdot e \cdot l_3}{3 \cdot (l_1^2 + l_3^2) + 2 \cdot (l_2)^2} = 66.74\ lb$$ Resisting forces in bolts 1 to 3

$$\sigma_t := \frac{P_3}{B_{TSA}} = 141.39\ \frac{lb}{in^2}$$ Stress in bolt due to tension

$$\tau := \frac{P_s}{B_{TSA}} = 20218.27\ \frac{lb}{in^2}$$ Stress in bolt due to shear

$$\tau_{max} := \sqrt[2]{\left(\frac{\sigma_t}{2}\right)^2 + \tau^2} = 20218.4\ \frac{lb}{in^2}$$ Maximum shear stress in bolts

$$L_f := \frac{Y_s}{\tau_{max}} = 2.97$$ Load factor top row bolts

My contribution: Designing the structural components, outsourcing of hydraulic components, design hose paths in assembly and analyse shear stress on hardware under supervision.