Quiz 2

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$\bar{P} = 25000\ N$ $\quad \bar{D} = 0.020\ m$

$S_P = 15\ N$ $\quad S_D = 0.003\ m$

$(U_D)_P = \pm 1\%$ $\quad$ resolution $= 0.02\ mm$

$t = 0.010\ m$

$N_P = N_D = 15$

a) $F_{Br} = P/Dt$

$= 25000\ N / (0.020\ m \cdot 0.010\ m)$

$= 125 \times 10^6\ Pa$

$F_{Br} = 125\ MPa$

b) bias error

$B_t \doteq \emptyset$

$B_P = \pm 1\% \cdot \bar{P}$ $\quad B_D = \pm \frac{1}{2}(0.02\ mm)$

B_p — B_D —

$= \pm 1\% \cdot 25000$ $\quad = \pm 10^{-5}\,m$

$= \pm 250N$

$$B_R = \pm \sqrt{\sum_{i=1}^{N} \left(\frac{\partial R}{\partial x_i}\right)(B_{x_i})^2} \quad (95\%)$$

$$\frac{\partial F}{\partial p} = \frac{1}{Dt}, \quad \frac{\partial F}{\partial D} = \frac{p}{t}(D^{-1})$$

$$= \frac{p}{t}(-D^{-2})$$

$$= \frac{-p}{D^2 t}$$

$$B_F = \pm \sqrt{\left[\frac{B_p}{Dt}\right]^2 + \left[\frac{-pB_D}{D^2 t}\right]^2}$$

$$= \pm \sqrt{\left[\frac{250}{0.020 \cdot 0.010}\right]^2 + \left[\frac{-25000 \cdot 10^{-5}}{(0.020)^2 \cdot 0.010}\right]^2}$$

$$B_F = \pm 1.25\,MPa \quad (95\%)$$

c)

$P_t \doteq \emptyset$

$P_p = \frac{S_p}{\sqrt{N}}$ $\qquad$ $P_D = \frac{0.003}{\sqrt{15}}$

$P_p = 15/\sqrt{15^2}$ $\qquad$ $\boxed{P_D = 7.75 \times 10^{-4}}$

$\boxed{P_p = 3.87}$

$$P_R = \pm \sqrt{\sum_{i=1}^{N} \left(\frac{\partial R}{\partial x_i}\right)^2 (P_{x_i})^2}$$

$$\frac{\partial F}{\partial p} = \frac{1}{Dt}, \quad \frac{\partial F}{\partial D} = \frac{p}{t}(D^{-1})$$

$$= \frac{p}{t}(-D^{-2})$$

$$= \frac{-p}{D^2 t}$$

$$P_F = \pm \sqrt{\left[\frac{3.87}{0.020 \cdot 0.010}\right]^2 + \left[\frac{-7.75 \times 10^{-4} \cdot 2500}{0.020^2 \cdot 0.010}\right]^2}$$

$$P_F = \pm \sqrt{\left[\frac{3.87}{0.020 \cdot 0.010}\right]^2 + \left[\frac{-7.75 \times 10^{-4} \cdot 25000}{0.020^2 \cdot 0.010}\right]^2}$$

$$\boxed{P_F = \pm 4.84 \text{ MPa}}$$

d) overall uncertainty

$P_F = \pm 4.84$ MPa

$B_F = \pm 1.25$ MPa (95%)

$$U_R = \pm \left[B_R^2 + (t_{v,P\%} P_R)^2\right]^{1/2} \quad (95\%)$$

$N = 20$, $v = 19$

$t_{19,95\%} = 2.093$

$$U_F = \pm \sqrt{(1.25)^2 + (2.093 \cdot 4.84)^2}$$

$$\boxed{U_F = \pm 10.21 \text{ MPa} \quad (95\%}$$

$U_F = \pm 10.21$ MPa (95%)

c) appropriateness

$F_{Rivet} = 170$ MPa

$F_{Standard} = 125 \pm 10.21$ MPa (95%)

to meet standard:

$114.79 \text{ MPa} \leq F \leq 135.21$ MPa

∴ the rivet yields at a bearing stress of 170 MPa, it does not fall within the range of the standard for this application

∴ it is inappropriate for this application