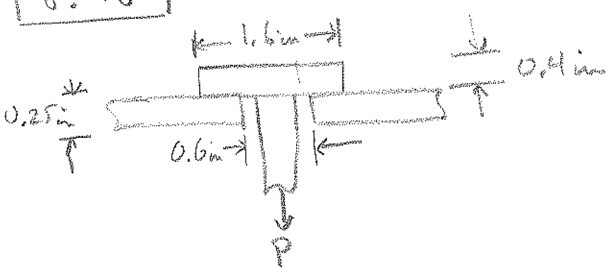
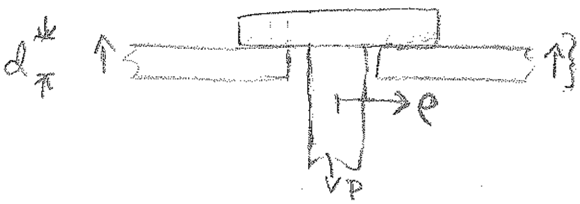
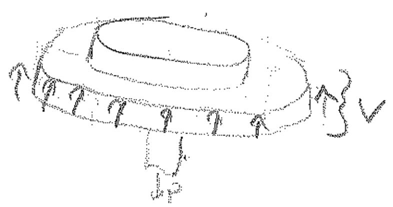
8.16 1 of 2



Aluminum Plate



(2D image)



(3D image)

$$\{\Sigma \vec{F}\} \cdot \hat{j} = -P + V = 0$$

$$V = P$$

$\rho = R \equiv 0.8\,in$ ← the radius of the "head" of the rod.

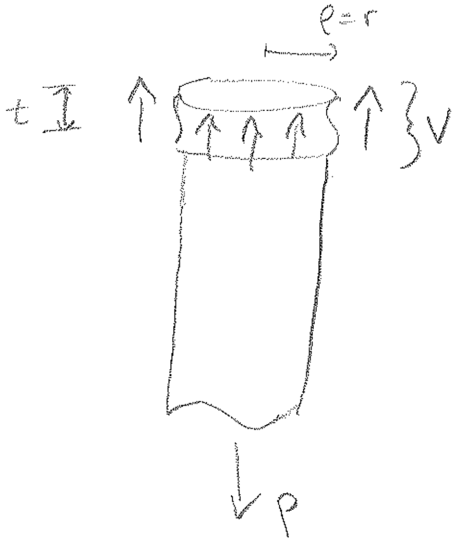
If ρ is less than R, shear force (V) will be less than P.

If ρ is greater than R, cross-sectional area is not minimized.

$\tau = \dfrac{V}{A}$ τ_{max} occurs when V is maximized <u>and</u> when A is minimized

$$\tau_{max} = \frac{P}{2\pi R d} \Rightarrow 10\,ksi = \frac{P}{2\pi(0.8in)(0.25in)} \Rightarrow P = 12.57\ kips$$

Steel Rod "head"



$$\left\{\sum \vec{F}\right\} \cdot \hat{y} = V - P = 0$$

$$V = P$$

$\rho = r \equiv 0.3\,in$ ⟵ the radius of the hole in the plate and (assuming that there is no gap) the diameter of the rod shaft.

$$\tau_{max} = \frac{V}{A} = \frac{P}{2\pi r t} = \frac{P}{2\pi (0.3\,in)(0.4\,in)} = 18\,ksi$$

$$\Rightarrow P = 13.57 \text{ kips}$$

$$\max P = \begin{cases} 12.57 \text{ kips for aluminum plate} \\ 13.57 \text{ kips for steel rod head} \end{cases}$$

max P allowable is $\boxed{P = 12.57 \text{ kips}}$ before aluminum plate fails.

Note If you examine the steel rod shaft

$$\left\{\sum \vec{F}\right\} \cdot \hat{y} = 0 = R_s - P \Rightarrow$$

$$R_s = P$$

Tensile loading ⟹ τ_{max} @ 45°

$$\tau_{max} = \frac{P}{2A_0} = \frac{P}{2\pi r^2} = \frac{P}{2\pi (0.3\,in)^2}$$

$$= 18\,ksi$$

$$\Rightarrow \boxed{P = 10.18 \text{ kips}}$$