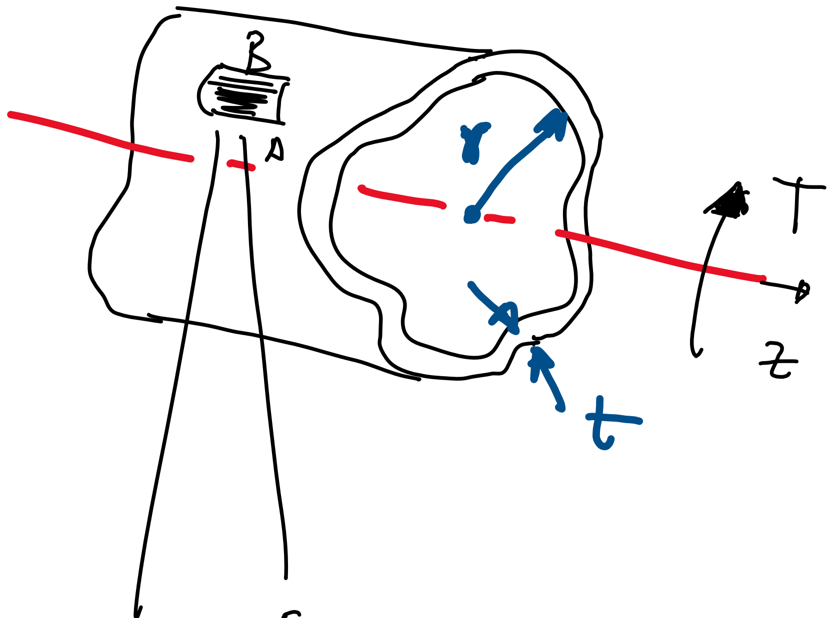
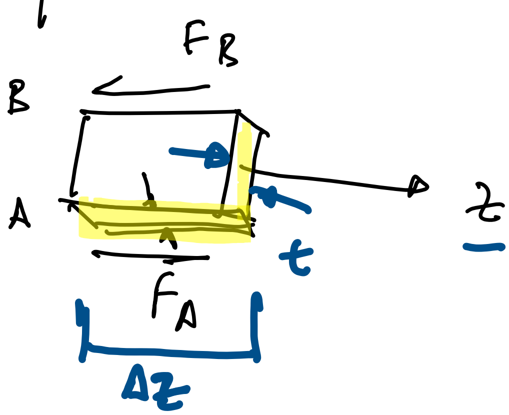
Shear stresses in a thin-walled tube



$r \gg t$

thin-walled

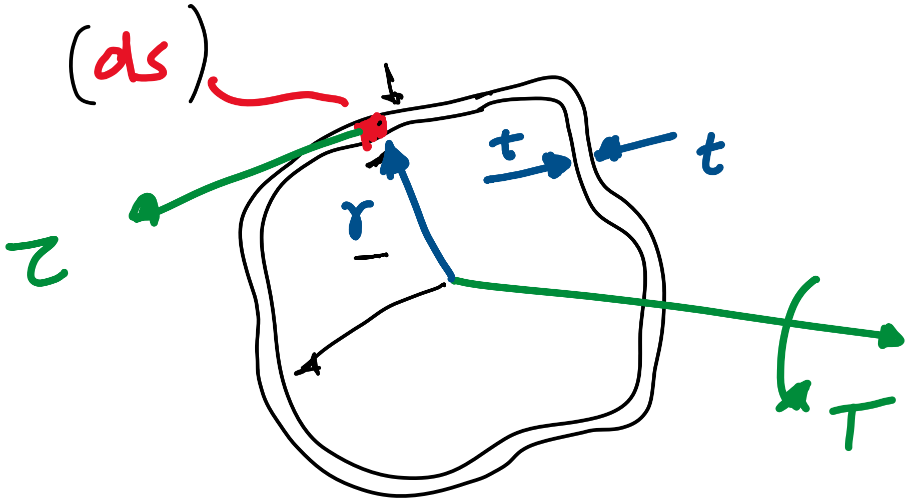


$$\sum F_z = F_A - F_B$$

$$= \tau_A (t_A \, \Delta z) - \tau_B (t_B \, \Delta z) = 0$$

$$\tau_A t_A = \tau_B t_B$$

$$\boxed{\tau t = \text{constant}}$$



$$dF = \tau\, dA = \tau(ds\, t)$$

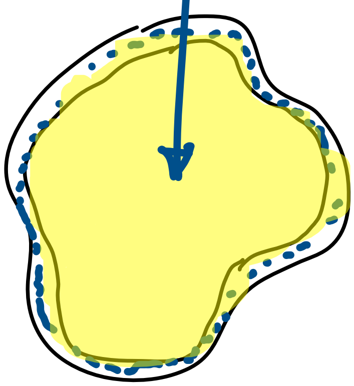
$$T = \int r\, dF = \int r\, \tau\, ds\, t$$

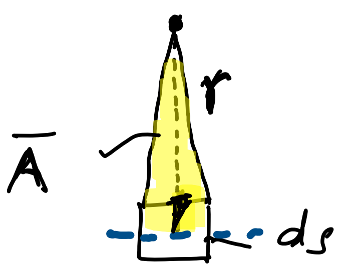
$$T = t\tau \underbrace{\int r\, ds}_{}$$

Why?

$$T = t\tau\,(2A)$$

area enclosed by the median line (dashed line)





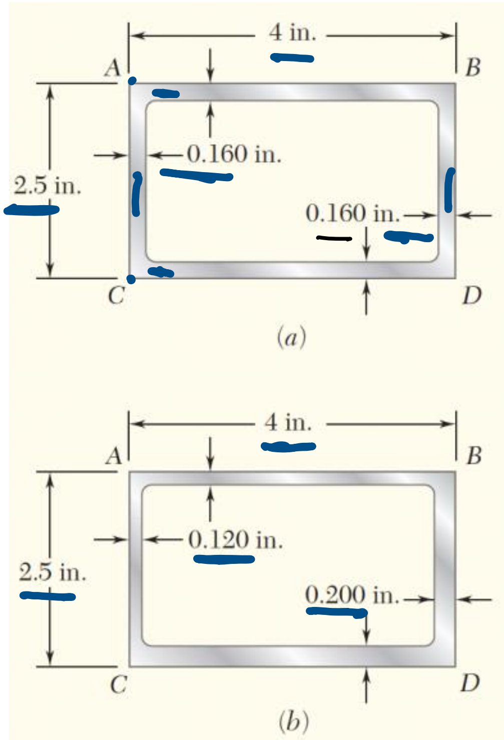
$\bar{A}$ = area triangle $= \frac{1}{2}(ds)\, r$

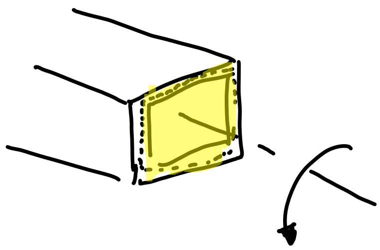
$$2\bar{A} = r\, ds$$

$$\boxed{\tau = \frac{T}{2tA}} \qquad \boxed{\theta = \frac{TL}{4GA^2 t}}$$

Q1

Compute the shearing stress in each of the four walls of two tubings when it is subjected to a torque of 24 kip-in.

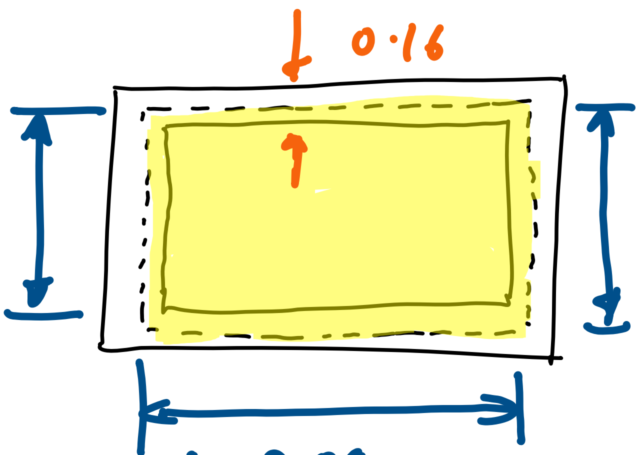




$T = 24$ kip-in

$$\tau = \frac{T}{2tA}$$

(a) $$\tau_{AC} = \tau_{AB} = \tau_{BD} = \tau_{DC} = \frac{T}{2tA} = \frac{24}{2(0.16)(2.34)(3.84)}$$



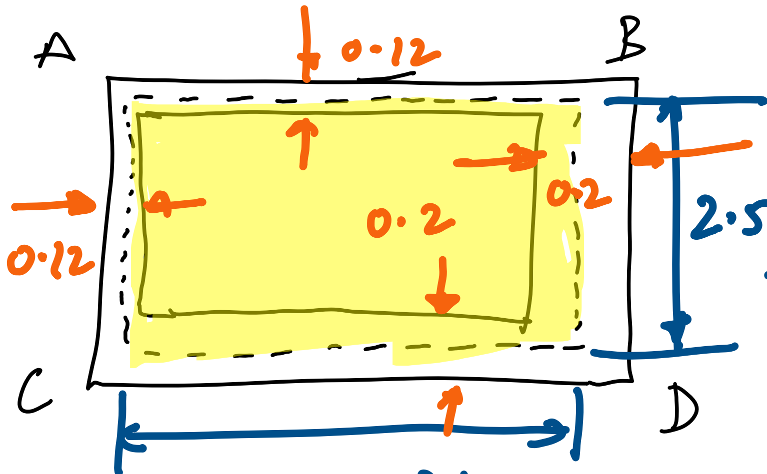
$2.5 - 0.08 - 0.08$
$= 2.34$

$4 - 0.08 - 0.08$
$= 3.84$

$$\boxed{\tau_{AC} = \tau_{AB} = \tau_{BD} = \tau_{DC} = 8.35 \text{ ksi}}$$

(b) $\tau_{AB} = \tau_{AC} = \dfrac{T}{2\underline{t}A} = \dfrac{24}{2(0.12)(2.34)(3.84)} = 11.13$ ksi

$\tau_{BD} = \tau_{DC} = \dfrac{T}{2tA} = \dfrac{24}{2(0.2)(2.34)(3.84)} = 6.68$ ksi



$2.5 - 0.06 - 0.1$
$= 2.34$

$4 - 0.06 - 0.1$
$= 3.84$