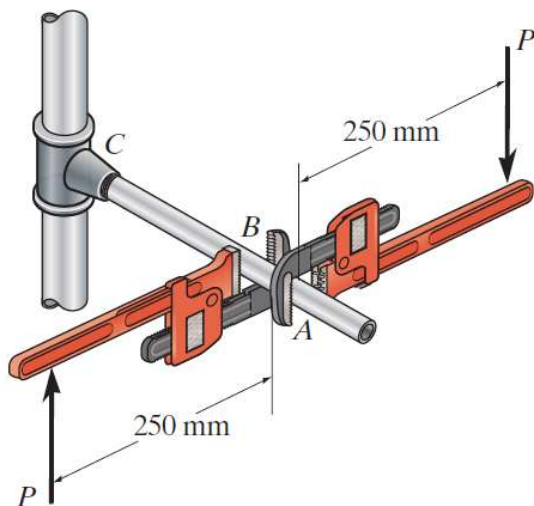


*5-20. Two wrenches are used to tighten the pipe. If the pipe is made from a material having an allowable shear stress of $\tau_{\text{allow}} = 85 \text{ MPa}$, determine the allowable maximum force P that can be applied to each wrench. The pipe has an outer diameter of 25 mm and inner diameter of 20 mm.

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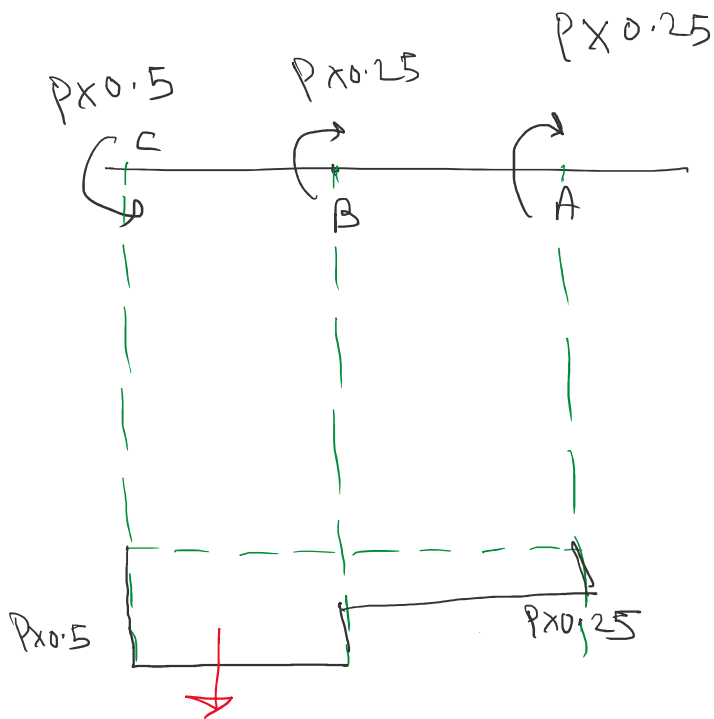


We know

$$\frac{\gamma_{\text{max}}}{R} = \frac{T}{J} \quad [\text{Torsion equation}]$$

T is always internal torque.
which is always found from

which is always found from
internal torque distribution
diagram.



Max. T in BC \Rightarrow critical s/c \downarrow

Shear check on critical
section BC

$$T_{max, BC} = P \times 0.5$$

$$\tau_{all} = 85 \text{ MPa [Given Data]}$$

$$\Rightarrow \tau_{max} = 85 \times 10^6 \text{ N/m}^2$$

From Torsion equation:

$$\frac{\tau_{\max}}{R} = \frac{T_{\max}}{J}$$

For BC (critical S/CN):

$$\frac{85 \times 10^6}{\frac{0.025}{2}} = \frac{P \times 0.5}{\frac{\pi}{2} \left[\left(\frac{0.025}{2} \right)^4 - \left(\frac{0.020}{2} \right)^4 \right]}$$

Solving gives

$$P = 307.925 \approx 308 \text{ N}$$

This problem was solved by Civil Thinking (<https://civilthinking.com>)

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