Mode A

Inputs:

diameter of rod (mm)
force (kN)

Outputs

stress (MPa)

Mode B

Inputs:

diameter of rod (mm)
stress (MPa)

Outputs:

force (kN)

Mode C

Inputs:
force (kN)
stress (MPa)

Outputs: diameter of rod d (mm)

Calculations:

$\sigma \to MPa \quad d \to mm$

$F \to kN$

$$\sigma = \frac{F}{A} \quad \} \text{ general form}$$

$$\sigma = \sigma_{val} \cdot 10^6 \quad (\text{to account for Mega prefix})$$

$$F = F_{val} \cdot 10^3 \quad (\text{to account for Kilo prefix})$$

$$A = \pi r^2 = \pi \left(\frac{d}{2}\right)^2$$

$$= \pi \left(\frac{d_{val}}{2} \cdot \frac{1}{1000}\right)^2 \quad (\text{to account for milli prefix})$$

$$\sigma = \frac{F}{A} \to \sigma_{val} \cdot 10^6 = \frac{F_{val} \cdot 10^3}{\pi \left(\frac{d_{val}}{2} \cdot \frac{1}{1000}\right)^2}$$

$$10^3 \cdot \sigma_{val} = \frac{F_{val}}{\pi \left(\frac{d_{val}}{2000}\right)^2}$$

$$\sigma_{val} = \frac{F_{val} \cdot 2000^2}{1000 \, \pi \, d_{val}^2}$$

① $\sigma_{val} = \dfrac{4000 \, F_{val}}{\pi \, d_{val}^2}$

② $F_{val} = \dfrac{\pi \, \sigma_{val} \, d_{val}^2}{4000}$

③ $d_{val} = \sqrt{\dfrac{4000 F_{val}}{\pi \, \sigma_{val}}}$

$$\underbrace{\text{Cross-sectional area}}_{m^2} = \pi r^2$$

$$= \pi \left(\frac{d}{2}\right)^2$$

$$\sigma = \frac{F}{A} \Rightarrow A = \frac{F}{\sigma}$$

$$\underbrace{= \pi \left(\frac{d_{val}}{2} \cdot \frac{1}{1000}\right)^2}_{\text{in } m^2}$$

$$A_{val} = \frac{F_{val} \cdot 10^3}{\sigma_{val} \cdot 10^{\sigma 3}}$$

$$A_{val} = \frac{F_{val}}{1000 \; \sigma_{val}} \quad \rightarrow \quad A_{val} = \frac{F_{val}}{1000 \; \sigma_{val}}$$