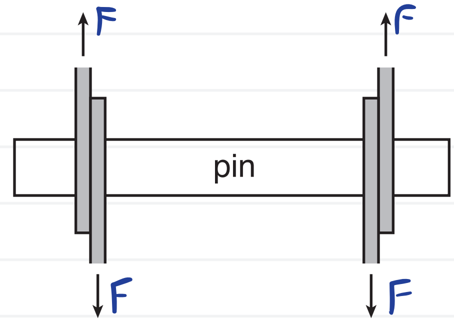
Example

Suppose we are designing a pin for a heavy-duty latch. Suppose the pin is primarily loaded is shear, as shown.



Given that the pin is made of AISI 1050 steel, quenched + tempered to 205 °C, and that we are quite confident in the yield strength in Table A-21 within 20%, and that we are quite confident that we can manufacture a pin within 10% of the nominal diameter D, what should D be? Use $F_{max} = 5 \pm 0.1$ kN and preferred sizing (Table A-17). What is the design factor n_d? What is the factor of safety?

Solution

Force + stress: $\tau = F/A = F/(\pi D^2/4)$.

Strength: yield strength $S_y = 807$ MPa $\Longrightarrow S_{yc} = 646$ MPa

shear yield strength $S_{sy} = 0.577\, S_y$

$= 466$ MPa

$S_{syc} = 0.577 \cdot S_{yc} = 373$ MPa

Conservative stress:

$F_{maxc} = 5.1$ kN. $\tau_c = F_{maxc}/(\pi D^2/4)$

Equate: $\tau_c = S_{syc} \Rightarrow \dfrac{F_{maxc}}{\pi D^2/4} = 373 \text{ MPa} \Rightarrow D = \left(\dfrac{4 F_{maxc}}{\pi \cdot 373 \text{ MPa}}\right)^{1/2}$

$= 4.20$ mm //

Design factor: $n_d = \frac{\text{loss of function strength}}{\text{allowable stress}}$

$$= \frac{S_{sy}}{\tau} = \frac{466 \text{ MPa}}{(5 \text{ kN}/(\pi D^2/4))} = 1.29$$

If we choose a preffered size of 4.5 mm (A-17),

$D = 4.5$ mm → factor of safety: $n_s = \frac{466 \text{ MPa}}{(5 \text{ kN}/(\pi D^2/4))} = 1.48$