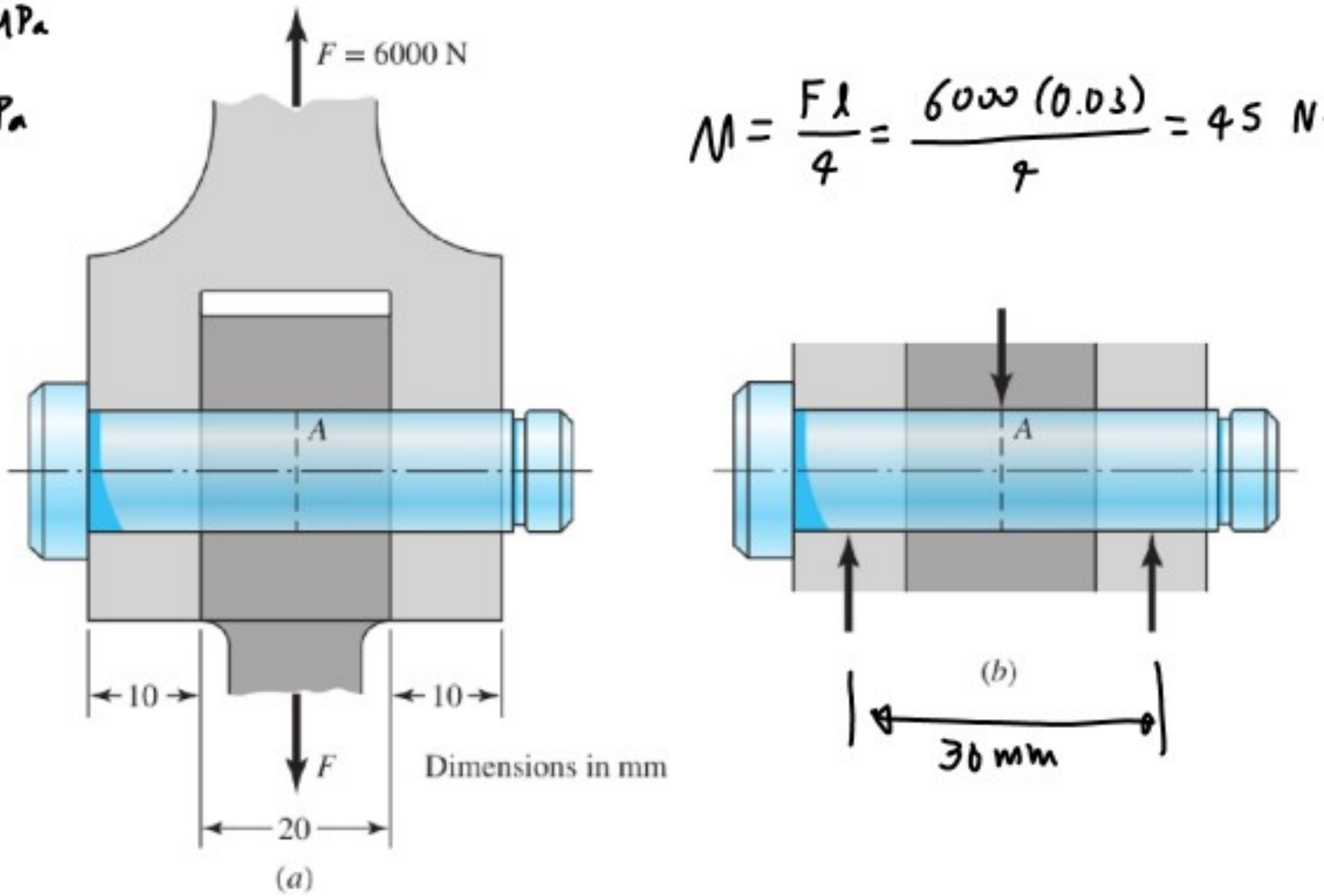
A pin in a knuckle joint is shown in part (*a*) of the figure. The joint is subject to a repeatedly applied and released load of 6000 N in tension. Assume the loading on the pin is modeled as concentrated forces as shown in part (*b*) of the figure. The shaft is made from AISI 1018 hot-rolled steel that has been machined to its final diameter. Based on a stress element on the outer surface at the cross-section *A*, determine a suitable diameter of the pin, rounded up to the next mm increment, to provide at least a factor of safety of 1.5 for both infinite fatigue life and for yielding. Table A-18

Table A-20 $S_y = 220$ MPa

$S_u = 400$ MPa

Table A-9: 5



(a) (b)

$$M = \frac{Fl}{4} = \frac{6000(0.03)}{4} = 45 \text{ N-m}$$

$$I = \frac{\pi d^4}{64}$$

$$\sigma = \frac{Mc}{I} = \frac{45\,\frac{d}{2}}{\pi d^4/64} = \frac{458}{d^3}$$

$$\frac{S_y}{\sigma} = 1.5$$

$$\frac{220\times10^6}{1.5} = \sigma = \frac{458}{d^3}$$

$d = 15$ mm

$S_e' = 0.5(400) = 200$ MPa

$S_e = S_e' \, k_a k_b k_c k_d k_e$ Sec 6-9 pg 309

$= 200 \cdot 0.8 \cdot 1 \cdot 1 \cdot 1 \cdot 1 = 160$ MPa

$d = 17$ mm $k_b = 0.92$

A 1-in-diameter solid round bar has a groove 0.1-in deep with a 0.1-in radius machined into it. The bar is made of AISI 1020 CD steel and is subjected to a purely reversing torque of 1800 lbf · in.

(*a*) Estimate the number of cycles to failure.

(*b*) If the bar is also placed in an environment with a temperature of 750°F, estimate the number of cycles to failure.

Table A-18 $\quad J = \frac{\pi d^4}{32}$

Table A-20 $\quad S_{ut} = 68$ Kpsi

$\tau_{max} = \frac{Tc}{J} = \frac{1800\,(0.4)}{\pi\, 0.8^4/32} = 17.9$ kpsi $\quad = \frac{\pi\, 0.8^4}{32}$

Fig A-15-15

$D = 1$ in $\quad D/d = 1.25$

$d = 0.8$ in $\quad r/d = 0.125$

$r = 0.1$ in

$K_{ts} = 1.4$

$\sigma_{max} = \tau_{max}$

$\sigma_{min} = -\tau_{max}$

$\sigma_a = \left| \frac{\sigma_{max} - \sigma_{min}}{2} \right| = 17.9$ kpsi

$N = \left(\frac{\sigma_a}{a} \right)^{1/b}$

Fig 6-23 pg 307

$a = \frac{(f S_{ut})^2}{S_e}$

$S_e' = 0.5 S_{ut}$

$S_e = S_e' k_a k_b k_c k_d k_e = S_e'\, 0.79 \cdot 0.879 \cdot 0.59$

$b = -\frac{1}{3} \log \left(\frac{f S_{ut}}{S_e} \right)$