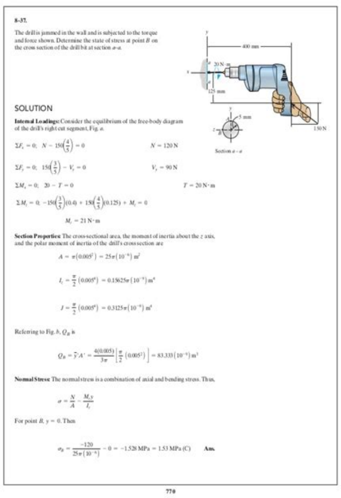

8–37.

The drill is jammed in the wall and is subjected to the torque and force shown. Determine the state of stress at point B on the cross section of the drill bit at section a–a.

SOLUTION

Internal Loadings: Consider the equilibrium of the free-body diagram of the drill's right cut segment, Fig. a.

$\Sigma F_x = 0;\quad N - 150\left(\frac{4}{5}\right) = 0 \qquad N = 120\text{ N}$

$\Sigma F_y = 0;\quad 150\left(\frac{3}{5}\right) - V_y = 0 \qquad V_y = 90\text{ N}$

$\Sigma M_x = 0;\quad 20 - T = 0 \qquad T = 20\text{ N}\cdot\text{m}$

$\Sigma M_z = 0;\quad -150\left(\frac{3}{5}\right)(0.4) + 150\left(\frac{4}{5}\right)(0.125) + M_z = 0$

$M_z = 21\text{ N}\cdot\text{m}$

Section Properties: The cross-sectional area, the moment of inertia about the z axis, and the polar moment of inertia of the drill's cross section are

$A = \pi(0.005^2) = 25\pi(10^{-6})\text{ m}^2$

$I_z = \frac{\pi}{2}(0.005^4) = 0.15625\pi(10^{-9})\text{ m}^4$

$J = \frac{\pi}{2}(0.005^4) = 0.3125\pi(10^{-9})\text{ m}^4$

Referring to Fig. b, Q_B is

$Q_B = \bar{y}'A' = \frac{4(0.005)}{3\pi}\left[\frac{\pi}{2}(0.005^2)\right] = 83.333(10^{-9})\text{ m}^3$

Normal Stress: The normal stress is a combination of axial and bending stress. Thus,

$\sigma = \frac{N}{A} - \frac{M_z y}{I_z}$

For point B, $y = 0$. Then

$\sigma_B = \frac{-120}{25\pi(10^{-6})} - 0 = -1.528\text{ MPa} = 1.53\text{ MPa (C)}$ **Ans.**

770

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