9.48

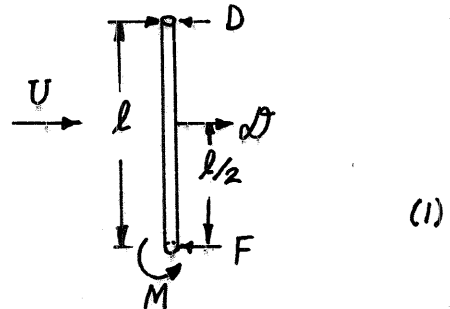**9.48** Determine the moment needed at the base of 20-m-tall, 0.12-m-diameter flag pole to keep it in place in a 20 m/s wind.

For equilibrium, $M = \frac{\ell}{2} \mathcal{D}$ where   (1)

$\mathcal{D} = C_D \frac{1}{2} \rho U^2 \ell D$

Since $Re = \frac{UD}{\nu} = \frac{(20\frac{m}{s})(0.12\,m)}{1.46 \times 10^{-5} \frac{m^2}{s}} = 1.64 \times 10^5$, it follows from Fig. 9.21

that $C_D = 1.2$

Thus, $\mathcal{D} = 1.2 \left(\frac{1}{2}\right)(1.23 \frac{kg}{m^3})(20\frac{m}{s})^2 (20\,m)(0.12\,m) = 708N$

Hence, from Eq. (1)

$M = \frac{20m}{2}(708N) = \underline{\underline{7,080\,N\cdot m}}$