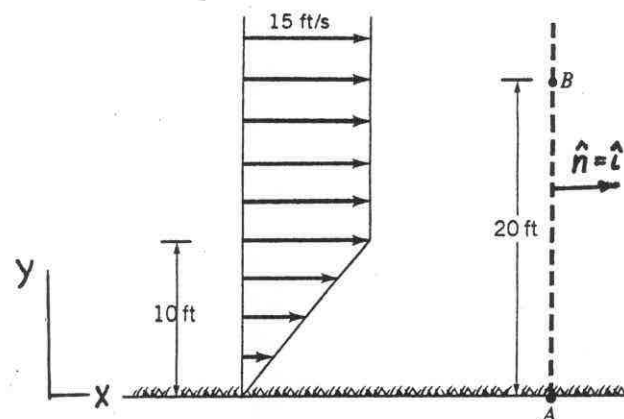


4.73

4.73 The wind blows across a field with an approximate velocity profile as shown in Fig. P4.73. Use Eq. 4.16 with the parameter  $b$  equal to the velocity to determine the momentum flowrate across the vertical surface  $A-B$ , which is of unit depth into the paper.



■ FIGURE P4.73

$$\begin{aligned}\vec{B}_{AB} &= \int_{AB} \rho \vec{b} \vec{V} \cdot \hat{n} \, dA = \int_{AB} \rho \vec{V} \vec{V} \cdot \hat{n} \, dA = \rho \int_{y=0}^{y=20 \text{ ft}} (V \hat{i}) [(V \hat{i}) \cdot \hat{i}] (1 \text{ ft}) \, dy \\ &= \rho \hat{i} \int_0^{20} V^2 \, dy\end{aligned}$$

But,  $V = \frac{15}{10} y \frac{\text{ft}}{\text{s}}$  for  $0 \leq y \leq 10 \text{ ft}$  (i.e.,  $V = 0$  at  $y = 0$ ;  $V = 15 \frac{\text{ft}}{\text{s}}$  at  $y = 10$ )  
and  $V = 15 \frac{\text{ft}}{\text{s}}$  for  $y \geq 10 \text{ ft}$

$$\begin{aligned}\text{Thus,} \\ \vec{B}_{AB} &= \rho \hat{i} \left[ \int_0^{10} \left( \frac{15}{10} y \right)^2 \, dy + \int_{10}^{20} (15)^2 \, dy \right] = \rho \hat{i} \left[ 2.25 \frac{y^3}{3} \Big|_0^{10} + 225 y \Big|_{10}^{20} \right] \\ &= 0.00238 \frac{\text{slugs}}{\text{ft}^3} \left[ 750 \frac{\text{ft}^4}{\text{s}^2} + 2250 \frac{\text{ft}^4}{\text{s}^2} \right] \hat{i} \\ &= \underline{\underline{7.14 \hat{i} \frac{\text{slug ft}}{\text{s}^2}}} = 7.14 \hat{i} \text{ lb}\end{aligned}$$