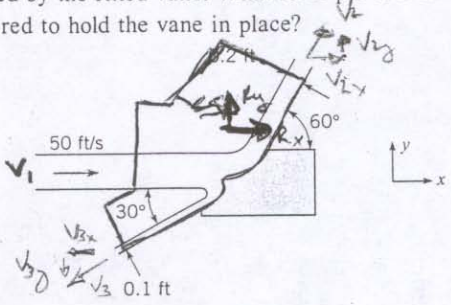
6.11

6.11 This horizontal two-dimensional water jet is deflected by the fixed vane. What force per foot of width is required to hold the vane in place?



PROBLEM 6.11

$$\Sigma F_x = \frac{d}{dt}\int_{cv} \rho u \, d\forall + \int_{cs} \rho u \underline{V} \cdot d\underline{A}$$

$$F_x = \sum_{cs} \rho u \underline{V} \cdot \underline{A}$$

$$F_x = V_1 \rho (-V_1 A_1) + V_{2x} \rho (V_2 A_2) + V_{3x} \rho (V_3 A_3)$$

$$0 = \sum_{cs} \rho \underline{V} \cdot \underline{A} \Rightarrow -V_1 A_1 + V_2 A_2 + V_3 A_3 = 0$$

$$p_1 + \rho/2 V_1^2 = p_2 + \rho/2 V_2^2 = p_3 + \rho/2 V_3^2 \Rightarrow V_1 = V_2 = V_3$$

$$A_1 = (V_2 A_2 + V_3 A_3)/V_1 = A_2 + A_3 = .3 \text{ ft}$$

$$\begin{aligned} F_x &= V_1^2 \rho (-A_1) + V_1^2 \cos 60^\circ \rho (A_2) - V_1^2 \cos 30^\circ \rho (A_3) \\ &= V_1^2 \rho [-A_1 + A_2 \cos 60^\circ - A_3 \cos 30^\circ] \\ &= 50^2 \cdot 1.94 [-.3 + .2 \cos 60^\circ - .1 \cos 30^\circ] \\ &= 2500 \cdot 1.94 (-.287) = -1391 \text{ lbf} \end{aligned}$$

$$\Sigma F_y = \sum_{cs} \rho v \underline{V} \cdot \underline{A}$$

$$\begin{aligned} &= V_{2y} \rho (V_2 A_2) + V_{3y} \rho (V_3 A_3) \\ &= V_1^2 \rho [A_2 \sin 60^\circ - A_3 \sin 30^\circ] \\ &= 597 \text{ lbf} \end{aligned}$$