5.83 A snowplow mounted on a truck clears a path 12 *ft* through heavy wet snow, as shown in Figure P5.83. The snow is 8 *in.* deep and its density is 10 *lbm/ft³*. The truck travels at 30 *mph*. The snow is discharged from the plow at an angle of 45° from the direction of travel and 45° above the horizontal, as shown in Figure P5.70. Estimate the force required to push the plow.
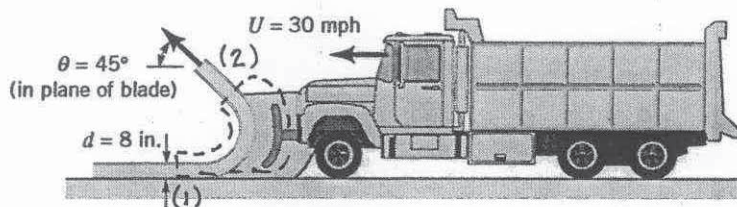

■ FIGURE P5.83

To estimate the force required to push the snowplow we use the control volume shown in the sketch above and Eq. 5.29. We neglect the friction force between the plow and the road surface. We also neglect any force associated with the plow deflecting air. We only consider how much force is required to turn wet snow 135°.

For the wet snow "flow" we get from Eq. 5.29

$$F_x = \dot{m}\,(W_1 + W_2 \cos 45°)$$

Since,

$$\dot{m} = \rho A W_1$$

we assume $W_2 = W_1$ and get

$$F_x = \rho A W_1^2 (1 + \cos 45°)$$

Then

$$F_x = \frac{\left(10\,\frac{lbm}{ft^3}\right)\left(\frac{8\,in.}{12\,in./ft}\right)(12\,ft)\left[\left(30\,\frac{mi}{hr}\right)\frac{\left(5280\,\frac{ft}{mi}\right)}{(3600\,s/hr)}\right]^2 (1+0.707)}{\left(32.174\,\frac{lbm \cdot ft}{lb \cdot s^2}\right)}$$

$$F_x = \underline{\underline{8220}}\ lb$$