5.28

5.28 Water flows through a horizontal, 180° pipe bend as is illustrated in Fig. P5.28. The flow cross section area is constant at a value of 9000 mm^2. The flow velocity everywhere in the bend is 15 m/s. The pressures at the entrance and exit of the bend are 210 and 165 kPa, respectively. Calculate the horizontal (x and y) components of the anchoring force needed to hold the bend in place.

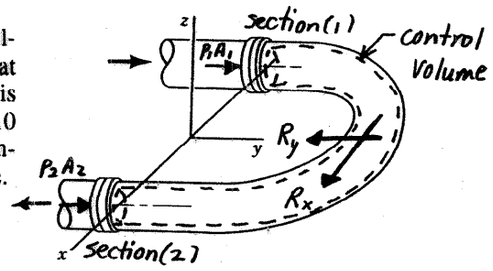

FIGURE P5.28

This analysis is similar to the one of Example 5.11. A fixed, non-deforming control volume that contains the water within the elbow between sections (1) and (2) at an instant is used. The horizontal forces acting on the contents of the control volume in the x and y directions are shown. Application of the x-direction component of the linear momentum equation (Eq. 5.22) leads to

$$R_x = \underline{\underline{0}}$$

Application of the y-direction component of the linear momentum equation yields

$$-v_1(\rho v_1 A_1) - v_2(\rho v_2 A_2) = p_1 A_1 - R_y + p_2 A_2$$

or

$$R_y = \rho A_1 v_1 (v_1 + v_2) + p_1 A_1 + p_2 A_2$$

Thus

$$R_y = \left(999 \frac{kg}{m^3}\right)\left(\frac{9000\ mm^2}{(1000\ mm/m)^2}\right)\left(15 \frac{m}{s}\right)\left(15 \frac{m}{s} + 15 \frac{m}{s}\right)\left(1 \frac{N}{kg \cdot m/s^2}\right) + \frac{(210\ kPA)(9000\ mm^2)}{(1000\ mm/m)^2\left(\frac{1}{1000\ N/m^2 \cdot kPA}\right)}$$

$$+ \frac{(165\ kPA)(9000\ mm^2)}{(1000\ mm/m)^2\left(\frac{1}{1000\ N/m^2 \cdot kPA}\right)}$$

$$R_y = \underline{\underline{7420}}\ N$$