A large, open tank contains water and is connected to a 6-ft diameter conduit as shown in Fig. P2.51. A circular plug is used to seal the conduit. Determine the magnitude, direction, and location of the force of the water on the plug.

\[ F_R = \gamma h_c A = (62.4 \text{ lb/ft}^3)(12 \text{ ft})(\frac{\pi}{4})(6 \text{ ft})^2 = 21,200 \text{ lb} \]

\[ y_R = \frac{I_{xc}}{y_c A} + y_c \quad \text{where} \quad I_{xc} = \frac{\pi}{4} (3\text{ ft})^4 = 63.6 \text{ ft}^4 \]

Thus,

\[ y_R = \frac{\pi}{4} (3\text{ ft})^4 + 12 \text{ ft} = 12.19 \text{ ft} \]

The force of 21,200 lb acts 12.19 ft below the water surface and is perpendicular to the plug surface as shown.