A plate of negligible weight closes a 1-ft diameter hole in a tank containing air and water as shown in Fig. P2.88. A block of concrete (specific weight = 150 lb/ft³), having a volume of 1.5 ft³, is suspended from the plate and is completely immersed in the water. As the air pressure is increased the differential reading, \( \Delta h \), on the inclined-tube mercury manometer increases. Determine \( \Delta h \) just before the plate starts to lift off the hole. The weight of the air has a negligible effect on the manometer reading.

For equilibrium,
\[ \sum F_{\text{vertical}} = 0 \]

So that
\[ W = PA + F_b \]

where:
- \( W \) = weight of concrete
- \( P \) = air pressure
- \( A \) = area of plate
- \( F_b \) = \( b \)

Thus,
\[ (150 \frac{lb}{ft^3})(1.5 \text{ ft}^3) = \rho \left( \frac{16}{9} \right) (1 \text{ ft})^2 + (62.4 \frac{lb}{ft^3})(1.5 \text{ ft}^3) \]

So that
\[ \rho = \frac{167}{\frac{lb}{ft^2}} \]

The manometer equation is
\[ \rho = \delta_{mg} \Delta h \sin 30^\circ \]

So that
\[ \Delta h = \frac{\rho}{\delta_{mg} \sin 30^\circ} \]

\[ = \frac{167 \frac{lb}{ft^2}}{(62.4 \frac{lb}{ft^3}) \sin 30^\circ} = 0.394 \text{ ft} \]