**1.16** A town has a 1-million-gallon storage capacity water tower. If the density of water is 62.4 lb/ft$^3$ and local acceleration of gravity is 32.1 ft/s$^2$, what is the force, in lbf, the structural base must provide to support the water in the tower?

**KNOWN:** A town has a 1-million-gallon storage capacity water tower.

**FIND:** Determine force, in lbf, the structural base must provide to support the water in the tower.

**SCHEMATIC AND GIVEN DATA:**

$\rho_{\text{Water}}$ = 62.4 lb/ft$^3$
$V$ = 1 million gallons
$g_{\text{local}}$ = 32.1 ft/s$^2$

**ENGINEERING MODEL:**
1. Local gravitational acceleration is constant at 32.1 ft/s$^2$.
2. Standard gravitational acceleration is constant at 32.174 ft/s$^2$.
3. The weight of the tower itself is ignored.

**ANALYSIS:** The structure must exert a minimum force equivalent to the weight of the water, which can be expressed as the mass ($m$) of the water times acceleration of gravity, $g$.

$$F = Weight = mg$$

The mass of the water can be determined from its density times the volume the water occupies

$$m = \rho V = \left(62.4\frac{\text{lbf}}{\text{ft}^3}\right)(1{,}000{,}000\ \text{gal})\left|\frac{0.13368\ \text{ft}^3}{1\ \text{gal}}\right| = 8{,}341{,}632\ \text{lbf}$$

Substituting for mass and acceleration of gravity and applying the appropriate conversion factor yield

$$F = mg = (8{,}341{,}632\ \text{lb})\left(32.1\frac{\text{ft}}{\text{s}^2}\right)\left|\frac{1\ \text{lbf}}{32.174\ \text{lb}\cdot\text{ft/s}^2}\right| = \underline{\mathbf{8{,}322{,}446\ lbf}}$$

*Since the water is located in an area where the local acceleration of gravity is less than the standard acceleration of gravity, the water weighs less than an equivalent volume of water located where the acceleration of gravity is the standard value.*