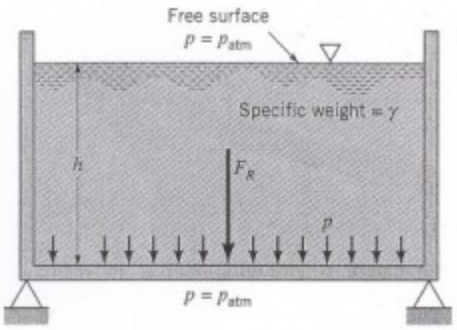
Main question: How exactly the forces exerted by the atmospheric pressure on an open plane tank cancels each other?

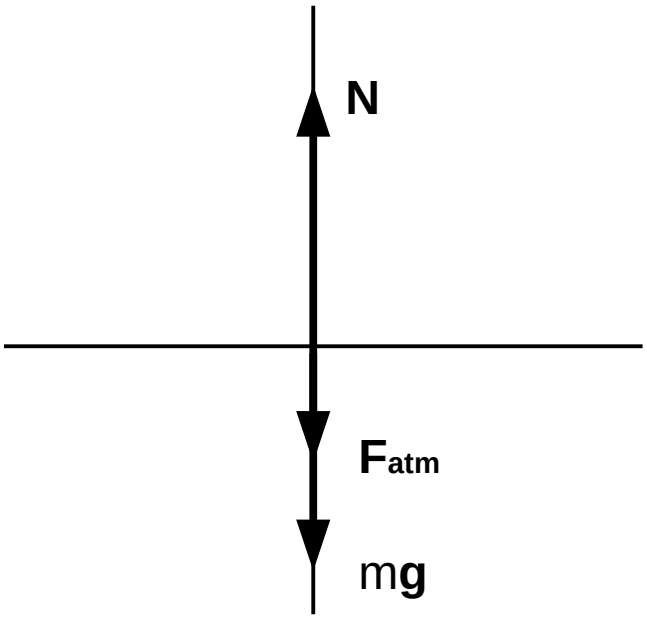



■ FIGURE 2.16 **Pressure and resultant hydrostatic force developed on the bottom of an open tank.**

Consider the liquid-filled tank shown in the figure 2.16. According to this book (see "chapter2_2.pdf", page 61) the atmospheric pressure is not included when you want to calculate the hydrostatic force due to the liquid on the bottom of this open tank because acts on both sides of the bottom. Quote:

**"Note that if atmospheric pressure acts on both sides of the bottom, as is illustrated, the resultant force on the bottom is simply due to the liquid in the tank..."**

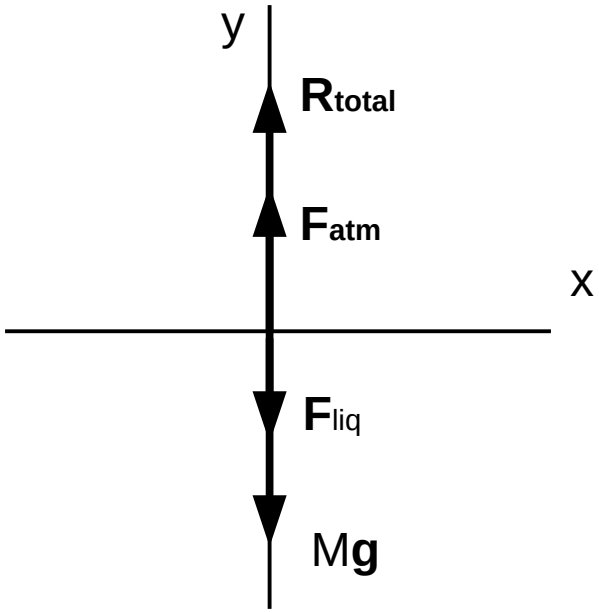
Now, I will try to derive such a result using free body diagram and Newtons laws on the liquid and bottom of the tank. First, lets make a free body diagram (only vertical forces are shown) of the liquid,



where **N** is the normal force that the bottom of the tank exerts on the liquid, $\mathbf{F_{atm}}$ is the force exerted by the atmospheric pressure on the top of liquid and m**g** is the weight of the liquid. Since the liquid is at rest, we have

$$\sum F_{tankY} = N - mg - F_{atm} = 0 \qquad (1)$$

Now, free body diagram of the bottom of tank,




where $\mathbf{R_{total}}$ is the total reaction force acting on the bottom due to the triangles that hold it located at the corners of the bottom, $\mathbf{F_{atm}}$ is the force exerted by the atmospheric pressure, $\mathbf{F_{liq}}$ is the force exerted by the liquid on the bottom and M**g** is the weight of the bottom. Since the bottom is in equilibrium, we have

$$\sum F_{bottomY} = R_{total} + F_{atm} - Mg - F_{liq} = 0 \qquad (2)$$

According to Newton's third law, the force exerted by the liquid equals in magnitude to the normal

force, so

$$N = F_{liq} \qquad (3)$$

inserting eq. (3) into (1),

$$F_{liq} - mg - F_{atm} = 0$$

solving for $F_{liq}$

$$F_{liq} = mg + F_{atm} \neq mg$$

This results contradicts the standard results given by books, according to this the force due to liquid on the bottom of the tank is the weight of the liquid plus the force exerted by the atm pressure. Also, I dont see how the atm pressure cancels so that send me back to the original question. **How the forces exerted by the atmospheric pressure on a plane tank cancels each other?**

**Note: The figure 2.16 is not mine, I took it from this website**

**http://www.geo.hunter.cuny.edu/~hsalmun/intro2fm07web/lectures/chapter2_2.pdf**