Willard Says……

Really useful stuff to know
about things that walk on water

Flotation Facts

Most of us do not give much thought to the laws of physics that describe how we can "walk on water" each time we board a vessel. Usually, the vessel has been floating for a considerable time and we take that as assurance that it will not "let us down" so to speak.

Most of those whose livelihood depend on flotation or are in some way responsible for maintaining the "floatability" of a vessel do not understand why their boat floats. They just know that it does and leave the how and the why to others with the result that it is almost always a big surprise to all concerned when their boat quits floating. Perhaps a refresher course on flotation would be useful.

Any hope that our public school education system is in process of enlightening our young on the subject of flotation were dashed recently. I came across a current fifth grade textbook that introduces the subject of flotation by stating that the ability of a body to float depends on the **shape** of a body. Ignorant statement! The ability of a body of any shape to float depends entirely on the **volume** of water it displaces.

> Note: Scientific types like to use the word "body" to describe most anything. We will be more specific and refer to a "body" as a vessel, dredge or pontoon.

Displacement

Displacement is the "secret ingredient" that enables a vessel to float on water. Any vessel that weighs less than the weight of the water that it displaces will float. If it weighs more than the weight of the water it displaces it will sink. Another way to picture displacement is to think it as the volume of space taken up by that portion of the vessel that is located below the surface of the water beneath the vessel. Displacement is space on a vessel where water would go if it could.

Let us take a 5-gallon bucket out on the dock so that we can fill it with water from the lake. A 5-gallon bucket brim-full of water weighs about 44 lb (42 lbs of water plus 2 lb of bucket). I suppose all of us have filled a small container by simply pushing it straight down into the water until water flows into its open top. We can fill our 5-gallon bucket that way, however, we may find it difficult to push straight down with enough force to sink the bucket and cause water to flow uniformly over its rim. The downward force we apply to the bucket meets increasing resistance as we attempt to sink it further and further into the water. That increase in resistance is the result of increased displacement. The further we push the bucket down in the water the more water we displace and water will not flow over the bucket's rim until we have pushed downward with a force of 40 lb. The weight of the bucket gives us the other 2 lbs we need to displace 42 lbs of water and sink the bucket until water runs over its brim.

The shape the 5-gallon bucket makes no difference. If it weighs 2 lbs it will still require 40 lb of downward force to sink it to the point where water will flow into it all around its rim.

The weight of a floating vessel (a craft designed to navigate on water) can be determined with great accuracy if the volume of water that it displaces is accurately measured. The measurement would be quite complicated if we were attempting to determine the displacement of a cruise or warship's curved and tapered hull. Fortunately, we are concerned ourselves with small dredges, which are made up of easily measured rectangular and cylindrical flotation cells.

Want to know how much your dredge weighs? Measure the hull and pontoons in feet to determine only that volume of each that is below the surface of the water. Add all the volumes together to obtain the total dredge displacement in cubic feet. How do we get from volume to pounds of dredge weight?

A Cubic Foot

A cubic foot (a cube that is 12 inches wide by 12 inches long by 12 inches deep) of fresh water weighs 62.4 pounds (lbs.). Every cubic foot of fresh water out there in that pond or stream or where ever else we find it weighs 62.4 lbs. A cubic foot of salt water weight 64 pounds.

That cubic foot of water does not have to be a cube—it can be any shape as long as its volume is one cubic foot. A cubic foot contains 1,728 cubic inches (12 x 12 x 12). A cubic foot of water could be shaped like a bar that is 1 inch high by 1 inch wide by 1,728 inches (144 feet) long.

If the dredge displaces a total volume of 1,930 cubic feet its total dry weight can be found by multiplying the cubic feet of displaced volume by 62.4 lbs of water per cubic foot. Your dredge weighs 1,930 cubic feet x 62.4 lbs/cubic foot = 120,432 lbs.

If a pontoon boat cruising up the river weighs a total 2,496 lb including the boat, motor, fuel and all the people with their gear it is displacing 40 cubic feet of water. (2,496 lb divided by 62.4 lb per cubic foot = 40 cubic feet).

Lessons learned in this Chapter

- Displacement enables a vessel to float.
- Displacement is measured as cubic feet of space. (It should be obvious that if water can leak through the walls of the displaced volume it will gradually decrease. Prevent leaks!)
- A cubic foot of displacement volume can be any shape.
- A cubic foot of displacement takes up the same amount of space as 62.4 lb of fresh water.
- How to determine the weight of a dredge.

Dredge design considerations

At first I designed dredges with rectangular pontoons because that was what all the other kids had and that was what the customer expected. As I refined my designs to make these machines more productive, durable, unsinkable and less expensive it became obvious that round pontoons offered numerous benefits.

Round pontoons made our dredges "different." Competing dredge builders soon zeroed in on our use of round pontoons and issued dire forecasts of the calamities that awaited their users. One builder prepared and furnished prospective customers with a paper that made numerous claims that, based on "engineering principles," round pontoons were a really bad idea. The paper was so flawed that it gave engineers a bad name.

Another ~~ignorant~~ block-headed detractor claimed that if round pontoons were loaded to the extent that they sank more than half way into water they would just continue to go on down! Perhaps just a victim of a public school education.

Contact willard@willardsays.com with questions, comment or criticism.