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HOW DO YOU CALCULATE THE SHIP AND CALL, SO IT WILL FLOAT

Abstract

The article discusses the calculation of sustainable navigation of vessels in fresh and sea water-numbered based on the consideration of forces acting on a ship. Laboratory work is proposed, covering physics, mathematics, and computer science.

Keywords: stability, Center of mass, Center of tonnage, AR-Achimeda, fresh water, sea water, the density of water.

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A SHIP WILL SAIL THE WAY YOU CALCULATED AND NAMED IT

Abstract

The article discusses the calculation of sustainable ships in fresh and seawater based on re-viewed the forces acting on the ship. A laboratory work, covering physics, mathematics and infor-matics is given.

Keywords: ship stability, center of gravity, center of buoyancy, Archimedes' principle, fresh water, seawater, density of water.

The first author of the article works in the International Association for the properties of water and steam (www.iapws.org). Its members gather every year in different cities peace, closely related to vodoj1. In the year 2014, for example, such a meeting was held at Moskve2, and the final banquet, which is neither scientific event, was on board the ship Xia, kursirovavshego under the walls of the Kremlin. In 2015 year such a meeting was in Stockholm. and the final banquet was held at the Museum of the legendary Swedish sailing Ko rablja "Vase", which was launched in the year 1628. sank. In 1961 year Ko rabl was raised, frozen, restoration and now jeksponi-in a specially built for him by the Museum (fig. 1).

Figure. 1. Restored ship "Vasa"

But the meeting of the International Association for the properties of water and steam, of course, consists not only of the banquets. Falls and work — review and approval to wait for documents describing the procedure for calculating the properties of this important substance [4]. These formulations are becoming standards for all countries and produced guides, given POPs programs for computers. Russian similar reference guide [1] is notable for the fact that he supplemented by Internet sites with open interactive network calculations of properties of water and water vapor. Figure 2 displays one such Internet payments, for which you can define the density of sea water, depending on its temperature, pressure and salinity.

Figure. 2. The website where it is possible to estimate the density of sea water

Online calculation, shown in Figure 2, the author recalled, as he sat at a banquet in the Stockholm museum alongside the unlucky vessel (fig. 1). And here's why. One of the versij3, rollover the vessel "Vase" comes from the fact that it has not been taken into account by changing the density of water at the outlet of the vessel from the freshwater Bay in the salt sea. More dense water lifted the ship, a gust of wind on its krenil and water-through open hatches Cannon gushed in the holds.

So it was, anyway, one could argue, but that there was some sort of engineer-bug with incorrect calculations, is an indisputable fact.

As a model of the ship take the wooden block, in the form of a parallelepiped with parties 10 mm (width "deck" is the variable w),

30 mm (height of the vessel is in) and 250 mm (length — d) (fig. 3, left). This simplification is not so far away from life: a real modern-court are almost rectangular central cross-sections (fig. 3, right), and only the nose and Stern made sharpened to reduce water resistance when DWI situation.

Let's put our model ship in the water so that the sides 10 mm (w) and 250 mm (d) formed the deck and bottom our "ship", and the side 30 mm (in) is the height from the bottom up to the deck. Experience shows that this wooden bruska in water will not be sustained (see fig. 4, left); FT force (gravity, attached to the center of mass) and the strength of the FA (the pushing force of Archimedes, attached to the displacement of the Center, to the center of the liquid volume, eclipsed by a floating body) deployed our "vessel", and it will fall to one side.

Figure. 4. Forces acting on a "vessel" (left-right without ballast is ballasted)

This is explained by the fact that the center of mass was higher Center of displacement, and any small deviation of such a "ship" from the equilibrium position it under the action of couple forces turn over. But this condition is necessary but not sufficient, and we still note below.

To reduce the point location of the center of mass of the sostrugaem let the little plane bottom "ship" and prikleim there a metal strip thickness nm. It will be the same ballast, which should keep the "vessel" from rollovers (see fig. 4, Centre and right). Sailing warships built high to gun shot ahead and it was easy to take boarding enemy ships. Without quite massive ballast such a ship could not resist would be afloat even without the raised sails. Analyze the stability (stability, as saying the professionals [3]) of our "ship" with Mathcad (fig. 5).

Figure. 5. the withdrawal of the formulas for calculating the height of the Centre of displacement (h?) and the center of mass (HT)