THE NEW METHOD OF DETERMINATION OF VESSEL WEIGHT AND APPLICATE OF ITS CENTRE OF GRAVITY BY USING OF ELASTIC INFLATABLE TANKS

НОВЫЙ МЕТОД ОПРЕДЕЛЕНИЯ ВЕСА СУДНА И АППЛИКАТЫ ЕГО ЦЕНТРА ТЯЖЕСТИ С ИСПОЛЬЗОВАНИЕМ НАДУВНЫХ ЭЛАСТИЧНЫХ ЕМКОСТЕЙ

Eng. Sharapov I. [1], Prof. Anosov A.[1]
Department of Shipbuilding and Ocean Technics [1]- Far Eastern Federal University, Russia

Abstract: *The new and modified method of experimental determination of the vessel weight and the coordinates of its center of gravity without launching using inflatable elastic containers are shown in this article.*
KEYWORDS*: VESSEL, INCLINING, TEST, ELASTIC, TANKS*

1. Introduction

The methods of inclining and weighing tests which are proposed in article “Determination of vessel weight and its centre of gravity by using of elastic inflatable tanks”, published in “trans&MOTAUTO’13 digest” had some difficult and limits.

The main difficulty in case of transverse arrange of elastic inflatable tanks (EICT) is to determine the contact area of EICT with the bottom of the vessel. This is due to the fact that when the ship heeled standing on the elastic vessels perpendicular the vessel center line, the contact area takes the curved shape. (fig. 1-3).

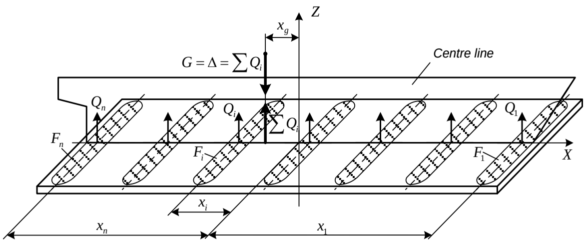


Fig. 1. *Transverse arrangement of EICT*

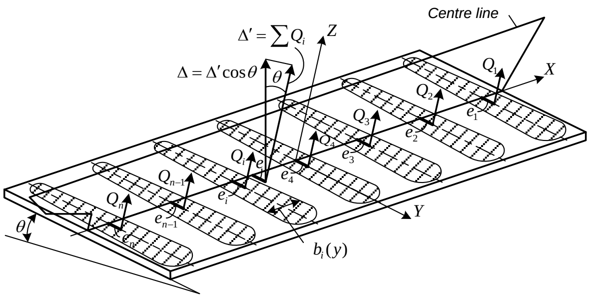
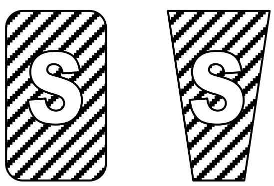


Fig. 2. *Heeled condition of vessel on transverse arranged EICT*



a) b)

Fig. 3. *Comparison of contact area*

a) before inclination

b) after inclination

The second important issue is the strengths problems of the deck for install the solid ballast for heeled condition. The weight of solid ballast is depends on the displacement of the vessel. Installation the cargo on big ships require additional local deck strength calculation. These points makes very difficult to carry out the proposed methods of inclining and weighing tests.

The presented paper work is the development of work on the “Determination of vessel weight and its centre of gravity by using of elastic inflatable tanks”. The paper identified a number of significant challenges. During the elaboration of this issues the technical solutions have been proposed.

To facilitate and accelerate inclining and weighing test the longitudinal placement of inflatable tanks scheme (parallel center line) had proposed. The heeling of the vessel in use of this scheme is due to change the EICT pressure in the EICT located from one side of center line. The advantages of this scheme is that the use of cargo for inclining is not required, hence not require the deck strengths calculations.

To simplify the determination of the contact area are encouraged to use the flat “platform” between EICT and ship’s hull. When using this “platform”, contact area with EICT and bottom of vessel is known and does not change when the vessel heeled.

These solutions help to simplify and expedite the inclining and weighing tests by using of EICT.

2. Description of new method

The proposed method is based on two solutions to simplify the calculation process. The main difference - longitudinal position of inflatable elastic tanks symmetrically relative to the center plane. (Fig. 4).

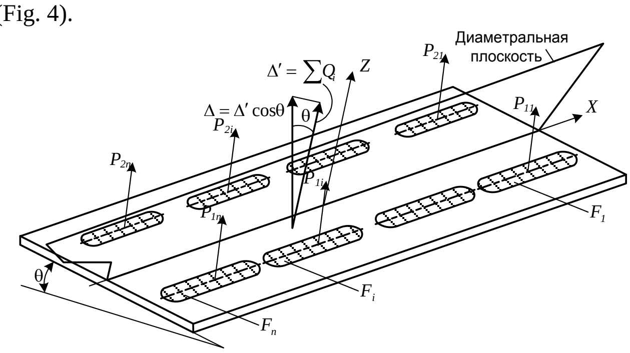


Fig. 4. *Determination of vessel weight and applicate of centre of gravity without solid ballast*

EICT group of each side connected to compressed air systems and fitted with pressure gauge. Thus, by changing the pressure in tanks on one side, can change the position of the hull. Consequently, applying bank housing can be produced without the use of pressure roll changing ballast tanks on one side. (Fig.5).

The second solution is to use a rigid rectangular pad is positioned between the EICT and the vessel's hull. (Fig. 6).

Use of this site makes known and constant contact area with the hull capacity and greatly simplifies the calculations.

Using this method can greatly simplify the calculations. In contrast to the long and complex calculations proposed in the first article, the new method of calculation reduces to determining the pressure in the cylinders, the calculation of the total contact area and the calculation of the angle of the hull.

Drafted by a mathematical model allow to calculate the weight of the vessel and the applicate of vessel center of gravity.

Vessel weight G, equal to the sum of responses P_i.

$$G = \Sigma P_i$$

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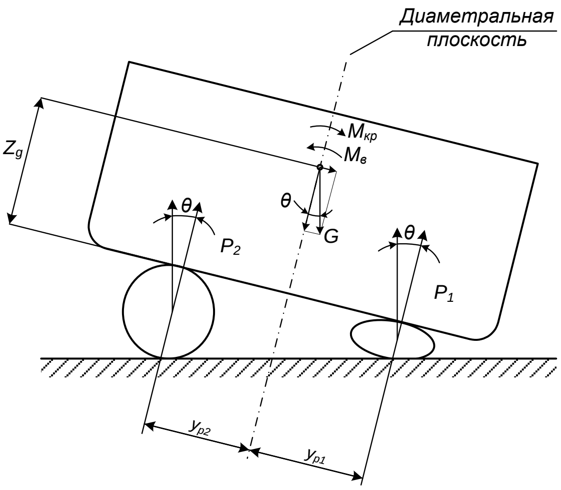

Fig. 5. *Calculation of applicate of centre of gravity*

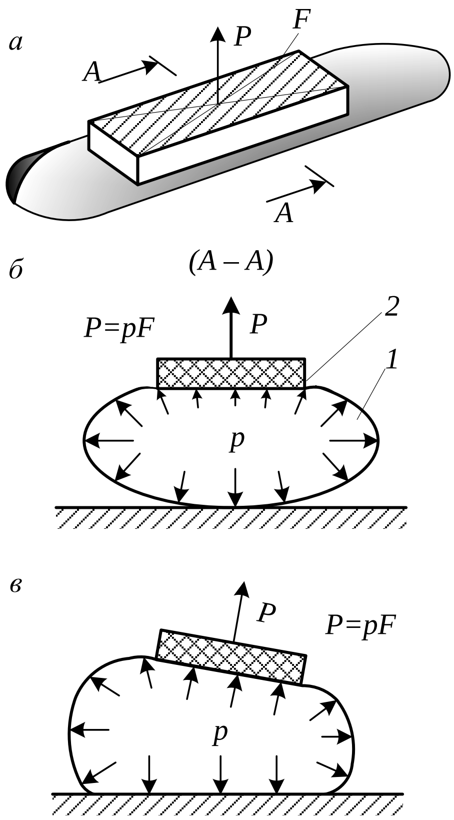

Fig. 6. *Flat platform between EICT and ship's hull*
a – general view; б – section in the equilibrium position without heel; в – section in the heeled condition

When heeled vessel weight of the vessel is determined by the formula 1.

$$G = \Sigma P_i \cdot cos\theta \qquad (1)$$

When heeled vessel heeling and righting moment are, respectively:

$$M_{кр} = -G \cdot z_g \cdot sin\theta;$$
$$M_в = P_1 \cdot Y_{p1} - P_2 \cdot Y_{p2};$$
$$\Sigma M_i = 0;$$
$$M_{кр} + M_в = 0;$$

Applicate the center of gravity is calculated by equating the moments of Equation 2.

$$-z_g \cdot sin\theta + P_1 \cdot Y_{p1} - P_2 \cdot Y_{p2} = 0$$

$$-z_g = \frac{P_1 \cdot Y_{p1} - P_2 \cdot Y_{p2}}{G \cdot sin\theta};$$

$$z_g = \frac{P_1 \cdot Y_{p1} - P_2 \cdot Y_{p2}}{(P_1 + P_2) \cdot sin\theta \cdot cos\theta} = \frac{2(P_1 \cdot Y_{p1} - P_2 \cdot Y_{p2})}{(P_1 + P_2) \cdot sin2\theta} \qquad (2)$$

3. *Conclusion*

As seen from the calculations, the mathematical apparatus developed a new technique allows to save time and simplify the calculations. At the moment, to test the theory developed a model experiment.

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