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THE INFLUENCE OF DAMAGE PARAMETERS OF THE SHIP HULL ON THE FLOODING TIME OF THE AUXILIARY POWER PLANT THE SHIP TYPE 888

ABSTRACT

Research on damage stability and unsinkability establishes the source of the knowledge according to a ship reaction after flooding the compartment. The flooding time of the damaged compartment is one of the basic parameters which has influence on the rescue action. Knowledge of the flooding time compartment is very important for the commanding officer making decisions while fighting for unsinkability and survival of the ship. The computational method was designed to provide information about possibility of calculation a flooding time of damaged the auxiliary power plant. On the basic of the built computer program, a simulation of the flooding process of the damaged compartment ship's type 888 was shown. Results received from research can be basic information to make a decision to carry out a proper action of damage control.

Keywords:
stability and unsinkability of a warship model, permability, flooding time, watertight compartment.

INTRODUCTION

The warship represents a complex technical system, which comprises a lot of technical equipment, that operational reliability has a serious influence on her warfare ability [3]. During warfare there may happen partial or total loss in functioning mechanisms and installation, in a work, the occurrence of breakdown.

Failures which are caused by navigational mistakes or manoeuvre ability represent the next group of reason for ship accidents and breakdowns. Flooding the ship compartment or the whole ship can be results of those damages.

In such a situation the crews activities decide about fighting ability of a warship and should be directed to carry out a proper action of damage control and protect a stability, sinkability and manoeuvre of the ship.

THE FLOODING TIME SHIP'S COMPARTMENT CALCULATION

The first stage of the flooding compartment time calculation is an assessing the water velocity flooding through the hull damage. Water flowing through the hole can be compared to the established flowing liquid phenomenon from the tank with a free surface *A*. Then, the water velocity can be obtained from the mathematic formula [5]:

$$v_w = \sqrt{\frac{2 \cdot g \cdot h_z}{1 - \left(\frac{A_0}{A}\right)^2}}, \tag{1}$$

where: A_0 — a cross section of a hole;
A — a horizontal cross section of a tank;
g — an acceleration due to gravity;
h_z — a high of a liquid inside the tank.

When the hull is damaged, in comparison with a sea surface, the surface of the hole is as small as the water velocity can be obtained according to Torricelli's formula [5]:

$$v_w = \sqrt{2 \cdot g \cdot h}, \tag{2}$$

where h — a depth of the hole.

For the real liquid the formula is [5]:

$$v_w = \varphi \cdot \sqrt{2 \cdot g \cdot h}, \tag{3}$$

where $\varphi = 0{,}97 \div 0{,}98$ — the velocity coefficient depended on the kind of liquid [5].

This equation is applied when the water surface, inside the hull, is below the lower edge of the hole. It means a constant pressure of the water. When the water pressure is changeable (the water surface inside the hull is above the edge of the hull and steel grow up) the velocity of the water flooding to the compartment can be obtained according to the formula [5]:

$$v_w = \varphi \cdot \sqrt{2 \cdot g \cdot (h - h_0)}\,, \tag{4}$$

where h_0 — a high of a liquid inside the tank above the edge of the hole.

The hole of the hull can have a different shape and dimension depended on the reason of damage. The influence of the damaged shape on the quantity of the water flooding to the compartment Q is applied by the narrowing coefficient $\chi = 0{,}61 \div 0{,}64$ [5]. The product of coefficients φ and χ, marked ν, depends on the shape of the hole. Therefore, the quantity of water, which will flood to the inside of the compartment can be obtained from the formula [5]:

$$Q = A_0 \cdot \nu \cdot \sqrt{2 \cdot g \cdot h}\,. \tag{5}$$

When the water pressure is changeable the quantity of water inside the compartment is calculated from the formula [5]:

$$Q = A_0 \cdot \nu \cdot \sqrt{2 \cdot g \cdot (h - h_0)}\,. \tag{6}$$

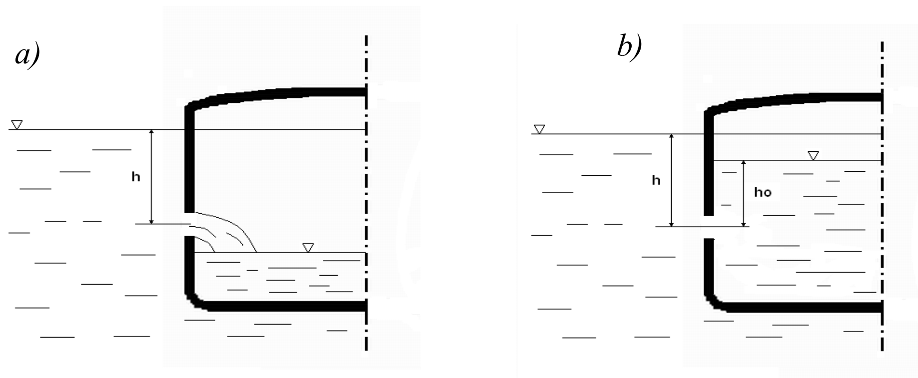

Fig. 1. Flooding the compartment: a) with a constant water pressure; b) with a changeable water pressure [3]

The flooding time of a ship's compartment is obtained [5]:

$$t = \frac{V}{Q}\,, \tag{7}$$

where V — the volume of the water inside the compartment.

The computation of the flooding time of the compartment was conducted for the damaged auxiliary power plant of the ship type 888. The computer and simulate program of the flooding process of the damaged compartment was built. Thanks to those programs, basic and necessary parameters to make a correct assessment of the ship's state after damage enable us to carry out a proper action of damage control.

THE VOLUME OF THE DAMAGED COMPARTMENT COMPUTATION

The damaged compartment volume is necessary to calculate the flooding time of the compartment. The lines plan of the ship's hull are supplied to computation the theoretical compartment volume v_t. On the basic of the lines plan, extracted sections on ribs number 25,30,35 of the damaged compartment were made. Sections are shown in fig. 2 [4].

The area of sections was calculated to estimate the accurate volume of the damaged compartment. Integral curves of sectional areas, received in this way, are presented in graphic form as a multinomial 7 degrees in fig. 3.

The theoretical compartment volume v_t can be calculated, knowing section areas and a distance between them, by the formula [1, 2]:

$$v_t = \sum \frac{(F_i + F_{i+1}) \cdot l_w}{2}, \tag{8}$$

where: l_w — the distance between sectional areas;

F_i, F_{i+1} — section areas.

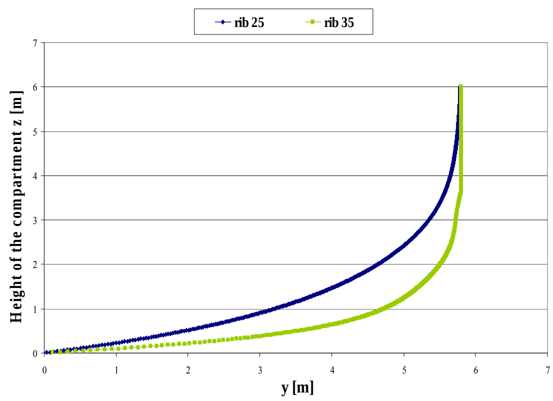

Fig. 2. Sections of the auxiliary power plant

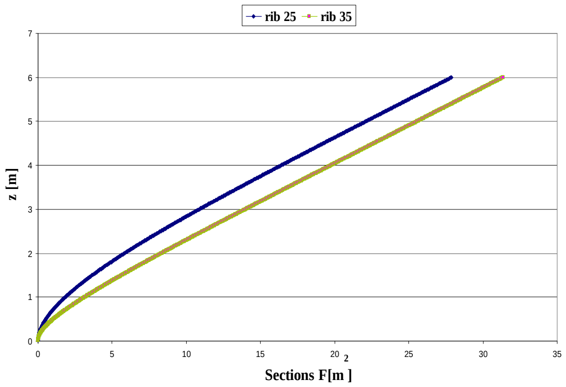

Fig. 3. The integral curve of sectional areas

The volume of the empty compartment was obtained as a result of a carried out calculation following the computer program. The volume of the empty compartment equals v_t = 329,3 m^3. The real quantity of the water, flooding the compartment, is less than theoretical volume of compartment because of volume of all mechanisms and devices inside it. The volume obtained from the measurement all mechanisms and devices equals v_u = 26,7 m^3. Hence, the real volume of water filling the compartment up equals v = 302,6 m^3. The volume of the auxiliary power plant obtained in such a way was taken to the calculation of the flooding time of the compartment.

The permeability of the compartment μ_v , which is obtained by the SOLAS 2006, is usually used to calculate the real volume of the compartment. During the preliminary research, the permeability was estimated. It depends on the water height level inside the compartment. The graph of the permeability is shown in fig. 4 [4].

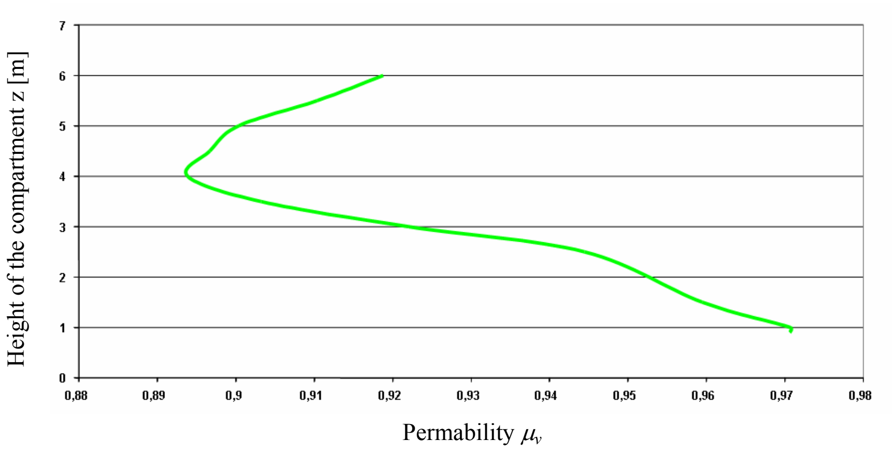

Fig. 4. The graph of the permeability μ_v for the auxiliary power plant

The average value of the permeability for the auxiliary power plant, obtained on the basic of research, equals 0,92 [4]. This value is comparable with the value of the SOLAS 2006, which equals 0,85.

The simulation model of the auxiliary power plant, equipped with all main mechanisms and devices, was made in the next part of research. The view of the flooding compartment is shown in fig. 5 [4].

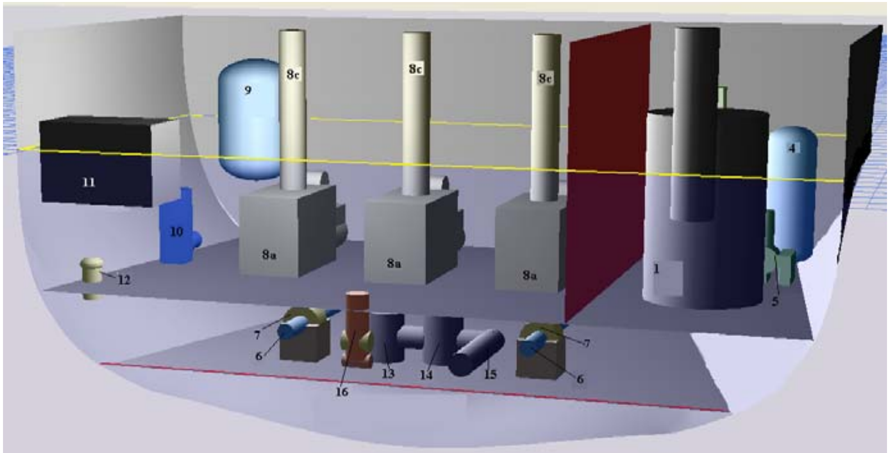

Fig. 5. The view of the partial flooding auxiliary power plant of ship's type 888

THE ANALISIS OF DAMAGE PARAMETERS INFLUENCE ON THE FLOODING TIME ON THE AUXILIARY POWER PLANT

The experimental research on the flooding time of the auxiliary power plant ship's type 888 was led for the different parameters of damages. During the research parameters of both, the place and the dimension of damage were taken into consideration.

The flooding time of the compartment was carried out in the first part of the research when the ship's draught equalled $T=4$ m and the dimension of damages with the radiuses equalled: $R=0{,}1$ m, $R=0{,}2$ m. The holes were placed from 0,1 m to 3,0 m below the sea water surface. The results of the research are shown as a graph form in fig. 6.

From curves presented in fig. 6 we can notice that the flooding time of the compartment for damage with dimension equals $R=0{,}2$ m placed 3 m below a sea water surface equals 4,4 minutes. This time is so short, that the fighting for unsinkability is senseless and a crew should leave the damaged compartment and direct all the efforts to protect spreading water covering the ship and strengthen the construction of the watertight bulkhead.

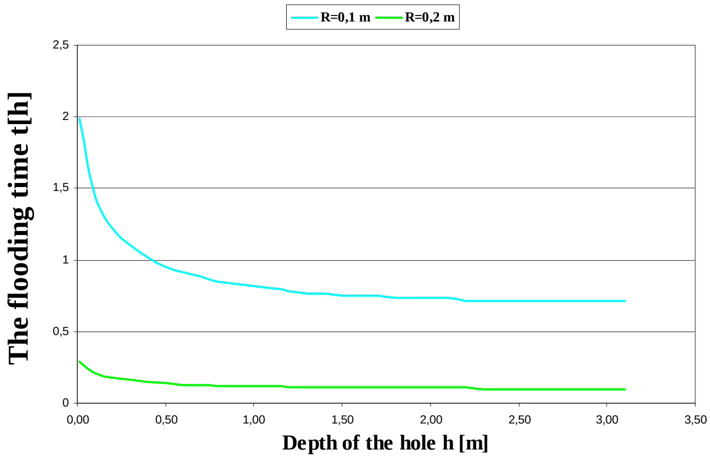

Fig. 6. The graph of the compartment flooding time depended on the place of damage

CONCLUSIONS

The presented method of the permeability determination enables us appointing its value depended on the water level inside the compartment. The flooding time damaged compartment depends on not only the dimension, but the place of damage as well. Knowledge of the flooding time compartment lets a commanding officer to make decisions while fighting for unsinkability and for the survival of the ship.

The compiled method can be abused to calculate the flooding time of damaged auxiliary power plant ship's type 888 and other watertight compartments depended on the damaged ship's hull parameters. This method can be adopted for different type of warships.

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STRESZCZENIE

Badania stateczności awaryjnej i niezatapialności okrętów stanowią źródło wiedzy na temat zachowania się okrętu po zatopieniu jego przedziałów. Jednym z podstawowych elementów mających istotny wpływ na prowadzenie akcji ratowniczej — w wyniku uszkodzenia kadłuba okrętu — jest określenie czasu zatopienia uszkodzonego przedziału. Znajomość czasu zatopienia przedziału okrętowego stanowi ważną przesłankę dla osoby odpowiedzialnej za bezpieczeństwo okrętu do wypracowania decyzji o sposobie walki o jego żywotność. W artykule zaprezentowano metodę obliczeniową czasu zatopienia uszkodzonego przedziału siłowni pomocniczej. Dokonano analizy wyników obliczeń oraz zaprezentowano komputerową symulację zatapiania siłowni pomocniczej okrętu typu 888 na podstawie opracowanego programu komputerowego. Otrzymane wyniki badań mogą być podstawową informacją do wypracowania decyzji o przeprowadzeniu odpowiedniej akcji ratowniczej przez osoby odpowiedzialne za bezpieczeństwo pływania.

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