Waldemar Mironiuk
Akademia Marynarki Wojennej

COMPUTER VISUALISATION OF FLOODING DAMAGED COMPARTMENTS IN VESSEL TYPE 888

ABSTRACT

The paper presents research on damage stability and unsinkability. The result of it is a valuable source of knowledge of ship performance while flooding its compartments. The paper includes a short description of accidents of and damage sustained by Polish vessels in 1985–2004. It also includes the method for calculating a volume of a damaged compartments. To calculate a real quantity of the water, the permeability of flooding compartment μ is used. Permeability of the main engine and auxiliary power plant was estimated on the basis of preliminary research presented in the paper. Its value depends on the height of the water inside the compartment. The built-in computer program was used to show the simulation of the flooding process of the damaged main engine and auxiliary power plant in ship type 888 was shown. The results of the experiments can be a base to define general rules to make proper decisions during the process of damage control.

Keywords:
damage stability, flooding damaged compartments, vessel type 888.

INTRODUCTION

Even highly organized fleets struggle with accidents and technical breakdowns which cannot be completely eliminated. The breakdowns can be classified based on their causes. The basic causes of the breakdowns are: warfare, defects of materials and defects within the production process, constructional defects, technological defects in the process of renovation, material's wear and tear, not meeting the requirements in operating and servicing an equipment, not taking security measures while storing dangerous cargoes, e.g. explosive materials, petroleum products and other chemical components of serious fire hazard.

A partial or total loss in functionality of mechanisms and installations can occur both during warfare and during daily operating a ship. Failures caused by navigational mistakes or wrong maneuverability represent a group of ship accidents and breakdowns which can lead to dangerous lost of floating of a ship due to flooding its compartments. The statistical data prepared by the Polish Navy Commission of Warship Accidents and Breakdowns reveal 156 vessel accidents and breakdowns between 1985 and 2004 year. The data mentioned are presented in figure 1 [4].

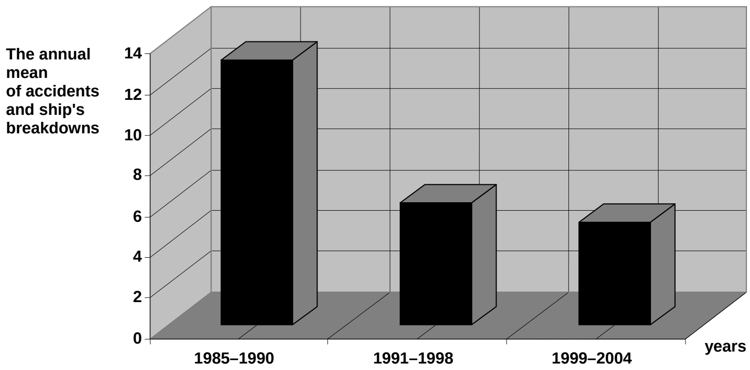


Fig. 1. The overall structure of accidents and breakdowns between 1985–2004

Source: own study.

In a situation of a breakdown crew activities deciding about ability of a vessel to fight should be directed to take a proper actions during the process of damage control and to protect stability, sinkability and maneuverability of the ship.

Exercises within the confines of the process of damage control, apart from construction solutions, increase the safety of both a ship and crew. Training is carried out in well prepared training centers which are situated in the United Kingdom, Germany, Netherlands and Pakistan. The centers are equipped with ship models designed for simulating failure states which most frequently occur while operating a ship. The same models were also used in the experiments reported in the paper. One of the goals of the experiments mentioned was to determine the following parameters: real quantity of water inside the damaged compartments and draught of the ship type 888 after hull damage. Presently, there are used only simplified method to calculation parameters above. The method presented in the paper has a distinctive difference compared to the existing, similar methods talk in some publications. The worked out method presents the permeability value depended on the water level inside the damaged compartment. Due to this, we can estimate more accurate quantity of the water in the compartment and finally more accurate the flooding time damaged compartment. The aim of presented method is providing experimental validation.

Information about: real quantity of water inside the damaged compartments and stability parameters is very important for a commanding officer. It enables him to make a proper decision during the process of damage control. The officer, based on the information should determine the point in time, when further fighting for unsinkability is senseless and when all effort should be directed to save the crew and documents.

COMPUTING THE VOLUME OF DAMAGED COMPARTMENTS

The volume and shape of a damaged compartment is necessary to present a simulation process of flooding damaged compartments. The lines plan of the ship's hull is used to compute the theoretical volume. Moreover, the plan was also used to have sections extracted at the place of ribs number 35, 40, 45, 50, where we can find the damaged compartment. The sections are shown in figure 2 [5, 7].

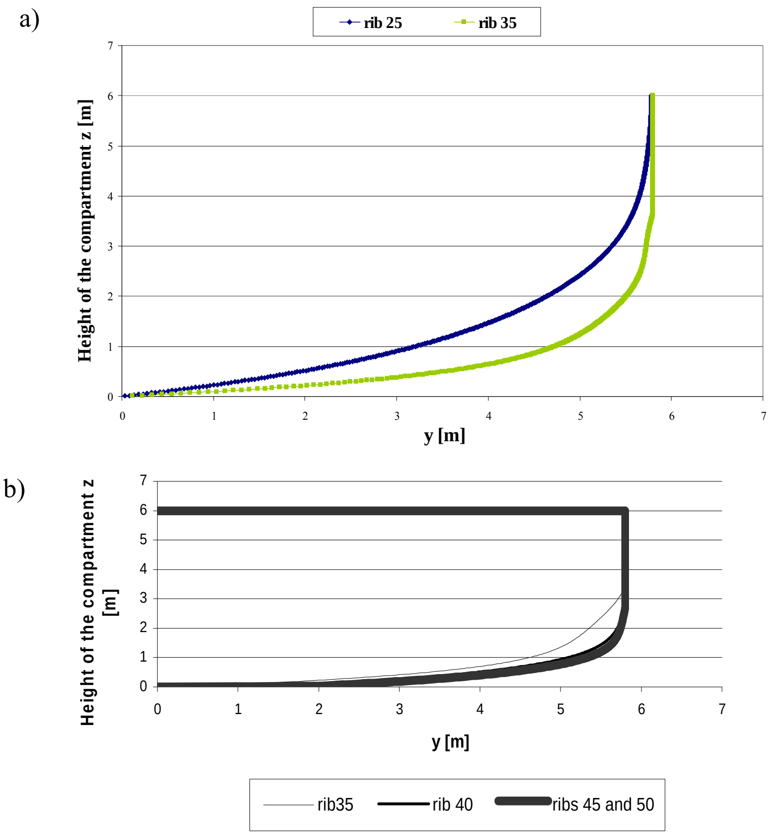
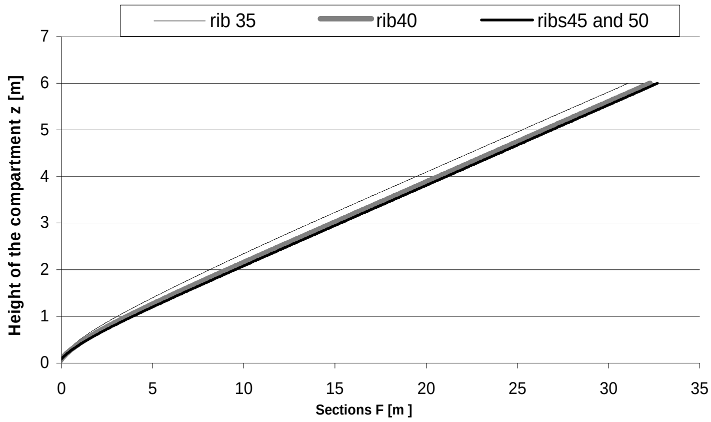


Fig. 2. Sections of: a) auxiliary power plant; b) engine room

Source: own study.

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

a)



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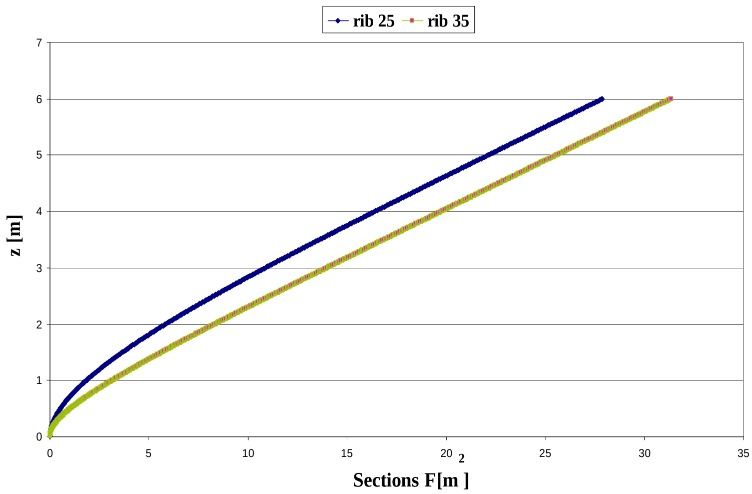


Fig. 3. Integral curve sectional areas: a) engine room; b) auxiliary power plant

Source: own study.

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

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

where:
l_w = the distance between sectional areas, and
F_i, F_{i+1} = section areas.

THE PERMEABILITY CALCULATION

The volume of the empty compartment was calculated with the aid of the computer program. The real quantity of the water, flooding the compartment, is less than the theoretical volume of the compartment due to the volume of all mechanisms and devices inside the compartment. Usually, to calculate a real quantity of the water, the permeability of flooding compartment μ is used. Permeability is used in ship survivability and damaged stability calculations. In this case, the permeability of a space is a coefficient from 0 to 1. The permeability of a space is the percentage of volume of the space which may be occupied by seawater if the space is flooded. The remaining volume (not filled with seawater) being occupied by machinery, cargo, accommodation spaces, etc.

The values of permeability for compartment is calculated by the formula [1]:

$$\mu = \frac{v}{v_t}, \tag{2}$$

where:
v_t = theoretical compartment volume;
v = real quantity of the water inside the compartment.

The numerical value of the permeability depends on both, a kind and destination of damaged compartment. The permeability of the compartment μ, which is announced in the SOLAS Convention, is usually used to calculate the real volume of the compartment. Typical values from the SOLAS Convention are:

- 0.95 for voids (empty spaces), tanks, and living spaces;
- 0.85 for machinery spaces;
- 0.60 for spaces allocated to stores.

This implies that for damaged stability calculation purposes, machinery spaces are only 15% full with machinery by volume (100% — 85% = 15%). In preliminary research presented in the paper, permeability of the main engine room and the auxiliary power plant was estimated. Its value depends on the height of the water inside the compartment. The graph of the permeability is shown in figure 4 [5, 7].

a)

b)

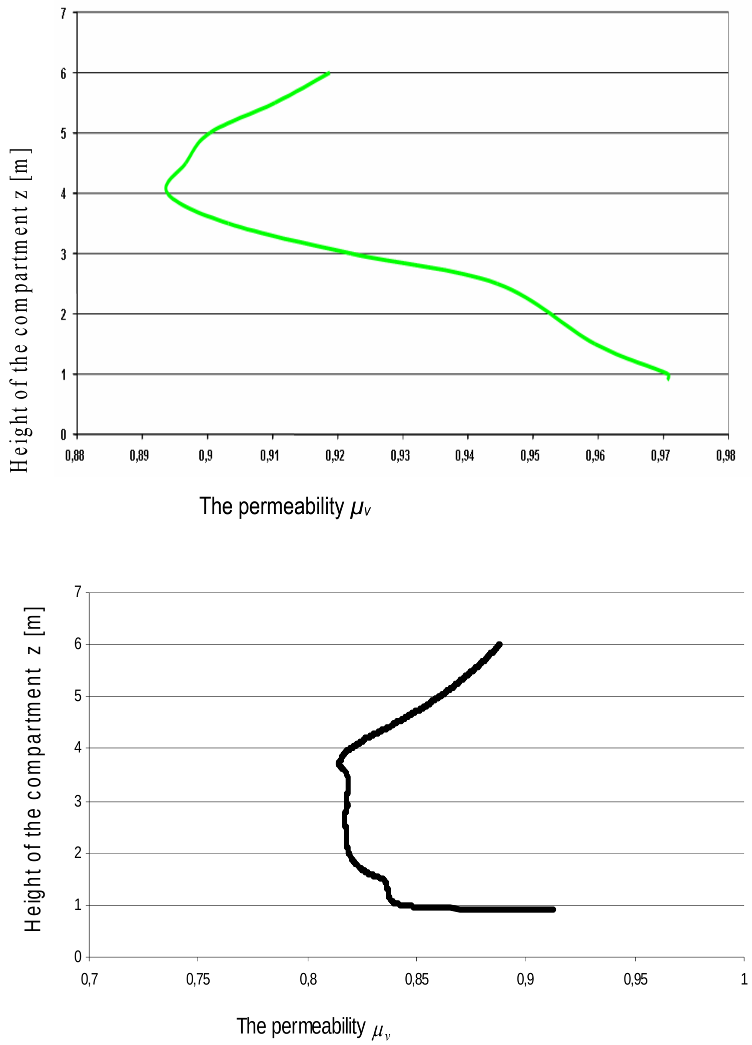


Fig. 4. Graph of permeability: a) the auxiliary power plant; b) the engine room permeability μ_v

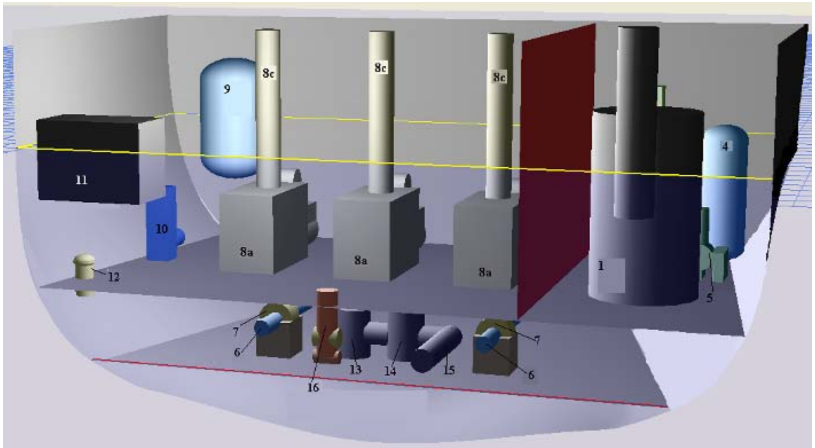
Source: own study.

The average value of the permeability for chosen compartments, obtained as a result of experiments, is comparable with the value of the SOLAS Convention and equals 0,84.

THE MODEL OF SIMULATION FOR DAMAGED COMPARTMENTS

The simulation models of the auxiliary power plant and the engine room, equipped with all main mechanisms and devices, were made in the next part of the research. The view of the compartments being flooded and the position of the ship are shown in figure 5 [5, 7].

a)



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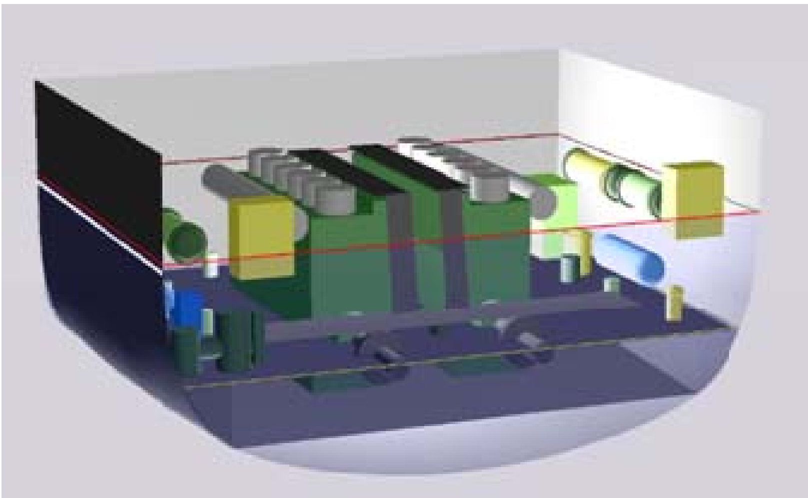

Fig. 5. Compartments being flooded: a) auxiliary power plant; b) engine room

Source: own study.

CONCLUSIONS

Computer visualisation of flooding process damaged compartments and ship position can be a base to define general rules to make proper decisions during the process of damage control. The method of determining the permeability presented in the paper enables us to calculate the real quantity of water inside the damaged compartment more accurate. The modified method can be used to calculate the flooding time t_f for ship type 888 with different types of hull damages. The method can be adopted for some other type of ship.

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KOMPUTEROWA WIZUALIZACJA ZALANIA USZKODZONYCH GRODZI JEDNOSTKI TYPU 888

STRESZCZENIE

Artykuł zawiera badania stabilności i niezatapialności. Ich wynikiem jest cenne źródło wiedzy o zachowaniu się jednostki podczas zatapiania jej grodzi. Artykuł stanowi krótki opis wypadków i uszkodzeń polskich jednostek w latach 1985–2004. Przedstawiono w nim także metodę obliczania pojemności uszkodzonych grodzi. W celu obliczenia rzeczywistej ilości wody zastosowano przepuszczalność zalanej grodzi μ. Przepuszczalność silnika głównego i pomocniczego została oszacowana na podstawie wstępnego badania przedstawionego w artykule. Jej wartość zależy od wysokości wody wewnątrz grodzi. Wykorzystano wbudowany program komputerowy dla pokazania symulacji procesu zalewania uszkodzonego silnika głównego i pomocniczego w jednostce typu 888. Wyniki eksperymentów mogą być podstawą do zdefiniowania ogólnych zasad podejmowania właściwych decyzji podczas walki z uszkodzeniem jednostki.

Keywords:

stabilizacja uszkodzenia, grodzie uszkodzone zalaniem, jednostka typu 888.