The Pressure of Hull Impact on Sea Bed in Shallow Water

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ABSTRACT

This research is based on the rigid-plastic material model of the hull (Norsok Standard, A.6.6) and the Mohr-Coulomb model for the soil. The coefficient of friction of the hull on a sand-gravel seabed equals $\mu = 0.4$. Calculations of the pressure on the hull have made using three methods. Thereafter, the following two calculations are made, on the basis of the theory, to describe the process of indentation, of the hull, into the soil. A triangular prism, with a shape designed to model the cross section of the real bow, is used during this calculation.

KEYWORDS: impact, shallow drafting, beaching operation, self-propelled barge, landing ship

INTRODUCTION

The plastic deformation experienced during the operation of the ship is a direct consequence of the external loads causing the stress to exceed the yield strength of steel (Galor, W. , O Samuli Hänninen. ). Due to the plastic deformation the bow plate acquires a residual deflection and shape is changed from the initial geometry. The plate passes into a plastic state stretched membrane condition. As result of the changes of the initial geometry, the bearing capacity of the plate is increased (Norsok Standard, A.6.9.2). The shape of deformed plate corresponds to the strength, which balances the external pressure. Knowing the residual deflection, the pressure which caused it can be calculated.

The other calculations for the external pressure definition are based on proposed theory of interaction between the seabed and the bow.

According to these calculations, mooring pressure on a ship’s bow is determined by the ratio of the bottom to the square of the area in contact as well as the load-carrying capacity of ground and the hull bow configuration. In order to define pressure on the bow, a formula that takes into account the statics of the loose grounds is offered.

Some equations are given for the calculation of forces, pressures and depths of the seabed ploughing by a ship mooring onto an unequipped (or conventionally equipped) shore. The balance of the equations for the kinetic and potential energies of a moving ship are applied in the solution as are the equations of fluctuation of an impulse and a passive soil pressure is also applied.

CALCULATION OF THE PRESSURE BY ANALYSIS OF ACCIDENTAL DAMAGE DATA AND THE HULL SHAPE AS THE BASIS

Hereafter the calculation of pressure the hull is based on the analysis of accidental damage data and the shape contour of the self-propelled barge (SB) Type 1733.

The pressure determined using the actual accidental damage data agrees with the pressure defined by the proposed theory of the interaction between the bow and the seabed. This fact allows us to propose an improvement to the hull design with the installation the double triangular skegs along the bow. The double triangular skeg makes the v-shaped bow contours sharper in section thus the impact of the bow against seabed is decreased.

SB Type 1733 was built in compliance with the requirements relevant for Russian Maritime Register of Shipping and has the survey class symbol is KM III. The ship has limited navigation area III without ice class. Interaction with ice including moderate or light ice conditions is beyond the design basis. Consequently the damage to the hull, described below, was caused by overpressure of the bow in contact with the seabed. General view of SB Type 1733 is shown in Fig. 1.

Main dimensions and parameters of SB Type 1733 used in calculations.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Length, $L$ [m]</td>
<td>13.0</td>
</tr>
<tr>
<td>Breadth, $B$ [m]</td>
<td>4.79</td>
</tr>
<tr>
<td>Depth, $T$ [m]</td>
<td>0.90</td>
</tr>
</tbody>
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