Computational Investigation of New Icebreaking Method

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ABSTRACT

This research work is devoted to a new method of ice failure, which consists in the dynamic impact on cylindrical solid to the ice inferior surface as a result of the explosion of air-gas mixture. Ice plate is assumed elastic and incompressible. Pressure, produced by the explosion products of the air-gas mixture, is specified with the help of test data. The research is carried out by the approved numerical procedure.

KEY WORDS: Ice breaking, mode of deformation, mathematical modeling, dynamic impact, deformable solid mechanics, fluid dynamics,

INTRODUCTION

The necessity of ice cover destruction occurs when solving many actual problems in offshore waters and on inland waterways. In offshore waters these problems are the protection of platforms working in the areas with intense ice conditions and creation of the navigation canals. On inland waterways ice cover destruction is substantially connected with the extension of navigation and removal of ice jams which occur at the time of a spring ice drift and cause water level rise and flooding.

The use of icebreakers for solving problems mentioned above is not always proven because of considerable power consumptions. Ice jams are mainly removed by blasting at which charges are placed either at a certain depth under the ice cover or within it. The main disadvantage of blasting is the negative effect to the water body environment.

Information of non-icebreaker facilities of ice destruction is summarized in the book by Bogorodsky et al. (1983) where mechanical, thermal, chemical, electrophysical and combined ice breaking methods are described in detail.

Facilities for the extension of the inland navigation including iceboats, air cushion vehicles, facilities for the increase of the iceboat effectiveness and ice-cleaning devices are considered by Zuev (1985), where also a comparative analysis of the effectiveness of the various facilities is carried out.

The method of ice destruction by the icebreaker attachment was researched by Odinokov and Sergeeva (2006, 2007, 2008). This method consists in the formation of the airless cavity with a specific geometry with the help of the attachment, so as a result, the ice above the cavity gets broken under its own weight and atmospheric pressure.

The formation, evolution, major effects alongside with the various methods of prevention, mitigation, decrease of the negative effects and removal of the river ice jams are considered by Beltaos et al. (1995).

Figure 1. The ice-breaking device.

The analyzed method of the ice cover failure consists in the following: a device, composed of two cylinders, nested in one another, is installed under the ice inferior surface (Fig. 1). Cylinders have the canals, where runs a flexible system, used for the feed of the air-gas mixture into the space between cylinders and also into the cavity in the lower cylinder end. Structural integrity is provided by the set of constraints of the vertical motion, which prevents the cylinders from falling. The dexterity of the structure is brought into effect by the engine system and the chamber, which may be filled either with water or air. Control