Unsteady Effect of Successive Shock Pulses on a Floating Sheet

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ABSTRACT
This paper deals with the linear two-dimensional task concerning the effect of the impulsive loads on a viscoelastic ice plate on the water surface. The three-dimensional experimental investigation of unsteady behavior of polymer plate due to successive and simultaneous shots is presented also. Analysis is made of the following factors: the variable depth of the basin, the time interval and the sequence of impulses activation on the amplitude of the plate deflection. There was derived that the maximum plate deflections occur at a sequential-applied in pairs regime of impulses (from the ends to the center, the central impulse is the last). Good agreement of theoretical and experimental results is obtained.

KEY WORDS: Viscoelastic ice plate, instantaneous impulsive load, flexural-gravity wave, plate thickness, depth of a basin.

INTRODUCTION

Ice blasting is known to be one of the ways of ice cover destruction. A number of charging devices are very often used to do it, they being located at a certain distance from one another and actuated either simultaneously or successively.

The effect of a singular shock impulse on an ice sheet has been investigated well enough by Kerr (1976), Fox (1993), and their other works. An extensive bibliography on ice cover destruction is presented by Squire et al (1996).

The problem of the effect of a shock pulse load (modeled by the delta function of time and of coordinates, as well) on the ice cover deflection (modeled by infinite elastic plate) was first considered by Kheisin (1967). In the works by Kozin and Pogorelova (2004) and Kozin and Pogorelova (2006) the problem was further developed for viscoelastic plate in axial-symmetric and two-dimensional tasks. The paper by Kozin and Zhyostkaya (2008) is devoted to a numeric solution of the problem of the effect of a shock pulse load (modeled by the delta function of time and of coordinates, as well) on the ice cover deflection.

MATHEMATICAL STATEMENT

The solving of the problem on the effect of successive shock pulses on the viscoelastic plate deflection is based on the earlier results obtained by Kozin, Pogorelova (2006).

The problem considered is two-dimensional. Let a thin viscoelastic ice plate float on an ideal elastic fluid. At first the plate is at rest, in a state of equilibrium and is then at the time moments $t_1, t_2, ..., t_n$ actuated by shock impulses $Y_1, Y_2, ..., Y_n$. The coordinates are positioned as follows: the coordinate basic origin is combined with the impulse application point $Y_1$, the axis Ox coincides with the unperturbed line water interface, and the axis Oz directs vertically upward. It is assumed the fluid motion is potential and the fluid density equals to $p_2$.

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According to Kheisin (1967) and Freudenthal, Heiringer (1962), the Kelvin-Voigt law of deformation of a delayed-elastic linear medium is used for ice.

By analogy with Kerr (1959) it is supposed that to describe the ice plate deflection we can use the technique of the superposition of its wave disturbance by shock pulses $Y_1, Y_2, ..., Y_n$, applied to points $t_1, t_2, ..., t_n$.

The differential equation of small vibrations of the floating plate will be as follows: