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Estimation of Force Impact from Agglomeration of Various Ice Features in Front of Structures in Arctic Seas

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ABSTRACT

When ice-resistant platforms for the development of the Russian Arctic deposits are designed, the accurate estimation of the ice loads is the most important for the operational reliability of the structure during all lifetime cycle. In whole, the ice cover of the freezing seas represents a composite spatially-non-uniform body consisting of various ice features, such as the level ice fields, drifting first-year or multi-year hummocks and solid hummocky fields, stamukhas and other ice features.

The purpose of this study is mathematical modeling of the interaction and failure inside agglomeration of drifting ice features in front of offshore engineering structures.

This paper continues the investigations of the authors concerning the given problem (Bekker et al, 2007), thus the new tasks have been solved:

- modeling of ice floe contact interaction inside agglomeration on basis of energy approach subject to the results of experimental research in ice deformation and failure process at different parameters (temperature, salinity, density, strain rate etc.);
- determination of significant parameters influencing the ratio of elastic deformation work to fracture work;
- probabilistic modeling of energy distribution at ice floe contact interaction.

KEY WORDS: ice features, agglomeration, energy, limit ice loads, ice scenario, deterministic model, probabilistic distributions.

INTRODUCTION

When designing ice-resistant platforms for the development of the largest Russian Arctic deposits is realized, it is necessary to estimate the reliable design ice loads with the target level of safety during all the lifetime of the structure. The level of reliability of ice load directly depends on quality and degree of accuracy of mathematical models describing “ice-structure” interaction.

Generally the ice cover of the freezing seas represents the composite spatially-non-uniform body consisting of various ice features, drifting in water areas with various sizes and concentration (Bekker et al, 2007).

In the previous studies (Bekker et al, 2007) the authors offered the deterministic model of local ice drift in the water area including contact interactions of ice fragments (level ice floes, ice pieces, etc.) with each other and with the fixed objects. In this model, the ice cover was considered as a mechanical system of single drifting ice floes which can interact with each other and with the fixed structure. As a result, kinematic characteristics of the ice cover were received in terms of the equation of balance of the exterior moving forces affecting the single ice floes.

The purpose of this study is mathematical modeling of the interaction and failure inside agglomeration of drifting ice features in front of offshore engineering structures. There the method of discrete units is used, i.e. the ice cover is represented as a unity of a great number of separate ice fragments (ice features, ice floes, rafting ice pieces, etc.), which drift in stochastic manner in water area and pile up in front of the structure. In this case limit-force loads on the structure may differ from the loads recommended by conventional design standard concerning the effect of separate ice features.

This paper continues the studies of the authors concerning the given subjects, thus the new tasks have been solved:

- modeling of ice floe contact interaction inside agglomeration on basis of energy approach subject to the results of experimental research in ice deformation and failure process at different parameters (temperature, salinity, density, strain rate etc.);
- determination of significant parameters influencing the ratio of elastic deformation work to fracture work;
- probabilistic modeling of energy distribution at ice floe contact interaction.

GENERAL ASSUMPTIONS

In the world practice the necessary theoretical ice force prediction models have been developed during last 20÷30 years. For this, an integrated approach has generally been used which combines theoretical research with full scale and laboratory experiments. This dual approach - full scale measurements and theoretical modeling of the force problem - was the most promising way in providing reliable