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Morphometry of First-Year Ice Ridges with Greatest Thickness of the Consolidated Layer and Other Statistical Patterns

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This paper describes the morphometric particularities of first-year ice ridges, comprehensively studied in the Kara and Laptev Seas. The distributions of the main morphometric characteristics of ice ridges are given, and the corresponding theoretical approximations are proposed. The connection between the parameters of the ice blocks that make up the sail and other morphometric characteristics of the ice ridge is shown. Empirical relationships between the parameters of the sail and the parameters of the ice ridge are proposed. The particularities of the morphometry of the ice ridges with the largest average consolidated layer thickness are revealed.

INTRODUCTION

Ice ridges are typically large ice features of the freezing seas, on the shelf area, where various economic activities are carried out. Information about the morphometric characteristics of ice ridges is necessary to assess the possible ice load in the design of offshore structures. To obtain adequate estimates of the morphometric parameters of ice ridges in a particular water area, a comprehensive field study of ice features in the area over several years is desired. However, this is not always possible because of high financial costs. Therefore, it is especially important to establish and assess the relationship between various morphometric parameters. Figure 1 shows a diagram of a cross section of an ice ridge with the main morphometric parameters.

This paper is a continuation of the studies of the morphometry and internal structure of first-year ice ridges presented in the work of Guzenko et al. (2020a, 2020b). In the spring periods of 2014–2017, 104 annual ice ridges were studied in various regions of the Kara and Laptev Seas. Figure 2 depicts the study regions. Studies in regions I–IV were carried out on drifting ice, and ice ridges of Khatanga Bay (region V) were located on landfast ice, in relatively shallow water. For each ice ridge, information on the external morphometric parameters (sail and keel dimensions, total thickness), characteristics of the internal structure (consolidated layer, porosity, position and size of ice layers of different densities and cavities), and parameters of the ice blocks of the sail were obtained. There was a lack of data for some ice ridges, but it was sporadic.

A large amount of data collected according to a uniform method allows us to clarify the statistical relationships between individual morphometric parameters. This is the first goal of this paper. The results of this analysis can be useful in the transition from one relatively easily measured characteristic of ice features to others that are more difficult to determine in the field. Another goal of this paper is to identify the empirical relationship between the consolidated layer (CL), which is the key characteristic of the ice ridges when estimating the ice load, and the overall dimensions of the ice ridges.

RESEARCH METHOD AND DATA VOLUME

At each ice station, outlined by the study program, the largest ice ridge within reach was selected. In choosing the ridges, we proceeded from practical problems: to determine the greatest ice load, we needed to study the largest ice ridges. A numerical comparison of the characteristics of the studied ridges and other ridges in the region was not carried out. Most of the morphometric characteristics of ice ridges were determined with the help of thermal drilling technology developed in the AARI under the

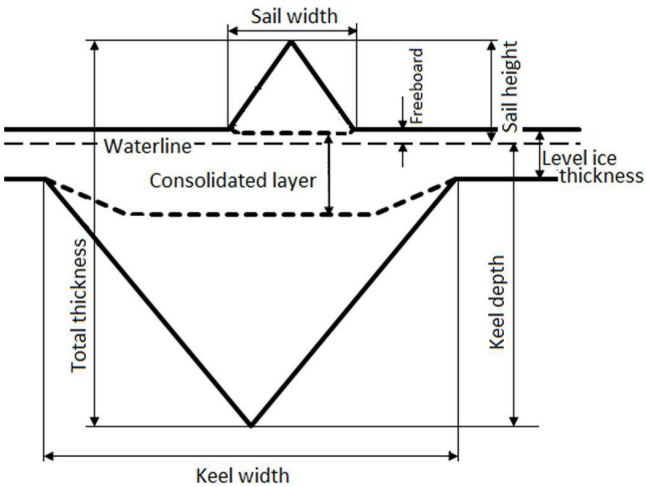

Fig. 1 Diagram of an ice ridge cross section. “Freeboard” is the elevation of the ice in the ridge above the waterline.

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KEY WORDS: Ice ridge, morphometry, consolidated layer, ice blocks, sail height.