Aalto University
School of Engineering

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New insight on ice-structure interaction in shallow water

Title of the dissertation	Ice-structure interaction in shallow water: A study based on laboratory-scale experiments and discrete element simulations
Contents of the dissertation	Global warming and retreating sea ice cover open new transportation routes and offer new opportunities to harvest renewable energy and explore natural resources in the Arctic regions. Consequently, the demand for offshore structures in ice-covered sea areas is constantly increasing. Optimizing the design of these structures still requires new engineering insight on ice-induced loads and the mechanics of ice-structure interaction processes. During an ice-structure interaction process, ice drifts against a structure and fails into ice blocks, which form an ice rubble pile. This process may subject the structure to very high loads. This thesis studies the ice-structure interaction against a wide, sloping structure in shallow water. In this case the rubble pile may ground, that is, may come to contact with the seabed. The work consists of model-scale experiments and full-scale numerical simulations. The thesis provides new holistic understanding on the shallow water ice-structure interaction process and the influence of ice properties on it. Results from the model-scale experiments showed that the ice loading process against a wide, sloping structure consists of two distinct phases. During the first phase the ice load is directly related to the weight of the increasing ice mass in front of the structure and during the second by the failure mode of the ice. The experiments also showed that the magnitude of the ice loads is not always directly proportional to the ice strength as is usually assumed. The numerical simulations surprisingly showed that the magnitude of the ice loads increase with decreasing water depth. In addition, a new way to scale the dimensions of an ice rubble pile was developed for the shallow water ice-structure interaction process. The results and new findings of this thesis may be used in safe and efficient design of Arctic marine structures, to improve the reliability of model-scale testing, and to develop numerical simulations.
Field of the dissertation	Mechanical engineering/Solid mechanics
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Place of the defence	Aalto University School of Engineering, Department of Mechanical Engineering, Otakaari 4, K1, 02150 Espoo, Finland, Auditorium 216
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