Background and motivation

Crystalline ice consists of water molecules arranged in a geometrically repeating pattern, either cubic or hexagonal. Almost all of the ice you see in the natural environment of Earth (e.g., in snow, your freezer, in the polar caps) is crystalline ice. The perception by most people is that ice as a material is brittle and relatively easy to crush and penetrate. This is not true for sea ice and in particular not for multiyear ice or Arctic Sea ice. For marine structures that are installed or operate in areas with multiyear ice, it is important to have a good understanding of the ice loads acting on the structures to ensure a safe design of the structures. The left figure shows an example of a wind turbine fundament that crushes the ice, and the right is an example of a submarine that penetrates the ice cover from beneath.

Objectives and goals of the project

The goal of the project is to develop a simulation model of an ice layer which is struck by a rigid object for different angles of attack. The ice thickness should be varied as well as the ice properties to mimic different ice types. The objective is to investigate what force is required to crush/penetrate an ice layer for different ice layer characteristics. With this knowledge, we can understand how specific structures need to be strengthened to not be damaged during ice impact loads.

Methods and tools

The numerical simulations can be carried out using the commercial software ABAQUS/Explicit. Constitutive and fracture models for different types of ice (including strain-rate dependence) need to be developed if needed.

Number of students: 2 students is recommended.

Prerequisites: FEA.

Tasks

- Literature study on the topic.
- Comparison of constitutive models for ice with an emphasis on fracture models.
- Modelling and simulation of structure-ice impact/crushing.
- Write a thesis report and present it at a public seminar.

Contacts

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