Winner „Safer"

Name: Aleksei Alekseev

Nationality: Russian

Age: 25

University: University of Rostock

Master thesis: Numerical Simulation of Ice Ridge Breaking

Short Abstract:

Increasing economic and industrial activities in Polar Regions require new engineering solutions to deal with arctic hazards. One of the main challenges for vessel navigation in ice are pressure ice ridges — sets of randomly oriented large pieces of sea ice along a line with keel and sail parts. These ice ridges may affect the normal exploitation of ice-going vessels, subsea pipelines, and equipment.

The objective of this master thesis was to develop and implement algorithms in a numerical tool, capable of simulating the process of ship hull breaking through pressure ice ridge. The tool is based on the idea to implement Discrete Element Method (DEM) and corresponding code developed at Hamburg Ship Model Basin (HSVA) for simulation of ice ridges creation.

In the thesis the following aspects have been covered: theoretical information on pressure ice ridges and the processes of their creation in nature and ice tank; review of available at present methods to estimate ridge and structure interaction; general idea of DEM and its application; ridge and hull interaction.

In the present project the author focuses on the following: modification of theoretical DEM algorithms in order to be adopted for ridge breaking simulation; method to introduce and to treat complex concave hull geometry with existing DEM software, taking into account adopted data structures of three-dimensional DEM; calculation of hydrostatic properties, inertial and other relevant characteristics of the ship hull (buoyancy, thrust, gravity, restoring forces); numerical integration of equations of motion of ship as discrete element in order to observe realistic performance of the vessel in an ice ridge. Interaction with level ice is not simulated but implemented in the form of an added ice resistance based on semi-empirical formulae of Lindqvist (1989).

The software is able to provide visualization of ship hull/ice ridge interaction, calculate ship resistance, position, velocity, acceleration, thrust, and other relevant parameters during

breaking through an ice ridge, and simulate ramming operations corresponding to reality when ship is getting stuck in the ridge.

The code has been validated with corresponding experimental data, provided by Hamburg Ship Model Basin. The results have been discussed and proposals for further calibration and validation of the existing model have been given. Finally some ideas are expressed on how to use developed methods to simulate interaction of floating structures with other types of ice formations.