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Kvaerner co-supervisor: Dr. Sergiy Sukhorukov

Title of the master project: Investigation of ice strength properties from in-situ experiments and numerical modelling

During spring 2016 I participated in different activities on Svalbard such as field works in Sveagruva on land fast ice of Van Mijen Fjord, laboratory works at UNIS etc.

I arrived to Longyearbyen at the end of February. After a few days of preparations our group of researchers went to Svea. The main goal of our tem there was investigation of mechanical properties of sea ice through conducting mesoscale and small-scale experiments. Complex of such experiments allows to explore behaviour of ice before and after failure. Compressive, tensile and flexural strength are the principal characteristics that may be estimated after the tests. This information is necessary for representation of ice failure envelope and prediction of ice behaviour during interaction with different objects as oil offshore platforms, vessels, onshore facilities etc. Most of my attention was payed to tests with L-shaped cantilever beams which was elaborated together with my supervisor Prof. A. Marchenko (Figure 1). Experimental results could be used in practice for the formulation of failure criterion of ice plates when applied forces on the ice edge initiate torsion. Results of the tests, numerical modelling and laboratory experiments are analysed and presented on IAHR International Symposium on Ice (*Murdza A., Marchenko A., Chystiakov P., Karulin E., Sakharov A., Karulina M. "Test with L-shaped cantilever beam for complex shear and bending strength". 23rd IAHR Symposium on ice. Ann Arbor, Michigan, USA. May 31 - June 3, 2016*).

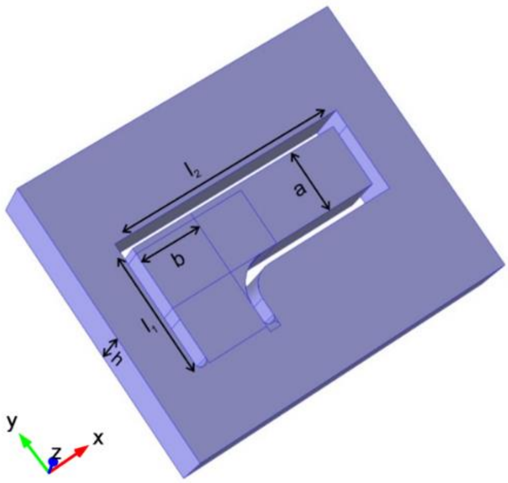

Figure 1. Configuration of L-shaped beam.

Figure 2. Preparation procedure: sawing with manual saws and drilling.

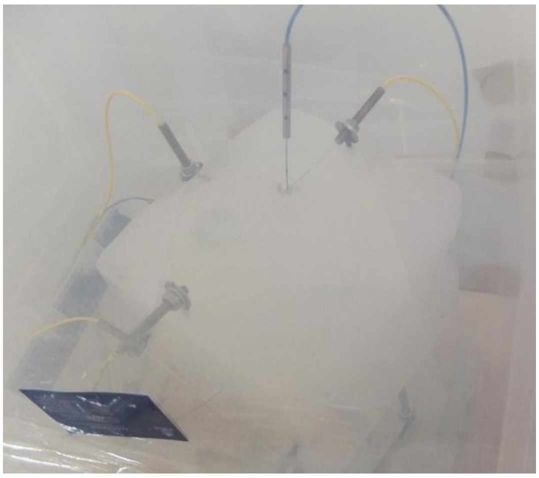

Figure 3. Test setup.

Experiments at UNIS cold laboratories were conducted during lab week course AT-211. I was responsible for conducting some experiments and processing the results with students. Main task of this activity was to investigate expansion and thermodynamic processes in sea ice. An ice cubic sample with approximate sizes 20*20*20 cm and salinity of 2.7 ppt was taken from Svea for this purpose (Figure 3). It was placed inside two plastic boxes in order to prevent evaporation which is caused by the wind from cooling system in the room. Three fibre-optic FBG strain sensors were installed mutually perpendicular that strain was recorded simultaneously in vertical and two horizontal directions. Also three thermistor strings with twelve temperature sensors in each were installed in the middle of facets of the ice cube that temperature profile was measured in three dimensions. Temperature in the room was changing in the rage from about -3^{o}C to -8 ^{o}C with a period ca. 20 hours.

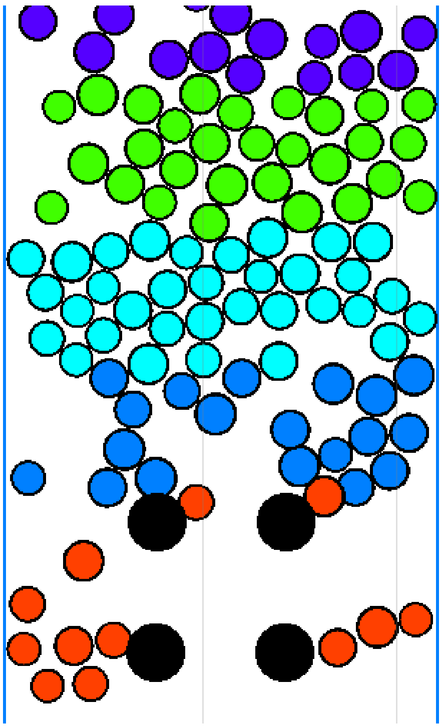

Figure 4. Configuration of the model.

In addition to all described above I was working on the problem "Estimates of loads on the moving structure in ice channel with broken ice". It was assumed that during towing of a Gravity Based Structure (GBS) only four cylindrical legs interact with ice and a large pontoon is submerged into water. It is supposed that an ice breaker creates a channel with broken ice in the front of the GBS. Thus, a problems of ice loads which affect a structure in such situations occur. Previous semester I tried to make some analytical estimates for considered problem. However, it turned out that only analytical approach is not enough to find out an adequate solution. Therefore, it was decided to use discrete element method for this purpose. In particular, distinct element software ITASCA with Particle Flow Code (PFC) has been chosen. As can be seen from Figure 4, 2D problem is considered during modelling. Four black circles correspond to GBS legs. These four circles are moving in the upward direction on the figure. All other balls (red, green, blue and violet) represent ice floes.