



SAMCoT News Letter 01/2014 (Nov-Dec 2013, Jan. 2014)

Work Package Adm.: Administrative reporting

Briefing on Activities:

During the month of November the Centre Manager Group finalized the planning of the Cost Time and Resources (CTRs) plans per work package for 2014.



SAMCoT's Board Members, Centre Manager & Coordinator during the last meeting of 2014 at HSVA, together with Dipl.-Ing. Peter Jochmann, Head of Department Arctic Technology at The Hamburg Ship Model Basin HSVA. PhD candidate Emilie Guegan and WPLLeader Knut V. Høyland were invited to present their work.

The CTRs were presented to the SAMCoT's Board during its second annual meeting.

HSVA hosted the event offering SAMCoT's Board members an opportunity to visit HSVA facilities on its 100 anniversary.

After adjustments made following SAMCoT Board's comments all WPs CTR's were reported to the Research Council of Norway together with a full activity report on December 1st.

Recruitment:

- ✚ A new PhD student within WP5, Martin Hassel, hired in January will work under the supervision of Ingrid B. Utne and R. Lubbad. Topic: 'Safety and reliability of marine systems for Arctic operations'.
- ✚ Henrik Nyvoll Bjørklund is hired as a research assistant at WP5 for a two months period in different activities related to the 360° camera.
- ✚ A new PhD position is now announced within WP3. The candidate is to build on the material model(s) for ice rubble developed within WP 2 (Material modelling) and extend it by adding a consolidated layer.

Achievements:

- November 2013: CTRs for 2014 approved by the Board.
- 1st December 2013: Progress Report to the Research Council of Norway (RCN).
- January 20th, financial reports sent to the RCN.
- The proposal for a change in the contract with the RCN has been delivered.

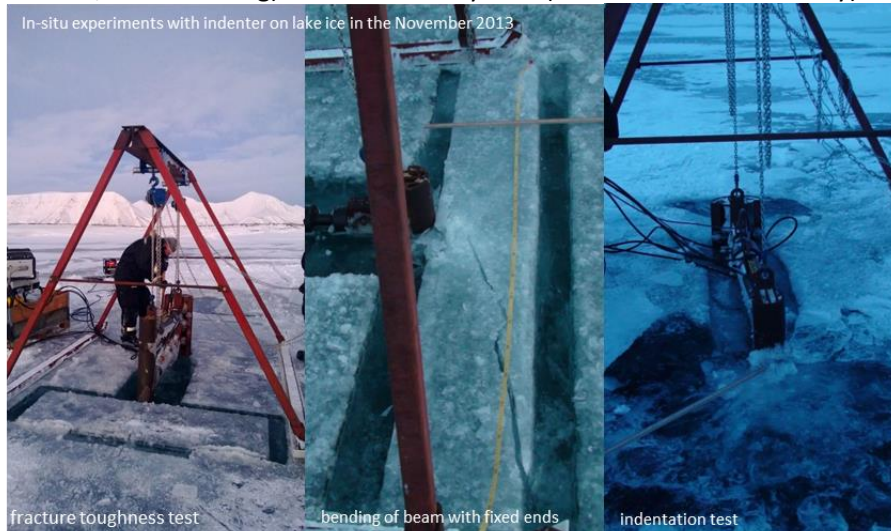
Notification:

- *SAMCoT Board Meetings 2014:* May 5th Trondheim, NTNU; November 13th location TBD.
- *SAMCoT Scientific Seminar 2014:* May 6th and 7th Trondheim, NTNU. (More information to come)
- *SAMCoT EIAC 1st meeting 2014:* May 8th Trondheim, NTNU. (Starting 09:00h)
- The Annual Report for 2013 will be presented to the RCN and available at SAMCoT's [webpage](#) (electronic version) on the 1st of April 2014.

Work Package 1: Data Collection and Process Modelling

Briefing on Activities:

Tests on in-situ measurements of fracture-toughness, strength of a beam with fixed ends and indentation were performed in November on the lake ice near Longyearbyen (Fig. 1). The field work was performed in cooperation with the guest researcher Evgeny Karulin (Krylov Central Research Institute, St'Petersburg) and Peter Chistyakov (Moscow State University).



A new scenario of beam failure with formation of the diagonal cracks was demonstrated.

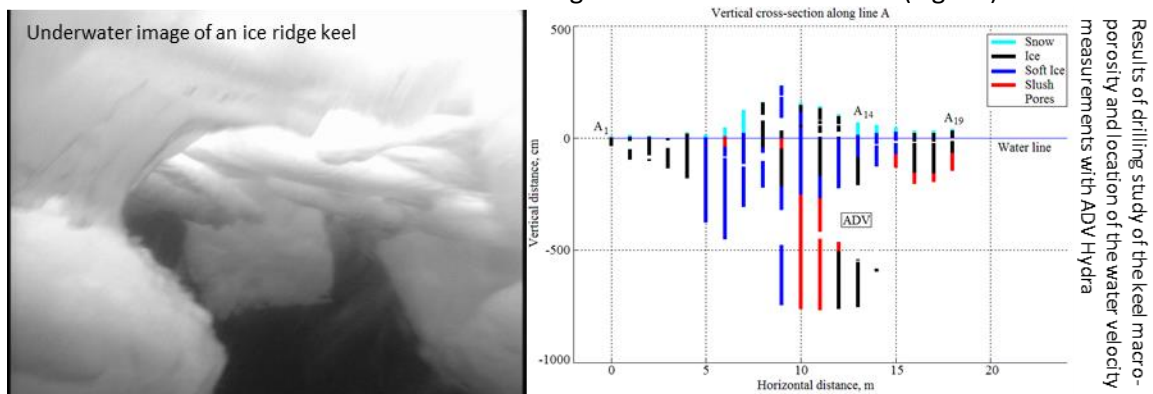
Indentation tests shown vibrations of the load associated with formation of numerous spalling and radial cracks.

Numerical simulations of the tests are currently performed. A paper will be submitted to the IAHR Ice Symposium 2014.

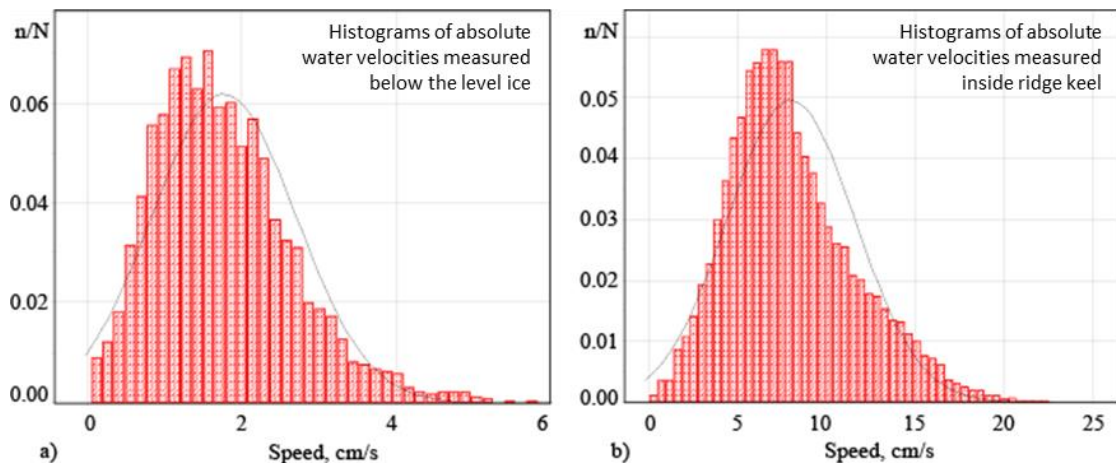
Records of water velocity performed with Acoustic Doppler Velocimeter below level ice and inside a ridge keel in the Barents Sea in 2007 were processed and analysed.

Underwater photographs show that the ice of the ridge keel was composed of blocks with vertical and horizontal orientation forming T-shape ice structures (Fig. 2a).

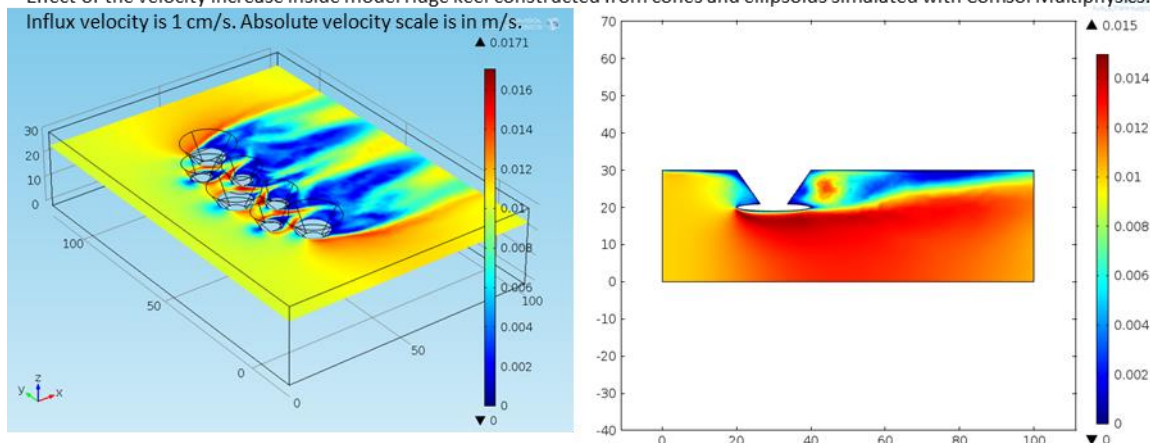
The ADV was installed inside a cave inside the ridge with entrance to the sea (Fig. 2b).



Comparison of water velocities measured below level ice and inside the ridge show that absolute velocities measured inside the ridge are higher than absolute velocities measured below the level ice.



Effect of the velocity increase inside model ridge keel constructed from cones and ellipsoids simulated with Comsol Multiphysics.



The effect was simulated with Comsol Multiphysics using the non-steady laminar flow module with real values of water viscosity and inflow velocity of 1 cm/s at the boundary of the computational domain 100x100x50 m. The model ridge was constructed from several truncated cones with attached ellipsoidal floes at the ends. Field measurements and numerical simulations were performed by A. Marchenko. A paper about field studies of ice ridges is being prepared for IAHR 2014 by A. Shestov and A. Marchenko.

Experiments on thermal expansion of fresh and saline ice samples in steel pipes were performed in the cold laboratory of the University College of London by B. Lishman and A. Marchenko. Thermal expansion was measured with Fiber Bragg Grating strain and temperature sensors. The influence of ice-steel friction by the thermal expansion was studied. It was discovered that the temperature range where negative thermal expansion of saline ice is observed, extended with the increase of the ice confinement by steel. Papers will be submitted for IAHR Ice Symposium and EGU Symposium.

Modelling of the rotation of drifting icebergs under the influence of Sverdrup wave of semidiurnal frequency was constructed using Kirchhoff equations with damping. It is demonstrated that iceberg rotation around vertical axis appears due to the property of floating body to keep major axis of inertia in transversal direction to the current. Icebergs rotate when the direction of tidal current changes in the time cyclically. The paper is submitted for the OMAE 2014 conference.

Research Associate N. Marchenko was working with the processing and analysis of the data from one year deployment of ADCP AWAC in Vestpynten, Advent Fjord, and data of surface drifters deployed for the monitoring of surface currents in the fjord. She also presented recent study of Arctic shipping challenges and ice induced accidents on the seminar of the Institute of Risk and Disaster Reduction, University College London.

Post Doc A. Shestov has been working with data collection from load shackles installed on mooring lines of a floating jetty in Longyearbyen. He is also working with SESAM software for the modelling of the behaviour of moored structures. Shestov presented his studies of ice rubble consolidation in the water with varying freezing point on the Ice rubble workshop in NTNU. PhD student D. Wrangborg processed the data from the deployment of ice pressure sensors GEOKON in land fast ice in Svea and laser scanner data. A paper about the influence of tide and air temperature on the ice stresses will be presented at IAHR2014. A. Marchenko presented sea ice research at UNIS and within SAMCOT WP 1 on the seminars in C-CORE and Memorial University of Newfoundland. A paper about observations of supercooled water in the Van Mijen Fjord during the winter field works 2013 was submitted to Annals of Glaciology by a group of authors from WP 1.

Achievements:

- A new methodology of ice strength tests with original indentation rig is developed
- Several conference papers are submitted for OMAE 2014, IAHR 2014 and EGU Symposium
- One journal paper are submitted during the period

Work Package 2: Material Modelling

Briefing on Activities:

Arttu Polojärvi has been continuing his work with discontinuum modelling of ice rubble with discrete element and combined finite-discrete element methods (DEM and FEM-DEM, respectively). There are two scenarios being modelled at the moment: (1) punch-through tests on 3D ice rubble with ice adjacent blocks being bound together by freeze bonds and (2) 2D DEM modelling of pseudo 2D shear box experiments performed at NTNU during the summer of 2013 with Anna Pustogvar.

Conference papers on both of the aforementioned studies are under work at the moment and the goal is to submit the papers to IAHR Symposium on Ice by the end of March 2014. After this the studies presented in these conference papers will be extended to journal papers during oncoming months. Polojärvi has also been working with Pustogvar and Høyland on a paper to be submitted to the OMAE conference on the shear box experiments mentioned above and was also recently visiting NTNU for nine days in order to work on this paper with Pustogvar and Høyland. In addition Polojärvi has been studying freeze bond geometries based on fieldwork and needed in accurate modelling of cohesive ice rubble together with Jukka Tuhkuri.



Pustogvar has been working on the OMAE conference paper about direct shear box tests on rubble ice studying the effect of block to box size ratio together with Polojärvi and Høyland. An abstract for the IAHR conference paper about odometer tests and effects of block size, gradation and other factors on compressibility of rubble ice has been submitted in December. Current occupation in the laboratory mostly relates to odometer tests and repose angle tests.

Sergey Kulyakhtin has working with biaxial compression data of ice rubble available in literature in order to obtain material constants for the developed model. A new way of interpreting data using Cam Clay dissipation potential was proposed and it was described in a paper submitted to OMAE 2014. Two abstracts were submitted to IAHR, one is dealing with influence of ice block size distribution on normal compression of ice rubble and the second with influence of submerging time on normal compression of ice rubble. Papers will use results of odometer tests scheduled on January - February.

Yared Bekele has continued to work on his THM coupled finite element model.

Stanislav Pavlov presented his statistical thermo-dynamical model in the ice rubble workshop, he explored the advantages of this approach to the classical one. An essential feature is to be able to simulate simple experiments and he works on simulating previous NTNU/UNIS experiments and he is planning experiments in the UCL laboratory.

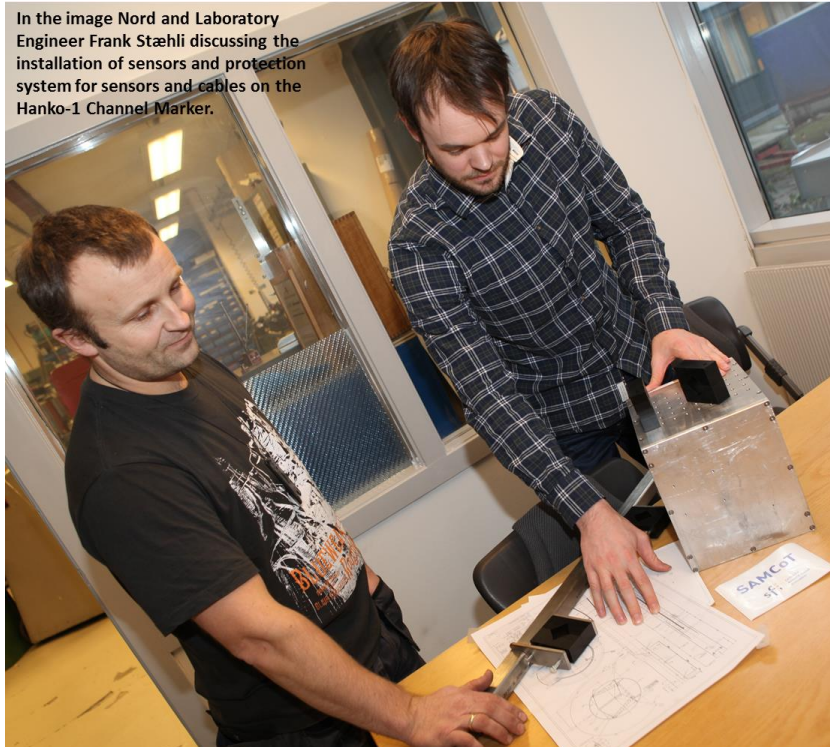
Achievements:

- Four abstracts were submitted for the IAHR Ice Symposium 2014 and two papers were submitted for the OMAE conference.
- One project thesis about ice production in the NTNU ice tank (FRYSIS II) was submitted.
- The second Ice-rubble workshop was held at NTNU on the 15th of January.

Work Package 3: Fixed Structures in Ice

Briefing on Activities:

Prof. E.M. Schulson, Dr. D.S. Sodhi and Dr. K. Kolari visited NTNU which gave an opportunity for in-depth discussions on the topic of Ice Induced Vibrations (IIV). The combined knowledge and different points of view of the group resulting in valuable input for the PhD students to follow from these discussions. PhD candidate H. Hendrikse has been working on a Journal publication in which an engineering model for the prediction of IIV will be presented.



In the image Nord and Laboratory Engineer Frank Stæhli discussing the installation of sensors and protection system for sensors and cables on the Hanko-1 Channel Marker.

PhD candidate T. Nord has been working on several papers, one conference and one journal paper about force identification in ice-structure interaction. The work is done together with Dr. Eliz-Mari Lourens, Prof. O. Øiseth and Prof. A. Metrikine. In November, Nord was teaching at UNIS during the LAB week (Physical Environ. Loads on Arctic Coastal and Offshore Structures AT-332). In early February T. Nord and Prof. M. Määttänen plan to deploy tilt and accelerometers on the channel marker Hanko-1 in the Gulf of Finland. The idea is to identify vibrational loads from these response measurements

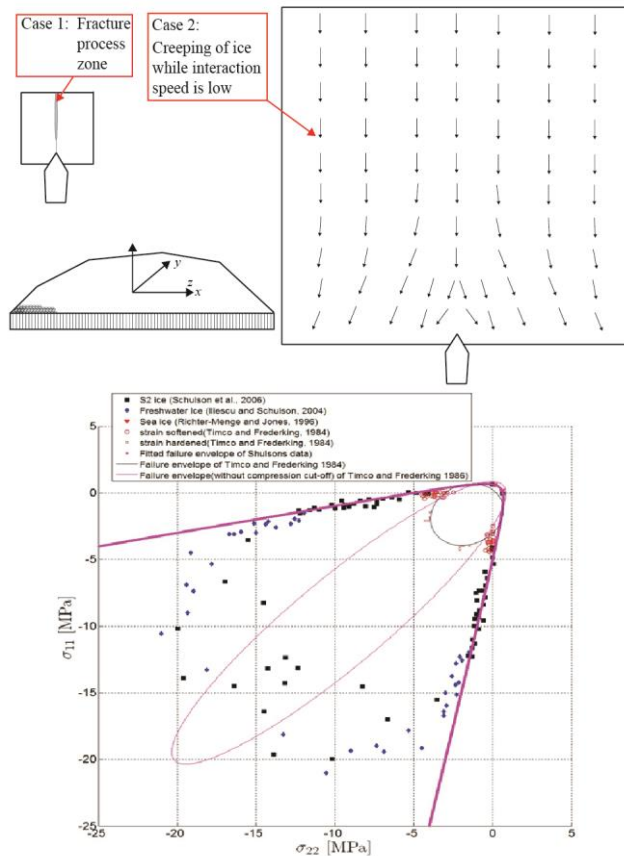
A mild winter in the Gulf of Finland have caused little ice formation so far at the Hanko-1 location, so the decision about deployment of sensors depends on the temperatures in the start of February. Some of the sensors will be located close to the water-line, thus there is a need for protection against the ice. The manufacturing of a steel protection system designed by Määttänen and Nord is ongoing. In collaboration between TU Delft and HSVA a MSc project has started on Ice Induced Vibrations which will be supervised by WP3 members. WP3 has also master-students at NTNU. Cathrine Pedersen will study the tactile sensor instrument for pressure measurements. She is going to work with laboratory data and do own experiments. We are especially interested in how well the tactile sensor reconstructs a hammer impact (Supervisors: K. Høyland and T. Nord). Øyvind Pettersen is working with force identification and state-space modelling. He will start using deterministic-stochastic techniques that allows inexact model equations in order to identify the forces. Both numerical and experimental data will be used in his thesis (Supervisors: O. Øiseth and T. Nord). Hanna Aarnes Nisja will study how well existing LS-Dyna material models may be used to simulate dynamic ice-structure interaction (Supervisors: Prof. A. Aalberg, K. Høyland and T. Nord).

Achievements:

- Conferences: 5 abstracts IAHR2014 and ENOC. 2 papers OMAE and Eurodyn.
- A paper submitted for OMAE 2014 conference in San Francisco on ice loads on offshore wind turbines. Contributions are made to two papers for the IAHR 2014 conference in Singapore on ice induced vibrations of floating structures, and the OATRC2013 research cruise.
- A detailed plan for the instrumentation of the Edge channel marker Hanko has been completed and all parts are fabricated.
- Two project theses were submitted at NTNU.

Work Package 4: Floating Structures in Ice

Briefing on Activities:



PhD candidate Wenjun Lu has focused on analysing the global splitting failure with an alternative approach based on plasticity theory. He aims to address two different cases in addition to the purely brittle failure of a large ice floe (left figure).

Case 1: a small ice floe with large fracture process zone that LEFM is not applicable;

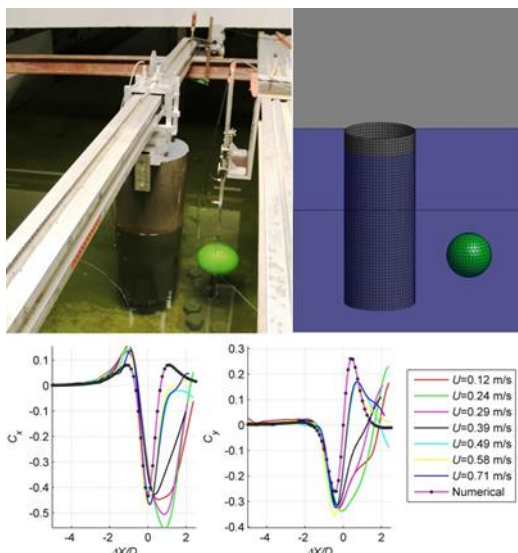
Case 2: a large ice floe but interacting with the structure at a quite low interaction speed that creep behaviour dominates.

The plasticity theory demands the construction of a yield function. Based on previous researchers' test results, Lu managed to back calculate a yield function to describe the anisotropic nature of columnar sea ice.

A draft paper regarding the theoretical analysis of splitting failure which combines both the brittle and creep nature of sea ice was finished by the end of January.

PhD candidate Ekaterina Kim submitted her PhD dissertation 'Experimental and numerical studies related to the coupled behaviour of ice mass and steel structures during accidental collisions', the defence is scheduled for May 9th

2014. Kim worked with prof. E. Schulson (Arctic Fulbright Chair at SAMCoT) on the conference paper "Some secrets of the pressure area curve" that will be presented at IAHR2014. Currently she works with prof. K. Høyland assessing whether or not the specific energy is scale independent during ice crushing. PhD candidate Martin Storheim is working on the vessel response to extreme ice events.



PhD candidate Andrei Tsarau works on his publications related to the modelling of the hydrodynamic interactions between floating structures and ice. His work includes processing of the data obtained from the recent tow-tank tests; numerical simulations of the tested case and others cases intended for the validation of the model; comparison of the results; and finally, writing the journal papers. More recent studies include simulations at large scale using a model of a real ice-class tanker.

PhD candidate Chris Keijdener is currently working on a model to investigate frequency lock in for floating offshore structures.

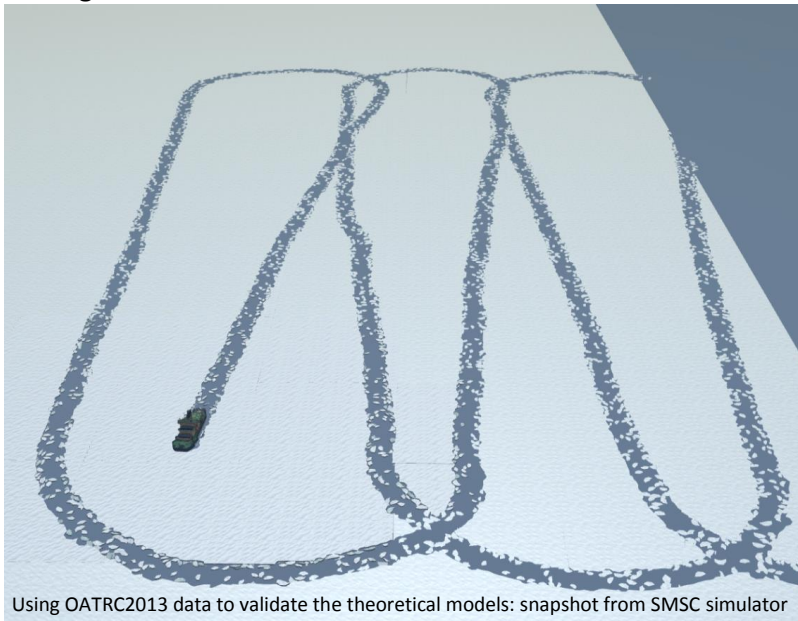
Dr. Sergiy Sukhorukov, now employed in Kvaerner, defended his doctoral thesis with success on the 13th

Achievements:

- Sukhorukov, S. (2013): Ice-Ice and Ice-Steel Friction in Field and Laboratory.
- Sukhorukov, S. and A. Marchenko (2014): Geometrical stick-slip between ice and steel. Cold Regions Science and Technology, Vol. 100, pp. 8-19.
- Several conference papers for IAHR2014 plus two journal papers submitted in this period.

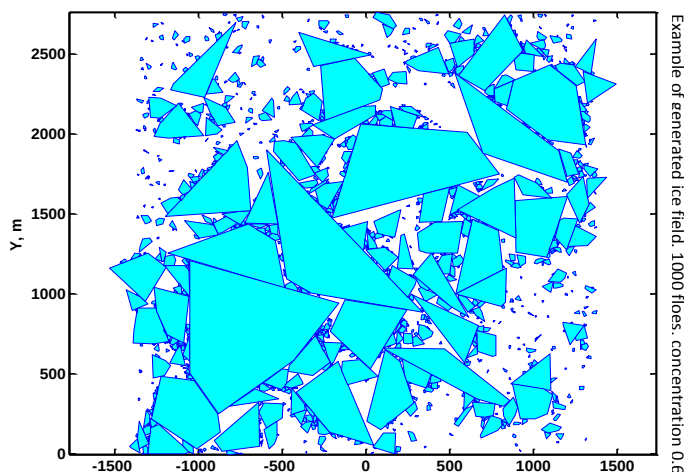
Work Package 5: Ice Management and Design Philosophy

Briefing on Activities:



PhD candidate Farzad Farid-Afshin in collaboration with SMSC and Statoil started to analyse data from OATRC2013. The plan in the months to come is to work on a publication for IAHR 2014 presenting and summarizing the ice management activities during the research cruise. In addition, Farid-Afshin submitted to OMAE 2014 a manuscript related to risk modelling of Arctic marine operations, and in specific ice management operations. The focus of this paper is on factors with an influence on the overall risk through their effect on parameters of a formal probabilistic risk analysis.

This framework allows prioritizing the influence factors, from the most important to the least important. In addition, a ranking can be made based on the return of investment. This means that the top factors having the most influence on gain in reliability with minimum investment can be determined. These factors should be prioritized by oil and gas companies in order to increase the reliability of their ice management operations with minimum cost. Finally, Farid-Afshin is carrying on a literature review with respect to formal methods of structural safety, as well as non-conventional frameworks. Various philosophies to risk assessment are also being studied.



PhD candidate R. Yulmetov took a step further towards modelling icebergs towing in pack-ice by developing a numerical scheme to generate an ice field. The generated ice field fulfils requirements regarding concentration, thickness, floe size distribution, roundness of the floes, etc. Mean Calliper Diameter (MCD) was chosen as a measure of ice floe sizes. Literature review showed that MCD of drifting ice is distributed according to the power law with negative exponent.

The value of exponent depends on mechanisms of floes' formation and can be expressed as a function of the distance to the ice edge. The results of this work will be presented at IAHR2014. Yulmetov is also analysing iceberg drift data from OATRC2013 and he is planning to present the results at IAHR2014.

PhD candidate M. Kashafutdinov is making progress studying drift and the deterioration of icebergs including effects of waves and iceberg motion.

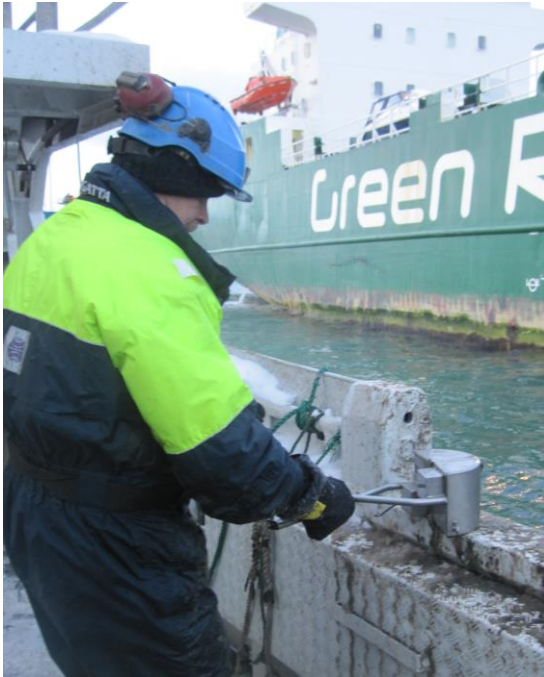
PhD candidate P. Norgren is in good progress with his courses. He submitted an abstract to IAHR 2014 planning to publish a survey paper about underwater vehicles in the Arctic, combined with some experiences from OATRC2013.

A new PhD student (Martin Hassel) joined WP5 in January, 2014. Hassel's main supervisor is Prof. Ingrid B. Utne and he will be studying safety and reliability of marine systems for Arctic operations.

Work Package 6: Coastal Technology

Briefing on Activities:

Dr. Anatoly Sinitsyn is now employed 60% in a researcher position in SINTEF, where he will mostly work on SAMCoT-related issues combined with a 40% teaching position at UNIS.



Field and experimental work:

Currents and waves measurements in Svea as well as sediment sampling around the the coal quay of Kapp Amsterdam, to increase understanding of sediment transport in the area. The field work was performed together with Prof. A. Marchenko at UNIS, with the UNIS research vessel *Viking Explorer*.

MSc and PhD work:

December 2nd Gunther Kassner of Münster University of Applied Sciences defended his MSc-thesis on the use of local soil as fill material for geotextile mattresses in Arctic areas. His thesis was performed as Erasmus cooperation between Münster University of Applied Sciences and SAMCoT research partner SINTEF.

PhD candidate Daria Aleksutyina has been working with laboratory studies of samples from the Baydara site and publication. PhD candidate Emilie Guegan has been working with data and publications.

Workshops and meetings:

On December 2nd WP6 held a workshop on Arctic Materials, together with the CRI COIN (Concrete Innovation Centre) discussing research on use of concrete and stabilized soils in Arctic areas, with focus on coastal challenges. Researchers from NTNU and SINTEF together with industry partners from both SAMCoT and COIN were present.

January 6th SAMCoT WP-leader Maj Bæverfjord and researcher Anders Gylland presented the status and plans for WP6 to the geotechnical engineers in Statoil in Stavanger. There were also discussions on possible spinoff-projects to SAMCoT.

In the middle of January Maj Gøril Bæverfjord and Anatoly Sinitsyn met with SAMCoT partner TOTAL to discuss the further implementation of the Varandey field site into WP6.

The WP leader also met with Kværner Concrete Solutions medio January, presenting not so much the status of the work package as the potential for further spinoff projects to SAMCoT.



Achievements:

- Conferences: 6 Abstracts to EUCOP 2014 and one Abstract to DUE Permafrost 2014.
- MSc thesis: "The use of local soil as fill material for geotextile mattresses in arctic areas" Gunther Kassner, Münster University of Applied Sciences
- Reports: Erosion protection in Kapp Amsterdam, 2013; Håkon Tangen; A survey of Coastal Erosion in Central Spitsbergen, Svalbard, 2013; Evangeline Sessford, Håkon Tangen; Field investigation and laboratory analyses; Baydaratskaya bay 2013; Daria Alexyutina, Anatoli Brouchkov, Jomar Finseth.