Top class ice research at Aalto University

Aker Arctic and Aalto University have a long history of cooperation, not least because many of Aker Arctic's employees have graduated as Naval Architects from the University. Arctic marine and ice technology research is strong at Aalto and through various Tekes (the Finnish Funding Agency for innovation) -funded joint projects Aker Arctic helps supporting the research.

”Our cooperation with Aalto University takes place on many levels," says Topi Leiviskä, head of research and testing services at Aker Arctic.

"Basic research on ice behaviour is an important area for both of us, therefore we want to be involved and support the research as much as we can. We regularly employ graduates for thesis projects and many of them have continued to work at Aker Arctic after graduation. We also offer part-time work for students at our ice model testing laboratory."

Unique squared basin

Aalto University in Otaniemi has its own ice model testing facility, which has recently been undergoing renovation and should be ready for use by the end of 2016. The basin is square in shape and measures forty times forty metres, being the only one in the world of this size.

"The university focuses on research projects. We can now rent their basin for commercial projects, where the square shape is beneficial, as there is plenty of space on all sides," Leiviskä says.

It is excellent, for instance, for turning tests, operational tests and manoeuvring tests as well as for tests related to offshore and ice management such as ice movement and ice flowing direction.

"Before the renovation began, we built, for instance, an island in the basin in order to see how ice piles up against the shore," Leiviskä adds.

Current research projects

Aker Arctic supports research projects at Aalto University through various Tekes (the Finnish Funding Agency for innovation) -funded joint projects.

Read Assistant Professor Arttu Polojärvi's description of two important research projects, ICESCALE and ARAJÄÄ, on the next page.

The Aalto Ice Tank is under renovation and will be upgraded significantly for future research.

The Aalto Ice Tank is a multipurpose basin, which is mainly used for ice model scale tests, but can also be employed for tests in open water. The tank is 40 m wide and 40 m long with a depth of 2.8 m. The facility has a rail-bound bridge (orange, see photo) and underneath the towing carriage (blue).

A 40 m wide segmented wedge type wave maker, which can generate both regular and irregular waves, is installed on one side of the basin.

Ice research seminar

A research seminar was held at Aker Arctic in March 2016, where professors and researchers from Aalto University gave presentations on on-going ice research activities.

The topics were:

- Overview on research on ship-ice interaction (Pentti Kujala)
- Stochasticity in full-scale ice load measurements of a ship's hull (Mikko Suominen)
- Risk management of Baltic winter navigation systems (Osiris Valdez)
- Ice load dependency on the conditions the ship is in (Mikko Kotilainen)
- Numerical modelling of model ice failure (Rudiger von Bock und Polach)
- Risk analysis of ice management (Risto Haimelin)
- Overview on research on ice-structure interaction in Aalto (Jukka Tuhkuri/Arttu Polojärvi)
- Statistics of peak loads in the ice-structure interaction process (Janne Ranta)
- Ice-structure interaction in shallow water (Sonja Schneider)

Ice research cooperation projects

Comprehensive understanding of Arctic marine technology is of crucial importance as operations in the northern seas keep on increasing. Finland as an Arctic country and Finnish Arctic technology companies are actively participating in these operations. The safety and efficiency of the offshore structures in the Arctic environment is a topic commonly discussed within the Arctic technology community and even in the public media. The ice loads are a major factor on the safety of these structures, yet predicting these loads accurately remains challenging.

ICESCALE

It is well known that the ice loads on structures are related to the failure and fracture of sea ice, but the detailed physics of the fracture processes are not well understood. This makes the fracture of sea ice an important research area. We know that the results from the fracture experiments on sea ice depend on scale: small sea ice samples appear to be stronger than large ones. The ICESCALE-project studies the fracture of fresh water ice and model ice by conducting unique fracture experiments in the Aalto Ice Tank. The work also includes modelling efforts.

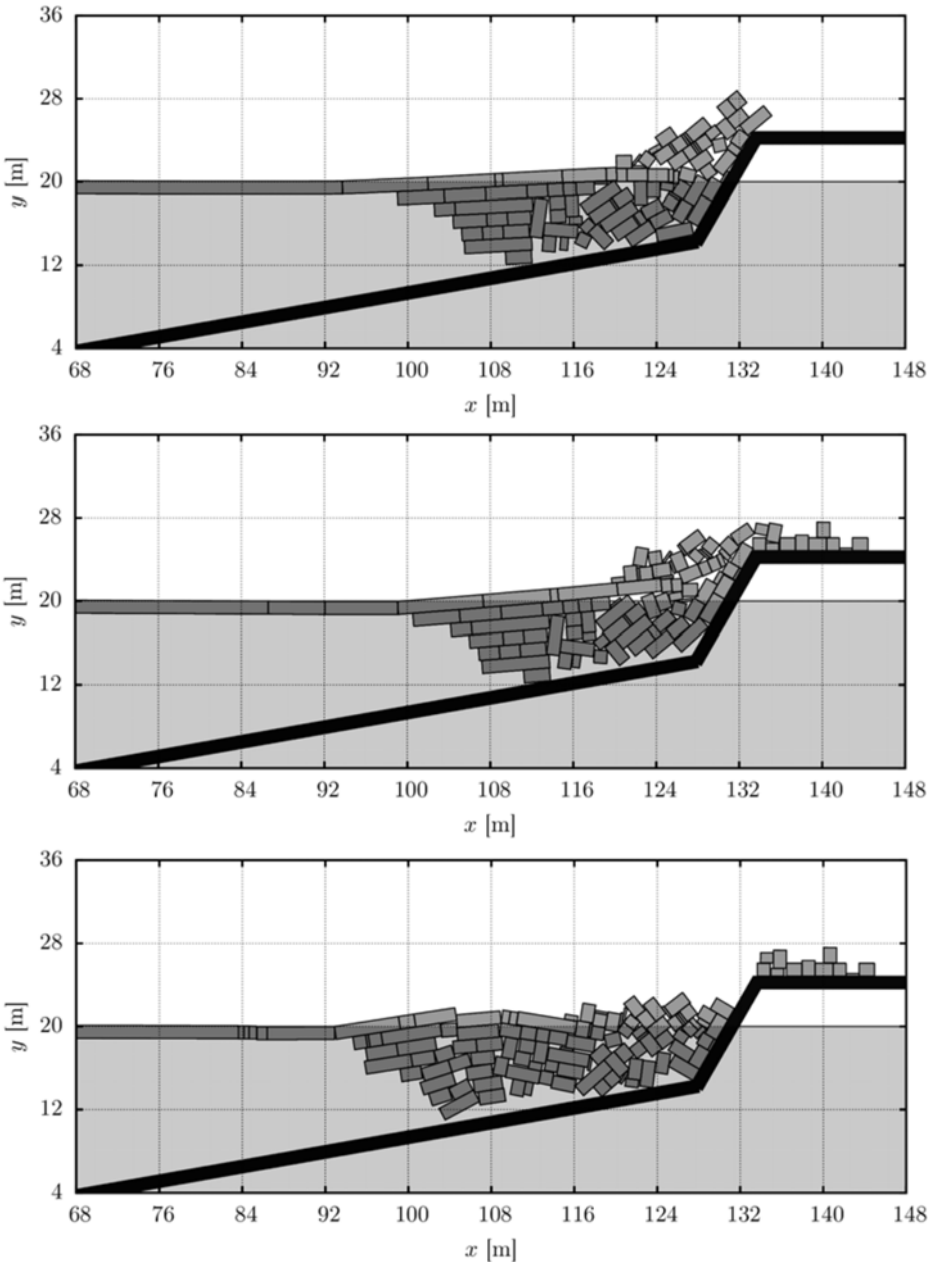
To ensure the success of our experiments, Aalto University has invited Professor John Dempsey as a FiDiPro-professor between 2015 and 2018 to work on ICESCALE. He is very well known for his research on the fracture and constitutive behaviour of sea ice. Professor Dempsey has exceptionally vast experience in high quality experimentation on sea ice. For example, he has been the lead investigator on six field projects in the Arctic and five in the Antarctic, conducting in-situ cyclic, creep-recovery, fracture and tension experiments on floating freshwater and sea ice.

Arttu Polojärvi is the Assistant Professor in Ice Mechanics at Aalto University School of Engineering, Department of Mechanical Engineering.
Photo: Johanna Ketola

ARAJÄÄ

Project ARAJÄÄ concentrates on a variety of topics closely related to design of Arctic offshore structures. The work is based on both numerical modelling and model scale experiments. The goals of the project are closely related to fracture of ice similarly to ICESCALE. On a general scale, ARAJÄÄ wants to improve the reliability and applicability of model scale tests. This should lead to more efficient and streamlined design processes for Arctic offshore structures. The work requires interaction between the Arctic Technology industry and researchers, and ARAJÄÄ increases this interaction through informal meetings discussing central topics in ice mechanics.

In addition, ARAJÄÄ studies ice loads on shallow water structure using numerical modelling and model scale experiments. This work aims to improve understanding of the fundamental mechanisms behind ice behaviour and the causes for ice loads. Numerical modelling helps us to obtain detailed knowledge of the problem, while the model scale experiments give reliable data for validation. We also look into ice management related model scale tests with an aim to understand how to increase the efficiency of ice management operations. We also aim to gain understanding for the implementation of an ice load portal, which, once in operation, could be used effectively in designs of offshore wind turbines for ice-covered seas.



Numerical modelling of the ice-structure interaction process in shallow water. These are performed in ARAJÄÄ together with model scale experiments on the same topic.