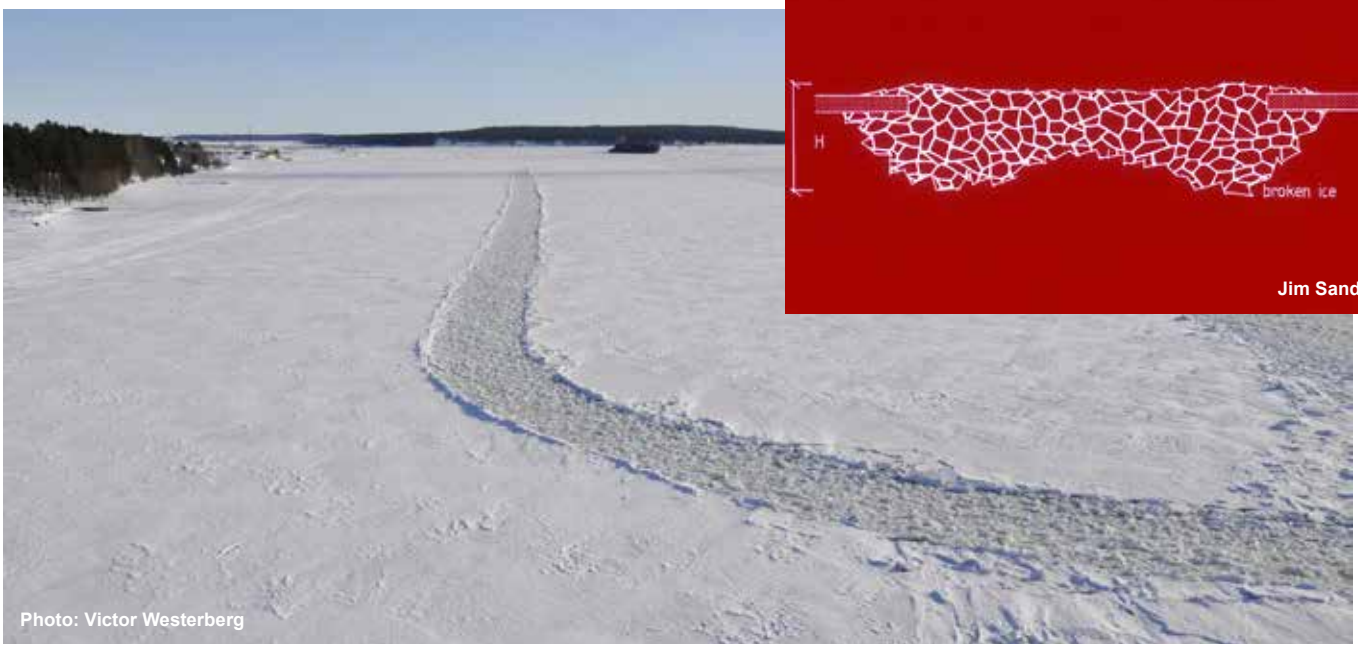
Brash ice growth - full scale ice tests in the Gulf of Bothnia for the Port of Sabetta

SSPA has successfully taken advantage of the easily accessible Gulf of Bothnia, this time for full scale brash ice tests. Brash ice growth and accumulated channel thickness was investigated in an extensive measurement campaign carried out in Luleå during the winter of 2012/2013 on behalf of Yamal LNG and TOTAL.



The test channel of approximately ½ nm in the port of Luleå. Inserted is a general example of channel profile. Channel edge depths up to several meters were measured.

Brash ice forms quickly during frequent passages in an ice channel filling the channel behind the vessel. As the broken ice consolidates between each passage, new brash ice is successively produced resulting in increased brash ice thickness meaning increased vessel resistance. With a lack of additional ice reducing resources like warm wastewater outlets, no alternative fairways and a full operational demand, optimised ice management and parallel channels are required.

However, limited depth in the approach and port area requires dredging and the overall question for the Port of Sabetta was: How many parallel channels are needed to be able to maintain full operation?

The field project, initiated to gain knowledge on brash ice growth, started with a pre-defined channel traffic frequency and a maximum acceptable brash ice thickness. The measurement campaign in Luleå was formed by SSPA in cooperation with Luleå Technical University, Luleå Bogserbåts AB and Bertin Technology.

Comprehensive measurements; full seasonal variation

Brash ice growth and thickness is affected by several parameters such as channel passage frequency, air temperature and radiation. With harsh conditions, seasonal variation and several affecting variables the ability to estimate brash ice thickness was necessary for the Yamal LNG project. In the development work of the brash ice growth model input was needed.

Brash ice profile measurements; input and validation

To gain more knowledge about the phenomenon and give input for validation to a brash ice growth model the dedicated test channel was established in sheltered waters in the Port of Luleå.

Channel profiles were measured once a week and controlled passages by the harbour icebreaker m/s Viscaria were carried out twice a week.

BRASH ICE

Accumulation of small pieces of ice produced by nature or due to repeated breaking by vessels, e.g. in an ice channel.

Harbour icebreaker m/s Viscaria played a key role in the project performing passages twice a week in the test channel. All relevant variables on-board were monitored and logged by the SSPA Datalogger system.

Several ice core samples were taken during the campaign which were analysed in the ice lab at Luleå Technical University. Compression tests and ice analysis under cross-polarised light were some of the tests that were carried out. In addition to the ice and vessel measurements, continuous metocean data such as air temperature, wind speed and radiation data etc. were collected.

In all, 14 measured channel profiles, about 30 measured channel passages and a vast amount of metocean data providing a well-founded basis for analysing the phenomenon and validation of the brash ice growth model was collected.

Increased Vessel resistance

To make progress in ice, the thrust produced by the prime mover system needs to bridge the total resistance of the vessel. During the controlled passages in the channel, added ice resistance due to increased brash ice thickness was investigated aided by reference tests in level ice and ice free water.

By monitoring the engine load during the season and comparing with level ice and ice free water loads for the corresponding speed, seasonal variation is obvious. Maximum ice growth and ice extension in the northern part of Sweden usually peaks in March, which correlates well with the last winter measurements.

If parallel channels are suitable a new channel is preferably opened when channel resistance exceeds level ice resistance, see figure below (marked). Note however that only *one* level ice thickness is shown in the graph and channel resistance is shown for various brash ice thicknesses during the season.

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Gulf of Bothnia; test area suitable for Arctic matters

The brash ice measurement campaign is yet another example on the possibilities of the Gulf of Bothnia as a test area for navigation in ice and Arctic operations. A wide variation of ice conditions at a reasonable distance from the ice lab at Luleå Technical University is available.

This time the sheltered area with shallow water in the port of Luleå was a perfect location for the measurements. Earlier in 2010, deeper water and pack ice was needed when measurements with a typical Arctic ice management vessel were performed. The Gulf of Bothnia was suitable and the location was used to perform acoustic measurements which are described in Highlights 51/2010.

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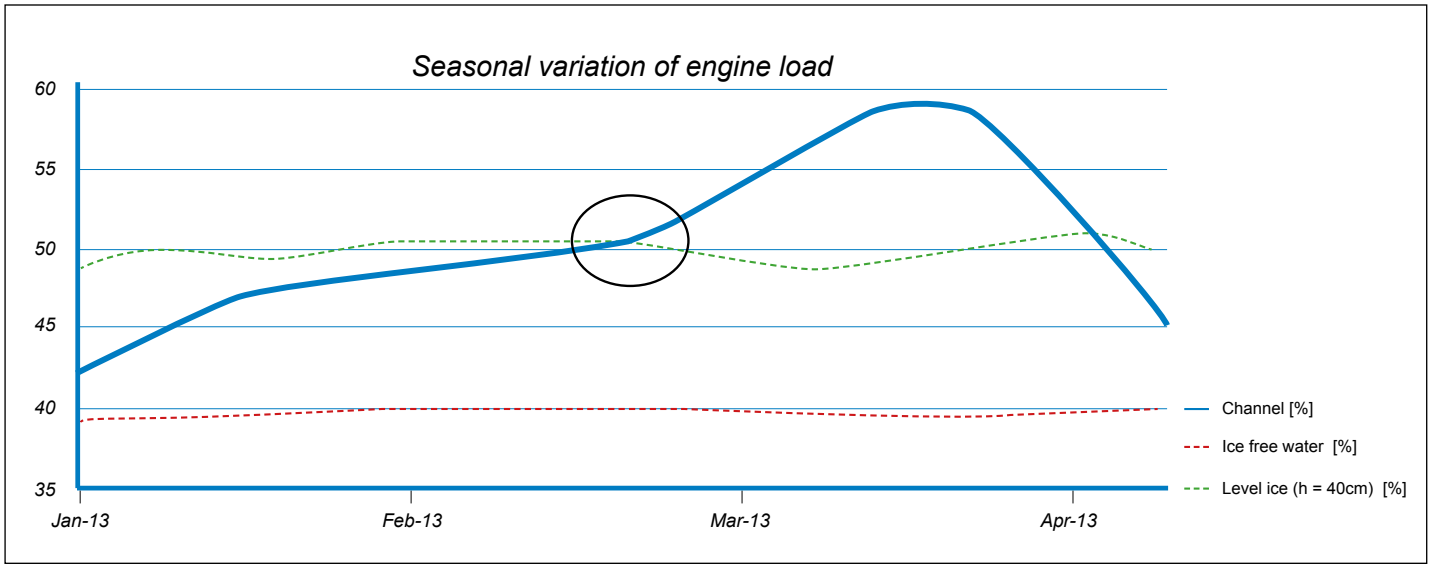

Engine load for each channel passage and corresponding reference tests in level ice and ice free water. Note where channel load crosses the level ice load, hence a parallel channel favourable.