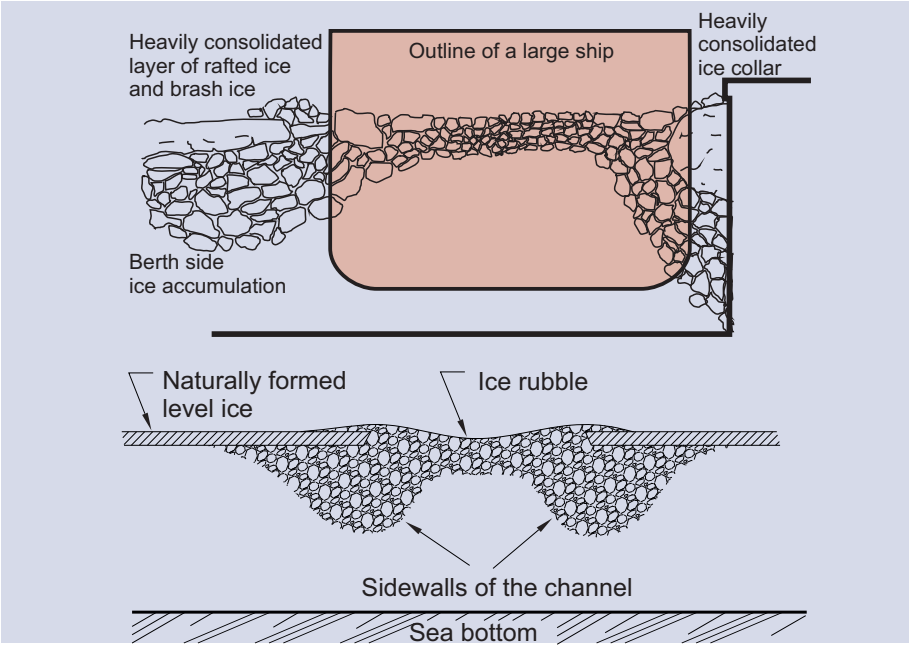
Brash ice management in harbour areas

Ice drifting into harbour areas and the formation of brash ice are challenging for winter navigation. Brash ice creates thick sidewalls on the navigation channels. It also accumulates by the pier walls, making it difficult for ships to berth and potentially damaging vessels. Therefore, brash ice needs to be managed.

Every time a vessel breaks ice, the pieces will mix with the cold water and freeze again. This causes the brash ice thickness to grow, and it will become more difficult to navigate over time.

With the formation of brash ice in harbours, the ice consolidates into bigger pieces, which are then pushed against the pier walls when ships approach. An ice collar grows attached to the wall affecting the berthing. This may become a major problem, especially in situations where positioning accuracy is essential for loading and unloading.



"When you break ice, you create more ice," says Cayetana Ruiz de Almirón de Andrés, project engineer at Aker Arctic.

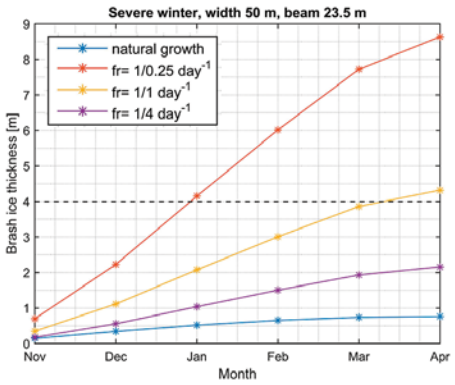
Affecting variables

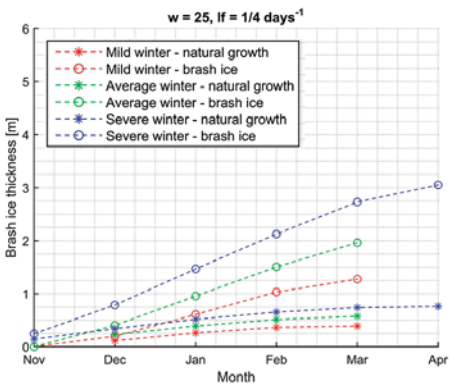
The main variables affecting the brash ice growth are breaking frequency, the air temperature and the ratio between beam of the ship and the width of the navigation channel.

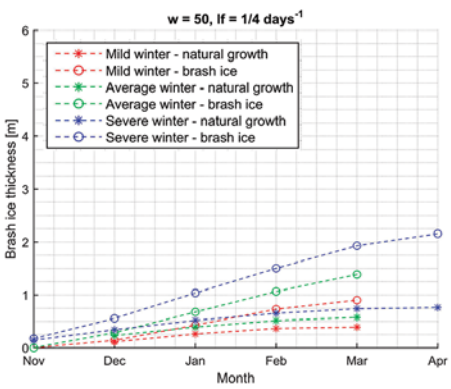
"The more often the ice is broken, the thicker the ice cover will become, because the blocks mix with cold water and freeze again," Ms Ruiz de Almirón de Andrés adds.

A narrow channel will create more brash ice. Conversely, if the channel is wide enough for vessels to move in more freely, the ice grows more slowly. This goes hand in hand with the beam of the ship. If the beam is the same width as the channel, more ice will be created. Air temperature is also a crucial factor. The colder the temperature, the faster the ice thickness will grow as the ice pieces mixed with water will freeze more quickly.

To manage all this, brash ice management methods are needed otherwise the ice formation will keep increasing. There are three main methods: brash ice management systems, ice management vessels or mechanical removal.







The main variables affecting brash ice growth are: breaking frequency, the air temperature, width of the channel and the beam of the ship.

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Surface current combined with warm water

A brash ice management system (BIMS) consists of a combination of a generated surface current to circulate the thermal energy and warm water (if available) released to the critical zones. The benefits are a reduction in brash ice cohesion and focused melting in specific locations. This system has been used successfully in Finnish harbours for decades.

Flushing the ice

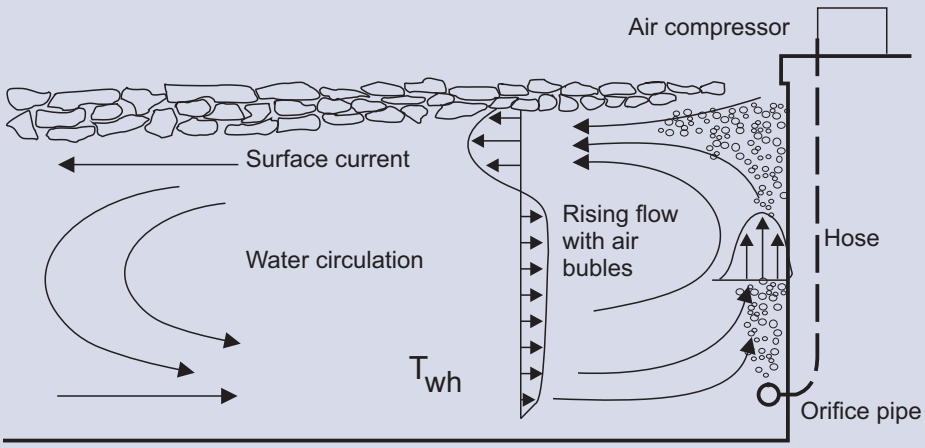
Another possibility is to use ice management vessels to flush the ice away in harbours and lateral transfer in navigation channels. This helps to clean the ice away, but does not prevent the ice from freezing again.

Example of flushing method using ice management vessel to clear the ice.

Mechanical removal

This method of managing ice is a more time-consuming option and therefore not as efficient. In this method, the ice is removed with cranes, scoops or excavators.

During winter, there are added costs for harbour operations due to the presence of brash ice. Mooring takes more time, fuel costs are increased and rudders are exposed to contact with ice.



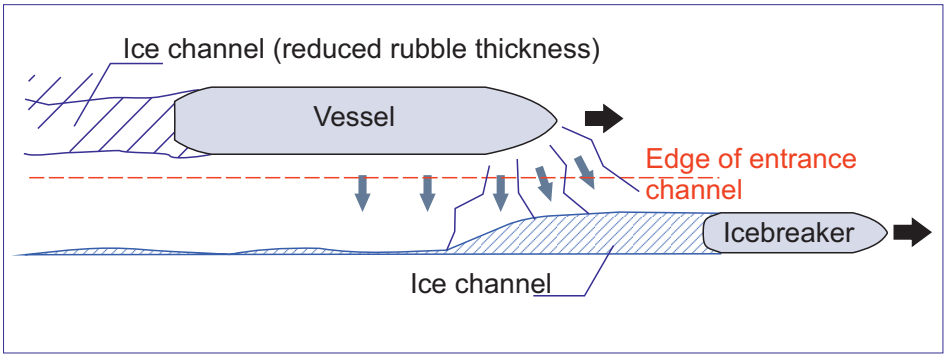
BIMS working principle

Working principles:

- Warm water is released close to the wharf wall
- A pipeline with orifices emits air bubbles, raising the flow up to the surface
- The bubbler system draws part of the thermal energy into the berth area and turns it into a current underneath the brash ice cover
- Additional mechanical removal

System elements:

- Water intake, boiler house and delivery facilities near the berths
- Compressed air facilities and bubbler lines to circulate the warm water for effective melting
- A Port Icebreaker Tug (PIBT) for assistance in berthing and departure (as well as turning in the harbour basin) of cargo vessels
- Excavators and cranes



Possible delays or cancellations are costly, and finally icebreaker assistance adds more costs. "Therefore we at Aker Arctic encourage ship owners to solve the problem and plan for this in advance," Ms Ruiz de Almirón de Andrés says.

Example of lateral transfer using ice management vessel in ice channels.

Meet Cayetana Ruiz de Almirón de Andrés

Cayetana Ruiz de Almirón de Andrés works at Aker Arctic as a project engineer specialising in harbour and terminal designs. She is originally from Granada in southern Spain and has been in Finland since the end of 2013. She completed her master's degree in integral management of ports and coastal zones at the University of Granada in 2011.

Before joining Aker Arctic, she worked at the University's hydraulic laboratory testing breakwaters and studying the morphodynamics of harbour areas. Her biggest passion is backcountry skiing, so she is not afraid of cold winters.