Light weight vessels operation in brashed ice

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Light weight ships and winter conditions

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Background
Are **light weight ships** e.g. WFSV or passenger ships built in aluminium or FRP **suitable** for operation in winter climate? … and how do to **manage** such operations?

Project goal
Gather and collect technical and operational experiences from existing organisations with light weight ships operating in winter conditions.

The knowledge base will be used for
• Indicating limiting factors
• Provide a background for in-depth studies, analyses and development
Challenges

- Many and diverse opinions
- Various backgrounds
- Different geographic locations
- Lack of documentation
Light weight ships and winter conditions

Based on 33 interviews
Hull shape

Mono hulls

Catamaran

Trimaran
Propulsion systems

- Fixed propeller / rudder
- Water jet
- Azimut / Pod / IPS
- Bow propeller
- Trim / Interceptors
Operation adaptation for winter traffic

Winter traffic time table
Shift of vessel
Reallocation of stops
Docking at night
Ice channels
Reverse manoeuvres
Restrictions
Existing damages

- Excessive wear bottom color
- Slashed bow fenders
- Holes in kind on aluminum vessels
- Damage to the bilge keels
- Damage to the attachment of the sonar
- Pressure damage on side planking close to the stern
- Hose rupture of water jets
- Over heating of the main and auxiliary engines
- Dry running of the fire pump
- Cracks in the gel-coat and top-coat
- Damage to the propeller
- Dropped rudders
- Damage in gel-coat in FRP single shell

Poor statistics on ice damage due deficiencies in the reporting system.
The class lacks experience when they do not rate these ships for navigation in ice.
Rules and regulations

The most common regulations for small ships used by interviewed organisations are

- NBS-Y, Nordisk båtstandard för yrkesbåtar under 15 m 1990 (Sverige, Norge, Finland Danmark)

- Sjöfartsverkets Yrkesbåtsregler (Finnish Maritime Administration - Commercial Craft Rules) Version 2009:1 (Finland)

- Bekendtgørelse om Meddelelser fra Søfartsstyrelsen F, teknisk forskrifts om mindre erhvervsfartøjers bygning og udstyr m.v. (Danmark)
Regulation development

- National rules before class
- Function based rules - concern about increased cost
- One way forward might be two tracks

- Light weight ship operation in ice
  - Finska Sjöfartsverkets Yrkesbätsregler
  - Function based rules for winter operation
Light weight ships and winter conditions

Based on 33 interviews
Light weight vessels operation in brashed ice

Magnus Burman & Niclas Niclasen
Lightweight operation in ice - motivation

Waterway will provide an capacity increase in public transport

Light weight and high speed vessels is part of a sustainable transport system

Few (if any) publication on interaction ice and lightweight (high speed) ships

Operator experience – no problem

Unverified opinions dominate the debate on light weight FRP vessels operating in ice
More information – www.waterway365.com
Operational profile – Stockholm

Table 3.1: Data on the Ekerö-Stockholm route

<table>
<thead>
<tr>
<th>Distance</th>
<th>9.2 [nm]</th>
<th>From appendix A.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draft restriction</td>
<td>3.2 [m]</td>
<td>Shallow water at Ekerö</td>
</tr>
<tr>
<td>Breath restriction</td>
<td>( \approx 20.0 ) [m]</td>
<td>Narrow passage at Ekerö</td>
</tr>
<tr>
<td>Air draft restriction</td>
<td>24.0 [m]</td>
<td>Under Västerbron</td>
</tr>
<tr>
<td>Maximum ice thickness</td>
<td>( \approx 0.2 ) [m]</td>
<td>Section 5.1</td>
</tr>
</tbody>
</table>
The vessel

Table 3.4: The Outline Specification (O.S.) in the form of a table

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waterline length of the vessel</td>
<td>20.68 m</td>
</tr>
<tr>
<td>Length overall</td>
<td>22.41 m</td>
</tr>
<tr>
<td>Moulded breadth of the vessel</td>
<td>6.92 m</td>
</tr>
<tr>
<td>Moulded depth of the vessel</td>
<td>3.20 m</td>
</tr>
<tr>
<td>Design draught of the vessel</td>
<td>1 m</td>
</tr>
<tr>
<td>Design speed of the vessel</td>
<td>40 kn</td>
</tr>
<tr>
<td>Displacement of the vessel</td>
<td>≈ 48 t</td>
</tr>
<tr>
<td>Lightweight of the vessel</td>
<td>38 t</td>
</tr>
<tr>
<td>Deadweight of the vessel</td>
<td>≈ 10 t</td>
</tr>
<tr>
<td>Water capacity</td>
<td>1,000 L</td>
</tr>
<tr>
<td>Fuel capacity</td>
<td>≈ 1,750 kg</td>
</tr>
<tr>
<td>Installed power (MCR)</td>
<td>1,400 kW</td>
</tr>
<tr>
<td>Passenger capacity</td>
<td>90 Passengers</td>
</tr>
<tr>
<td>Maximum number of seated passengers</td>
<td>64 Passengers</td>
</tr>
<tr>
<td>Number of life rafts</td>
<td>6</td>
</tr>
<tr>
<td>Life raft capacity</td>
<td>180 Persons</td>
</tr>
</tbody>
</table>
Ice loading – ice thickness
Ice impact model

Impact velocity, as a function of speed

Impact location, Speed: 25[kn], Draft: 1.68[m], Trim: 5.51[deg]
Impact velocity: 1.32[m/s]
Panels

Bröderna Aa

Docksta Shipyard
Test series

Rigid steel plate – impact speed variation (mass constant)
– impact mass variation (speed constant)

Aluminium panel 1 – impact speed variation (mass constant)
Aluminium panel 2 – impact mass variation (speed constant)

Carbon panel – impact mass variation (speed constant)

Mass – 215, 300, 400, 500, 600 kg
Speed – 1.50, 1.77, 2.05, 2.29, 2.51 m/s

(Corresponding kenitic energy in impact)
Making of ice

-26°C
 Crushed ice + water + cold
 Ice test block
 Freeze from bottom and up to avoid cracking

Ice structure analysis

Ice cone geometry
Impactor geometry

Initial test series to evaluate ice cylinder
Impact setup

- Ice impactor
- Pressure mapping film
- Markings for indentation measurements
Ice impactor

Impact weight

High speed camera
Carbon fibre sandwich panel

1.5 m/s, 215 kg

Aluminium panel
Fracture surface vs pressure mapping
Indentation measurements

Laser

Rail

Indication lines for measurements
Relative deformation of panel 2 AM after test AM3C.

Relative deformation of panel 2 AM at position 2.
Deformation CFRP sandwich

Relative deformation of panel 3 CM at position 2

Location of min
Max force / load readings

Load is sum of measurement from the four load cells under the panel
Ice fracture vs no ice fracture

300 kg, 1.5 m/s

400 kg, 1.5 m/s
Peak force – different settings
Aluminium panel

Aluminium panel 1 – impact speed variation (mass constant)
Aluminium panel 2 – impact mass variation (speed constant)
Aluminium panel
Aluminium panel 1 – impact speed variation (mass constant)
Aluminium panel 2 – impact mass variation (speed constant)
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