Lightweight construction applications at sea
Presentation at the LASS-conference 071031

Tommy Hertzberg

SP Technical research Institute of Sweden
Fire Technology
The LASS project

3.5 year (2005-2008) Swedish ~2.6 M€ project aiming at demonstrating techniques for using lightweight construction materials at sea

Financial support by VINNOVA (Swedish Governmental Agency for Innovation Systems) and participating industries
LASS members
20 original + 9 associated
Participants

- **Ship owners**
  - Wallenius
  - STENA
  - Marininvest*, Thun*

- **Ship yards**
  - Kockums
  - SWECOMP*
  - Fagerdala

- **Ship design**
  - Light Craft Design*
  - CORIOLIS*
  - FMV

- **Base materials**
  - DIAB
  - SAPA
  - SONOFORM*

- **Insulation**
  - Rockwool
  - Thermal ceramics
  - Isover/Saint Gobain

- **Off-shore & Modules**
  - Emtunga
  - Scanmarine*
  - Premec*, Isolamin*

- **Research**
  - SP, SICOMP
  - Chalmers, SSPA
  - KTH

- **Ship organisations**
  - Swedish Maritime Safety Inspectorate
  - Swedish Shipowners' Association
  - DNV, Sweboat

* = SME
LASS project targets:

- Design of 4 (6) lightweight objects
- Demonstration of technical solutions for 30% lighter objects at 25% lower total cost
- Demonstration of practical methodologies for using light-weight constructions at sea
Lightweight materials used

- Shapable aluminium
- Core material
- Polymer
- Fibre
- High-strength composite material
Advantages of light-weight at sea

• Economical advantages
  – Dead load → paying load
  – Less maintenance and fuel cost

• Ecological advantages
  – Less fuel/load
  – Environmentally friendly waste-treatment

• Stability advantages
  – E.g. increased stability using lightweight superstructure
Main obstacles for lightweight constructions at sea

• **Technical**
  
  – Solvable. Largest problem is fire safety.

• **Tradition**
  
  – Traditions and IMO-regulations+classification rules based on steel hinders light-weight material.

• **Cost**
  
  – Initial cost is higher. LCA/LCC neccessary for argumentation
LASS objects for study, 1-4

Wallenius Ro-ro; SOLAS

STENA High-speed catamaran; HSC

FMV Passenger vessel; HSC

STENA Ro-pax; SOLAS
LASS objects for study, 5-6

Thun Dry cargo freight vessel; SOLAS

Emtunga Offshore LQ; MODU-code, NORSOK
Fire-hazard management at sea
SOLAS, Chapter II-2

- Part A - General
- Part B - Prevention of fire and explosion
- Part C - Suppression of fire
- Part D - Escape
- Part E - Operational requirement
- Part F - Alternative design and arrangement
- Part G - Special requirements
Design team

Preliminary qualitative analysis
- Identification of prescriptive requirements
- Definition of alternative design
- Identification of fire scenarios/fire hazards

Preliminary analysis report

Quantitative analysis
- Quantification of design fire scenarios
- Development of performance criteria
- Check safety margins
- Evaluation of alternative designs

MSC CIRC/1002 and fire

Ok
Not ok
Philosophies for part F application

- "Total anarchy"
  - FTP
  - Active fire protection, trained staff, ...... or
- Follow prescriptive regulation and FTP as closely as possible
LASS fire safety philosophy:

Fulfil all functional construction requirements using HSC-defined elements

<table>
<thead>
<tr>
<th>Steel or equivalent</th>
<th>Composites</th>
<th>Test procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-class division</td>
<td>Fire resisting division 60</td>
<td>A.754(18) — MSC.45(65)</td>
</tr>
<tr>
<td>B-class division</td>
<td>Fire resisting division 30</td>
<td>A.754(18) — MSC.45(65)</td>
</tr>
<tr>
<td>C-class division</td>
<td>Fire restricting material</td>
<td>ISO 1182 — MSC.40(60)</td>
</tr>
</tbody>
</table>
                                           (Room-Corner)
Fire tests; large scale
(A.754, MSC 45(65))
Successful composite bulkhead penetration test
Fire restricting material: Room-corner
Fire tests; small scale
External composite fire: KNM Orkla
Test data for fire simulations
(data base www.sp.se/fire/fdb)
CFD-fire simulation

FDS-simulation
Egress simulations

No. of people that has not reached the assembly station

Simulex-simulation
Fire risk analysis
(by courtesy of Dag Mcgeorge, DNV)
certified composite constructions

- **Thermal Ceramics**
  - FRD 60 deck and bulkhead, 100 mm, 6.85 kg/m²
  - Fire restricting material, 20-25 mm, 0.96-1.5 kg/m²

- **Isover/Saint-Gobain**
  - FRD 60 deck and bulkhead, 100 mm, 7.5 kg/m²
  - FRD 30 bulkhead, 75 mm, 5.4 kg/m²
  - Fire restricting material, 3.3 kg/m²

- **MCTBrattberg+Thermal Ceramics (LASS/SAFEDOR)**
  - FRD 60 penetration constructions, deck and bulkhead

- **Lightweight primary deck covering (LASS/SAFEDOR)**

- **Planned:**
  - Thermal ceramics: FRD 60 bulkhead test of high temp core + phenolics
  - Isolamin+Isover: B-class lightweight panel tests
  - Hellbergs Int: FRD 60 test, door in composite construction
  - Norac+Isover: FRD 60 window tests
<table>
<thead>
<tr>
<th>OBJECT</th>
<th>ORIGINAL MATERIAL</th>
<th>NEW MATERIAL</th>
<th>WEIGHT REDUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wholly composite HSC</td>
<td>Aluminium</td>
<td>GRP-sandwich</td>
<td>28 %</td>
</tr>
<tr>
<td>Wholly composite HSC</td>
<td>Aluminium</td>
<td>CRP-sandwich</td>
<td>44 %</td>
</tr>
<tr>
<td>Superstructure on HSC</td>
<td>Aluminium</td>
<td>GRP sandwich</td>
<td>6 %</td>
</tr>
<tr>
<td>Superstructure on HSC</td>
<td>Aluminium</td>
<td>CRP sandwich</td>
<td>28 %</td>
</tr>
<tr>
<td>Upper decks on ro-ro</td>
<td>Steel</td>
<td>Aluminium</td>
<td>45 %</td>
</tr>
<tr>
<td>Upper decks on ro-ro, optimised</td>
<td>Steel</td>
<td>Aluminium</td>
<td>65-70 %</td>
</tr>
<tr>
<td>Superstructure on ro-pax</td>
<td>Steel</td>
<td>GRP-sandwich</td>
<td>63 %</td>
</tr>
<tr>
<td>Superstructure, etc on freight vessel</td>
<td>Steel</td>
<td>GRP-sandwich</td>
<td>&gt; 50 %</td>
</tr>
<tr>
<td>Offshore LQ</td>
<td>Steel</td>
<td>Aluminium</td>
<td>&gt; 30 %</td>
</tr>
</tbody>
</table>
Cost/LCC

- Composite HSC < aluminium HSC
- Payback time for ro-pax ~ 2 years
- Payback time for ro-ro vessel < 5 years
LASS: work in progress

- Support for commercial ship building projects:
  - Stena ro-pax with composite superstructure
  - Swedish cost guard patrol vessels in composite

- Large-scale cabin-corridor fire tests

- Development of EU-project co-operations (SAFEDOR, De-Light Transport, SURSHIP)

- Information exchange with other research projects

- Marketing of know-how
Further information at project website:

www.lass.nu

Thank you for your attention!