Lightweight construction application at sea

LÄSS

Lightweight in Living Quarters

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• What is a Living Quarter
• Fabrication - Modular concept
• Why lightweight
• Weight of a Living Quarter
• Weight saving in a Living Quarter
• Aluminum design
What is a Living Quarter?

- A living Quarter consists of:
  - Accommodation for crew
  - Safe area (Fire/gas/blast)
  - Dining area
  - Recreation
  - Central Control Room
  - Airport (baggage handling, sky lobby, etc)
  - Medical center
  - Office
  - Galley
  - Laundry
  - 20-250 POB
  - 500-4000m²
  - 250-2000 metric ton
What is a Living Quarter?

- Characteristics
  - Assembly phase
  - Load out
  - Sea transport
  - Installation (Lifting/skidding/etc.)
What is a Living Quarter?

- Load out
- Testing
- On barge
- Sea transport
- Installation
Overview – Modular concept
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Why lightweight?

• Customer requirements
  – Increased capacity – POB
  – Modification
  – New regulations
  – HSE requirements (regulations/Company)

• Challenge – Cover all new requirements using same support structure.

• This trend are global – Lightweight is important
Why lightweight

• Investment in modification project in Norway are expected to increase by near 100% next 8 years.

• This trend are global – Lightweight design has a market

Modification market in Norway only

50% Production increase
25% HSE
25% Maintain integrity

Million [SEK]

0 5 000 10 000 15 000 20 000 25 000 30 000 35 000 40 000
Weight of a Living Quarter

- Weight drivers
  - Temporary construction phases
  - Blast requirements
  - Deformations
  - Fire and Gas requirements
  - Wall panels
  - External items (HD, staircases, walkways, platforms, laydown areas.)
Weight of a Living Quarter

Weight distribution in a LQ (typical)

Reference project 1000 ton Stressed skin by Emtunga

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<th>Structure</th>
<th>Architectural</th>
<th>HVAC</th>
<th>EIT</th>
<th>Piping</th>
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<th>External Items</th>
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- **Hot spots**
  - Structure
  - Temporary phases
  - Architectural – wall panels
Weight saving in a Living Quarter

- **Structure**
  - **High strength steel**
    - Applicable in a few areas since deformation is the driver.
    - Possible items is limited to lifting points/support points.
  - **Aluminum**
    - 1/3:rd weight and 1/3 stiffness - equal?
    - Form section properties that is suitable for deformation. \( d = \frac{5}{384} q L^4 / E I \)
    - The structure is approximately a factor of 3 more expensive compared to steel
    - Longer lead time
    - Require more Passive Fire Protection
    - Typical structural weight saving is 25% compared to steel. Overall weight saving is 12-13%
Weight saving in a Living Quarter

• Wall panels
  – Saving is up to approximately 3%
  – Generates questions from customer regarding references, certification, etc. but possible
  – Rule of thumb – heavy material good acoustic properties………!
  – Can be adopted for both aluminum and Steel alternative
Weight saving in a Living Quarter

- **Temporary construction phases**
  - Newer accept that temporary phases adds on structural material that are dead weight during in-place operation
  - Focus on (Spend money on):
    - temporary structures
    - Lifting aids
    - Installation aids
    - Bottom lift
  - Weight saving is ~6%
Weight saving in a Living Quarter

- **Temporary construction phases**

  - **Loadout**
  - **Sea transport**
  - **Installation**

  **UPPER LATERAL SUPPORT FOR SEA FASTENING DURING TRANSPORT**

  **LOWER LATERAL SUPPORT FOR SEA FASTENING DURING TRANSPORT**

  **BASEFRAME**

  **VERTICAL SUPPORT FOR SEA TRANSPORT**

  **BARGE**
Weight saving in a Living Quarter

• **Temporary construction phases**
  Bad example !!
Weight saving in a Living Quarter

- Weight saving on hot spots
  - Using aluminum structure ~13%
  - Temporary construction phases ~6%
  - Using light weight wall panels ~3%
  
  Total: ~22%

- It should be noted that additional weight saving is possible in the support structure.
Aluminum design

• Focus on aluminum solution and wall panels in LÄSS project
  – New structural design adopted to modular construction (Emtunga)
  – Development in conjunction with SAPA
Aluminum design

• Basic panel alternatives investigated
  – Extruded panels 400mm
  – FS welded
  – Both alternatives can be used as wall panel as well as floor panel. Final design decided in each individual project.
Aluminum design

- Basic panel alternatives investigated
  - Both alternatives meet following criteria’s.
    - Shear load of 550 kN/m
    - Blast load of 30 kN/m² as shown below
Aluminum design

- Basic panel alternatives investigated

Reference - Steel

Solid panel Alt A

Solid panel Alt B
Aluminum design

• Basic panel alternatives investigated
  – Structural calculations and production feasibility study performed by SAPA shows following
    • Possible weight saving of 40-50% in the panel
    • Possible embedded feasibility to decrease fabrication time
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• Next step?
  – Improve/verify/approve PFP design
  – Detail design
  – Temporary support structure for lifting and handling of each module
End of presentation!

Questions?

Thanks for listening!