Lightweight composite gangway for the offshore access market
Who are we?

Koen van Valkenhoef
Structural Engineer

Siebert Frieling
Lead Engineer
What does Ampelmann Operations provide

Safe and efficient offshore access
What does Ampelmann Operations provide
Ampelmann offshore access system
Opportunities and risks of composites

- Low maintenance, lower OPEX
- Weight optimization
- Possible future product portfolio expansion

Failure mechanisms

- Safety
- Reliability
- Performance
Challenges of working with composites

So many choices…

Reference: Maximising the Advantage of Composites in Lifting Appliances, Dr. Linda Starink (Lloyd's Register)
Composite development roadmap

Composite T-Boom
- Proof-of-concept
- Gain knowledge and experience on:
  - Engineering
  - Fabrication
  - Performance

Composite Slideway
- Proof mass reduction capabilities
- Certification
- Offshore experience with composite product in operation

R&D Composites
- Design certification
- Structural health monitoring

Composite Gangway
- Lightweight system
- Certified line product

2019

2020

2021
Ampelmann offshore access system
Three main components built in the same mold
Side panels and deck adhesively bonded
Composite T-Boom in reality

Assembly

Testing
Comparable to steel but lighter

Steel T-Boom

Composite T-Boom

Mass -33%

€ +14%

- Structural performance
- Functional requirements
Composite development roadmap

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Innovation required in order to

- Reduce OPEX
- Weight reduction
- Design Certification
- Failure mechanisms

Corrosion Resistance

Safety
Certification

Offshore cranes
CLAME

Offshore access systems

Offshore wind turbines
DNVGL-ST-0376

Vessels
Class

Composite components
From steel to composite design validation

**Table:**

<table>
<thead>
<tr>
<th>Steel Failure Mechanisms</th>
<th>Composite Failure Mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yielding</td>
<td>Buckling</td>
</tr>
<tr>
<td>Buckling</td>
<td>Fibre failure</td>
</tr>
<tr>
<td>Deflection</td>
<td>Interfiber failure</td>
</tr>
<tr>
<td></td>
<td>Resin failure</td>
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<tr>
<td></td>
<td>Facesheet tearing</td>
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<td>Stress rupture</td>
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<td>Creep</td>
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<tr>
<td></td>
<td>Matrix cracking</td>
</tr>
<tr>
<td></td>
<td>Impact</td>
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</table>

**Equation:**

\[
\sigma_0 = F \sigma
\]

\[
\sigma_0 = \sqrt{\sigma_{xx}^2 + \sigma_{yy}^2 - \sigma_{xx} \sigma_{yy} + 3 \sigma_{zz}^2} \leq 1.1 \sigma_0
\]

**Load and Resistance Factor design**

\[
\gamma_F \gamma_{Sd} S_k \leq \frac{R_k}{\gamma_{M} \gamma_{Y}}
\]

**Allowable stress design**

<table>
<thead>
<tr>
<th>Material</th>
<th>Stress Factor</th>
<th>F</th>
<th>Factor</th>
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<tbody>
<tr>
<td>Steel</td>
<td>1.07</td>
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</tr>
<tr>
<td>Steel</td>
<td>1.15</td>
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**No. of independent engineering constants**

<table>
<thead>
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<th>Steel</th>
<th>2</th>
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<tr>
<td>Composite</td>
<td>21</td>
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</table>
Unpredictable failures

**Failure mechanisms**
- Composite
- Buckling
- Deflection
- Fibre failure
- Interfiber failure
- Resin failure
- Facesheet tearing
- Core failure
- Fatigue
- Stress rupture
- Creep
- Matrix cracking
- Impact

**Stress-Strain Diagram**
- Young's Modulus: Rise = Slope / Run
- Yield Strength: Rise
- Ultimate Strength: Fracture
- Strain Hardening
- Necking

**工作任务**
- 图表展示了应力-应变关系
- 复合材料的失效机制
- 常见失效模式及对应应力-应变曲线
- 失效类型包括：屈曲、位移、纤维失效、界面失效、树脂失效、夹层失效、核失效、疲劳、应力断裂、蠕变、矩阵开裂和冲击。
Desired equivalent safety & reliability level drives research on SHM area

Failure mechanisms

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Aimed goal of Structural Health Monitoring

Weight optimization

Structure Quality

- Reliability
- Cost of maintenance

SAFETY
RELIABILITY
What would an appropriate SHM technology be for offshore access applications?

Vibration-based

Acoustic Emission

Fibre-optics
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- Structural health

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2019 2020 2021
Offshore experience with Slideway
Composite development roadmap

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- Certified demonstrator
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Composite Gangway
- Lightweight system
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2019

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Share experience for a composite future in the maritime and offshore industry

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<td>R&amp;D Composite Engineer</td>
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