A comprehensive review on structural joining techniques in the marine industries


Introduction
Since many modules of a ship cannot be practically reduced to a single structure, joining technologies are employed to join various substructures and transfer loads between the different components. These joining methods include welding, mechanical fastening, adhesive bonding, overlamination, and hybrid joining. In the current study, a comprehensive review has been conducted on the mechanical performance of the common joining techniques in the marine industry.

Joining techniques in the marine industry
Overlamination method which consists of two parts that are joined by lamination, is widely employed in marine industry due to number of benefits such as increase in the fatigue resistance, and reduction of the fasteners [1]. Adhesive bonding is generally employed when the design and manufacturing requirements involve thin substrates, corrosion resistance, particular materials, low weight, surface integrity, and minimum stress concentration [2].

Overlamination
Figure 1 – Typical overlaminated joints: a) T-Joint, b) X-Joint, c) L-Joint, and d) Π-Joint

Adhesive bonding
Figure 2 – Typical types of adhesive joints: a) Butt-Joint, b) Corner-Joint, and c) T-Joint

Welding

Mechanical Fastening

Overlamination

Hybrid Joining

Figure 3 – Typical hybrid joints in the marine industry

Table: Mechanical Characterization of Various Joining Methods in the Marine Industry

<table>
<thead>
<tr>
<th>Method</th>
<th>Welding Bonding</th>
<th>Mechanical Fastening</th>
<th>Overlamination</th>
<th>Hybrid Joining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress concentration at joint</td>
<td>Medium</td>
<td>Low</td>
<td>Medium to high</td>
<td></td>
</tr>
<tr>
<td>Strength to weight ratio</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Fatigue endurance</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Vibration absorption</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>

Figure 4 – Mechanical characterization of various joining methods in the marine industry

Conclusions
Using suitable and efficient joining methods which maintain the integrity, reliability, and durability of the structure is a concerning issue that must be considered in joining components in marine structures. To design the most efficient joints to be used in the marine industry, criteria such as mechanical performance, manufacturing process, endurance against the environmental conditions, and the specific application of structure must be considered.

References

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