Liquefied Natural Gas Bunkering Barge

Project Statement
Team Marine Refueling Concepts (MRC) worked in collaboration with Moran Iron Works, Inc. to secure a new market for their core product of large pre-fabricated welded metal structures. Recent developments in natural gas extraction and propulsion systems have provided an opportunity to develop a marine construction sector in the Great Lakes region, providing that new market. The focus was on the development and fabrication of liquefied natural gas (LNG) bunkering barges to refuel ships on the Great Lakes. Team MRC conducted a feasibility study and conceptual design of an LNG bunkering barge. Design efforts focused on economic scaling of the barge, layout of refueling tanks and equipment, and capsize stability in Great Lakes waves, allowing for LNG sloshing in tanks, the latter phenomenon studied by simulation and wave tank experiments.

Wave Generation Tank
A wedge shaped plunger oscillates up and down to create uniform waves which travel the length of the tank. To prevent the waves from reflecting off the end wall, a ramp and porous sack filled with golf balls was used to dampen the waves. An accelerometer was used to record the wave induced lateral acceleration of the scale model for the case of an empty, half filled and full fuel tank. These results were used to test the validity of the MATLAB computational model.

Scale Model
This scale model features a simplified rectangular hull machined from prototyping foam and a single fuel tank constructed from clear acrylic.

Team Members
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Industrial Customer
Moran Iron Works, Inc. Onaway, Michigan
Specializing in custom welding & industrial fabrication

Wave Induced Roll of Full Size Virtual Model
Great Lakes Waves: 10’ Amplitude 4s Period

Industrial Contact
Victor Ruppert

Barge Stability
LNG is stored at -260°F and is 1/600th of its gaseous volume. Since baffles placed inside LNG tanks create friction resulting in boil-off gas, liquid sloshing is a concern. Wave induced liquid sloshing may cause the barge to become unstable and possibly capsize. Team MRC strived to reduce the effect of liquid sloshing by minimizing the free surface area of the liquid within the barge’s fuel tanks. Using parameters from Orca3D and a MATLAB computational model, Team MRC verified that the full size virtual model could withstand Great Lakes weather conditions.

Final Design Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Length Overall</td>
<td>300’</td>
</tr>
<tr>
<td>Beam Overall</td>
<td>60’</td>
</tr>
<tr>
<td>Depth</td>
<td>30’</td>
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<tr>
<td>Draft Loaded</td>
<td>12’ 9”</td>
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<tr>
<td>LNG Capacity</td>
<td>634,013 gal (2400m³)</td>
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<tr>
<td>Displacement Loaded</td>
<td>5,058 tons</td>
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