Tank testing of an offshore vessel in operational and extreme wave conditions

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Project Aim

To simulate the response of a floating production, storage and offloading (FPSO) facility to the extreme wave climate off the west coast of Ireland in order to inform engineers and designers in the oil, gas and renewables sectors.

Project Description

A wave tank testing programme was carried out in the Deep Ocean Basin at the National Ocean Test Facility, Lir, to simulate the Dynamic Positioning (DP) capability of a storage tanker or FPSO vessel in operational and extreme met-ocean conditions as found off the west coast of Ireland.

The tests provide an indication of the thrust requirements of any such vessel operating under these conditions. The testing was performed with a 1:85 scale model of a storage tanker in a six-point mooring system to simulate the DP system of the vessel for three different load conditions. The physical test results were validated with the outputs of numerical simulations.

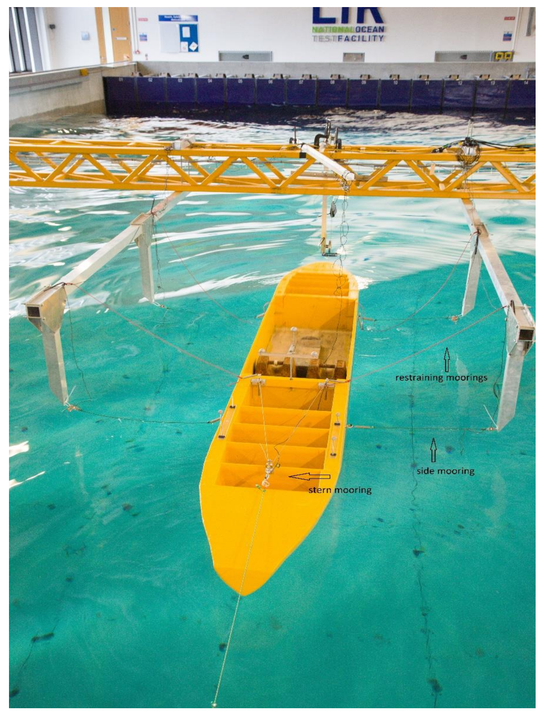

Figure 1. *Physical model test setup in the Deep Ocean Basin at Lir.*

Figure 2. *Pitching of the model.*

Model setup

To simulate the DP system, a six-point mooring system was designed. A bridle at the bow was attached to a mooring rope that led through a pulley system and had a weight attached to the end of the mooring rope, which simulated the main thrust of the vessel. Four infra-red cameras were mounted on a truss over the basin that could detect the position of seven markers placed on the model, in order to record the motion of the model during testing,

Eleven wave cases were chosen for the Brettschneider wave spectrum with varying significant wave heights (H_s), peak periods (T_p) and wave steepness. The values for a sample extreme wave case, Brett11, were as follows:

Full scale H_s	Full scale T_p	Model scale H_s	Model scale T_p
17 m	16.7 s	0.20 m	0.54 s

All regular and irregular wave cases were run for each load condition with zero-degree wave angles, i.e. the model had its bow directly into the travel direction of the waves, and 30-degree wave angles, coming in at the port side bow of the model. During testing the motion of the model, the loads in the four side moorings and stern mooring and the wave heights were recorded.

Figure 3. *Vessel trajectories under Brett 11 (extreme seas), full load, 0 degrees, physical testing*

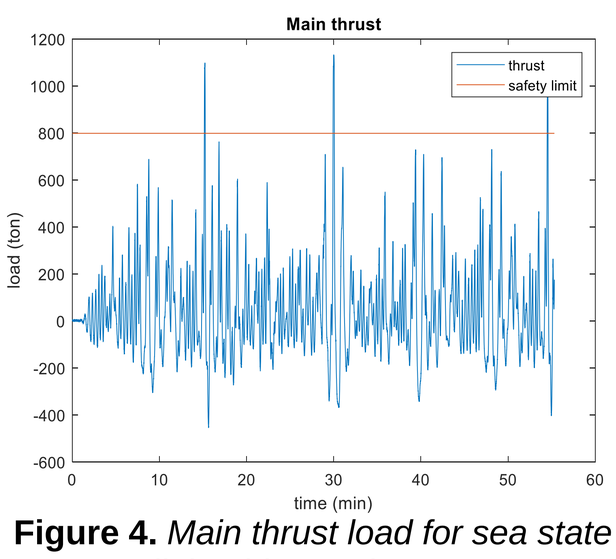

Figure 4. *Main thrust load for sea state Brett 11, light ship, 30 degrees.*

Key Results

- The model setup with the six-point mooring system was able to keep the vessel within the safety limit up to a sea state of H_s of 10m and T_p of 17s
- The model setup was able to survive the extreme wave cases (H_s of 17 m and T_p of 16.7 s), however, the safety limits were occasionally exceeded.
- **An offshore storage tanker with a length of 300 m and tonnage of 60,000 tons will be able to handle sea states with H_s of 10 m and T_p of 17 s, as can be found off the west coast of Ireland, while remaining within the safety limits maintained by the vessel operator.**
- Main thrust capacity, or bollard pull, would be 1200 tons and maximum thrust capacity of the side thrusters would be 190 tons.

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