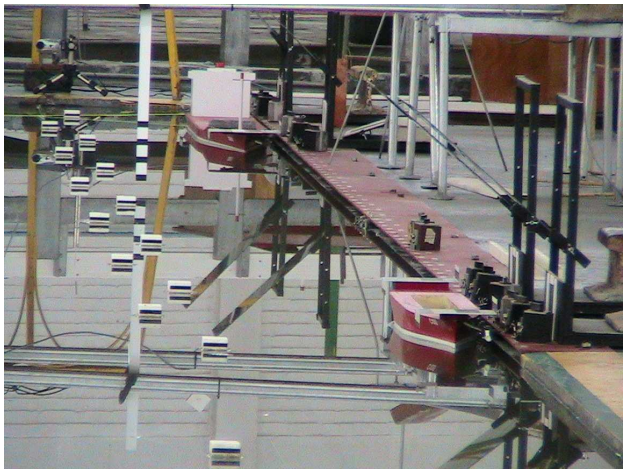
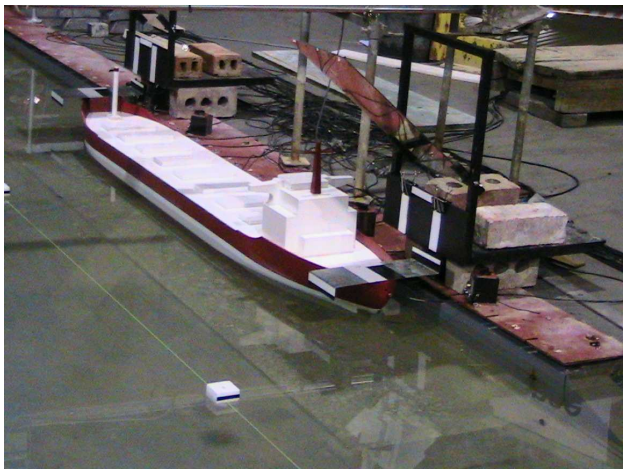
Khalifa Port, Abu Dhabi
Physical Model Tests of Wave Agitation and Vessel Response





Background

In 2007 Halcrow Group Ltd approached the CSIR to undertake physical model studies for the new Khalifa Port in Abu Dhabi. The objective of the model tests was to determine the wave conditions in the port basin, particularly along the EMAL Berth (bulk terminal) and the Main Berth (container quay), and to determine the motions and forces in mooring lines and fenders of three bulk carriers moored at the EMAL Berth and three container ships moored at the Main Berth.

Approach

The port and a part of the offshore area have been modelled in the CSIR's 60 x 34 m^2 wave basin at a scale of 1:100. Waves were generated at a 16 m wide bank of deep water wavemakers.

Waves were measured at ten locations outside the port basin: one directional capacitance wave gauge, seven capacitance wave gauges and two acoustic wave gauges. Waves were measured at 31 locations inside the port basin: six capacitance wave gauges, two acoustic wave gauges and 23 Keofloats, which are small light-weight floating blocks monitored with a camera.

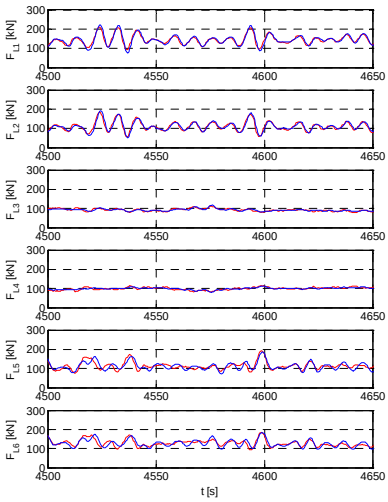
The motions of four ships could be measured simultaneously during a ship motion test. The CSIR's Keoship system was used to monitor the ship motions with two cameras per ship.

One berth was equipped with strain gauges at the bollard blocks and the fender strips to directly measure the forces in the mooring lines and fenders. The mooring forces at this berth and the other berths were calculated from the measured ship motions with the Keoship system as well.

Physical model study

In total 13 wave agitation tests and 34 ship motion tests were performed. The tests were carried out for different wave heights, peak periods and mean directions and for the ships moored at different berths. The measured ship motions were analysed to provide motion spectra, significant motions and maximum motions. These could be compared with the criteria.

The forces in mooring lines calculated from the Keoship system were compared with the forces measured with strain gauges. The results corresponded well, which provided good confidence in the ship motions and mooring forces from the Keoship system.



Forces in the mooring lines of the Handymax bulk carrier measured with strain gauges (red) and calculated from the measured ship motions (blue).

Conclusions

It has been concluded that the small waves, especially near the Main Berth in the rear end of the port basin, could be measured accurately with the Keofloat system. The small ship motions could be measured accurately with the Keoship system. Therefore, relationships could be made between the waves near the berth and the motions of the moored ship.

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