EXPERIMENTAL MEASUREMENTS OF MOVEMENTS AND MOORING FORCES OF A SHIP UNDER WAVE ACTION

L. Pinheiro1(*), F. Pedro1, S. Hossam2, M. Hinostroza2, J.A. Santos2,3, C.J.E.M. Fortes1

1LNEC - National Laboratory for Civil Engineering, Av. do Brasil, 101, 1700-066, Lisboa, Portugal.

(*Email: lpinheiro@lnec.pt)

ABSTRACT

This paper presents a series of tests on a reduced physical model to reproduce the behavior of a moored oil tanker. The measurement techniques used and all the instrumentation are presented. Data analysis techniques are also presented. The objective of the tests is the characterization of the incident marine agitation and the response of the ship, including the movements according to 6 degrees of freedom and the forces in the mooring system.

The tests were carried out in one of the tanks of the Marine Hydraulic Pavilion of the National Laboratory of Civil Engineering, using for the generation of marine agitation a batter capable of generating irregular waves.

The vessel used is a scale model of the "Esso Osaka" tanker with a length of 3.43 m, a width of 0.53 m and a maximum draft of 0.23 m and is lying in terminal A of the Port of Leixões. The entire port area was built at 1:80 scale, including bathymetry and port structures. The waves are generated outside the port to the bathymetric of -20m ZHL (zero hydrographic of Leixões). Several sea states were simulated with irregular waves with periods between 10s and 16s and significant wave heights between 2m and 6m.

The vessel is instrumented with an optical motion capture system according to the six degrees of freedom, composed of 4 cameras of high resolution that allows to follow the position of several targets placed in the ship and 6 load cells to measure the forces in the moorings and defenses. The measurement of free surface elevation was performed with a set of resistive probes and an ADV.

Keywords: Physical model, ship movements, marine agitation, movement and force measurement systems.

INTRODUCTION

Incident waves on moored ships may cause excessive ship movements, which may disrupt loading and unloading operations, lead to the breakage of the mooring system elements, or even damage the ship hull.

Physical model tests of moored ships can provide relevant information to characterize the moored ship response to incident waves, something of importance for the validation of numerical models for the same interaction.
The physical model results will be later used to validate a numerical model for moored ship behavior (Pinheiro et al. 2012) where such interaction can be simulated.

PHYSICAL MODEL TESTS SET-UP
The tests are conducted at a 22 m x 23 m (width x length) tank of the Ports and Maritime Structures Division of the Hydraulics and Environment Department of LNEC.

A scale model of a tanker ship is used in the tests. It is a scale model (1:100) of the Esso Osaka, a very large crude carrier. The overall length of the ship model is 3.43 m, its width is 0.54 m and max draught is 0.23 m. This ship whose movements are to be measured along its six degrees of freedom is instrumented with a set of targets that are followed by a 4 camera motion capture system.

To characterize the free-surface elevation outside the harbor and around the ship, a set of height resistive probes and a Quantum MX data-acquisition system with catman® DAQ Software are used. To determine the direction of waves, 2 ADV’s are used. The experimental set up is presented in Figure 1.

Results in terms of the associated response amplitude operators for each test case will also be presented and analyzed.

Fig. 1 - Experimental setup.

ACKNOWLEDGMENTS
The authors thank the Centre for Marine Technology and Ocean Engineering for lending the ship model and gyrocompass equipment. The financial support from FCT, through project “M&M Ships - Maneuvering & Moored Ships in Ports. Physical and numerical modelling.” reference PTDC/EMSTRA/5628/2014 is acknowledged.

REFERENCES