NUMERICAL SIMULATION OF THE BEHAVIOUR OF A MOORED SHIP INSIDE AN OPEN COAST HARBOUR.

L. Pinheiro [1], J.A. Santos[2] and C.J. Fortes[1]

Paper topic: Coastal waves, currents, tides and storm surges

1. Introduction

Sea waves inside harbors can affect ships' maneuvers or interfere with scheduled port operations. Hence it is important to correctly predict and characterize the wave field inside ports and also to correctly describe the movements of the ship and forces acting upon it.

2. Methodology

A classical approach to study ship – wave interaction is to assume that such interaction is linear, Cummins (1962). Then it is possible to decompose it in the so-called radiation and diffraction problems. Numerical models that solve such problems have been developed and used by the offshore industry for quite a while, Lee & Newman (2005), to study the interaction of sea-waves with floating objects, Tension Leg Platforms, for instance. However, this type of models cannot be used to solve the diffraction problem of a ship inside a harbour basin where nearby reflecting boundaries and shallow depths create very complex nonlinear wave fields.

A new set of procedures using coupled models is proposed in this work. First, a Boussinesq-type finite element wave propagation model is used to determine the wave field in the numerical domain containing the harbor. Then the velocity potentials are transferred to the ship's hull discretization points of a panel method ship-wave interaction model. Finally, the Haskind relations are used to determine the resulting forces acting on the ship according to the six modes of motion (heave, sway, surge, roll, pitch and yaw).

This procedure is validated with a simple geometry of a parallelepiped ship in open waters (test 1) and near a vertical wall (test 2). The results from WAMIT serve as validation. Finally, an application to a schematic harbor configuration will also be presented.

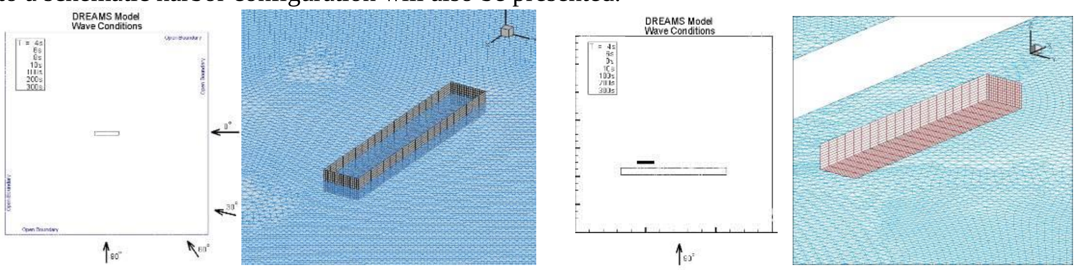

Figure 1: Numerical domain of DREAMS and wave conditions tested (left). Triangular finite element mesh of the fluid domain and panel discretization of the ship's hull (right).

[1] LNEC – National Laboratory for Civil Engineering, Av. do Brasil, 101, 1700-066 Lisbon, Portugal. lpinheiro@lnec.pt, jfortes@lnec.pt

[2] ISEL – Lisbon Superior Institute of Engineering, Rua Conselheiro Emídio Navarro 1 1959-007 Lisbon, Portugal. jasantos@dec.isel.pt

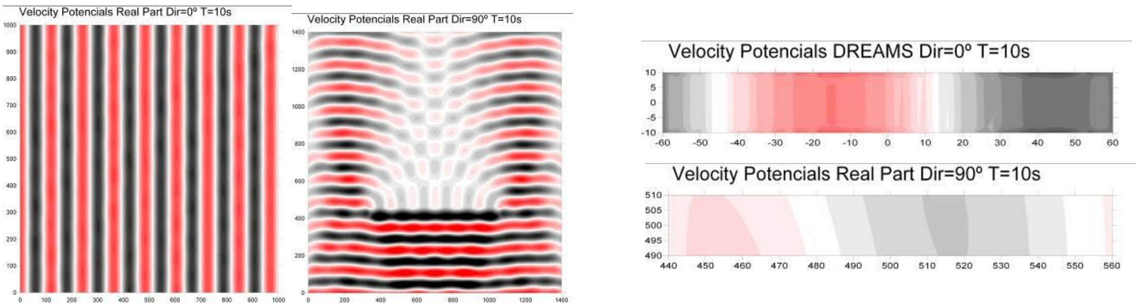

Figure 2: Velocity potentials obtained with DREAMS (whole domain and ship's location rectangle) for an incident wave of T=10s and Θ=0º.

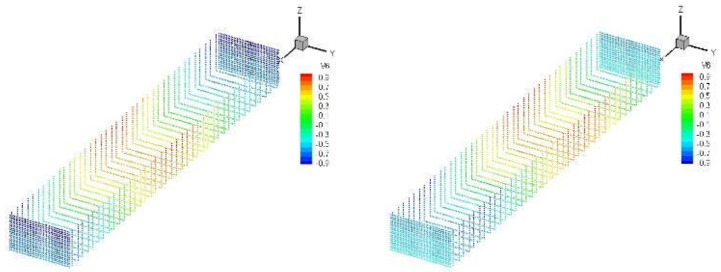

Figure 3: Velocity potentials obtained both with DREAMS and WAMIT on ship's panels centroids for an incident wave of T=10s and Θ=0º, Test1.

An application to a real harbor case study will also be presented.

3. Discussion

This new methodology for the evaluation of the diffraction forces acting on a ship placed inside a harbor basin is presented and tested in this paper. Movements of the moored ship and tensions on the mooring system are obtained using a numerical solver for the equations system for the movement of moored ships.

References

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