

NUMERICAL SIMULATION OF SHIPS ACCESSIBILITY AND SAFETY IN EXPOSED PORTS

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Abstract

Ports face challenges balancing economic growth, climate change, and energy transition. Demand for larger ships requires deeper and wider channels. Climate change increases extreme weather, impacting operations. Decarbonization and sustainable activities like marine renewables pressure ports to adapt and expand their infrastructure. At the same time, stricter regulations for ships safety are being put in place, following growing numbers of incidents. Numerical modelling is key to correctly assessing ocean, structure, and ship interactions.

A numerical methodology is proposed to determine ship accessibility and safety by simulating wave propagation and 3D hydrodynamic flow around the ship's hull, considering wind and current action. This methodology can be applied in both the planning and operational phases of port management.

In the planning phase, the minimum safety depths and widths of port entrance channels can be defined based on the local wave regime and the types of ships using the port. Numerical models transfer offshore waves to points along the access channel to determine the operational sea wave regime. The effect of waves on the ship's motions is determined using 3D simulation models. The maximum vertical motions of the ship are assessed based on wave characteristics. An operability level can be defined to determine the minimum safety dimensions of the entrance channel required to meet the minimum UKC.

In the operational phase, the methodology assesses safety conditions for ships entering or exiting the port based on forecasts of wind and wave characteristics and sea level data. Numerical models, such as SWAN and Boussinesq-type models, propagate waves from offshore regional scales to nearshore and port basin scales. The ship's response amplitude operators for the 6DoF are computed using a hydrodynamic 3D panel model. Heave and Pitch motions are key contributors to the vertical motion of the ship's hull, determining the maximum vertical displacement of the stern.

This methodology is used in an operational forecast and early warning system (EWS) for navigation, HIDRALERTA-SAFEPORT. The port of Aveiro serves as a case study. It is located in a growing economic area where offshore wind and marine renewable energy projects are being developed and is exposed to the energetic Atlantic Ocean. The proposed numerical methodology offers a way to enhance safety and accessibility in ports exposed to energetic seas. The methodology's application, especially with the development of an EWS, contributes to more resilient and competitive port operations.

Keywords: Port safety, wave propagation, hydrodynamic flow, early warning system, under-keel clearance