Ship manoeuvre patterns to prevent propeller scouring effects

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Abstract

The propulsion systems of Ro-Ro and Ro-Pax are getting closer to the soil of the docks generating erosion and stability problems to harbour's structures due to the increase in ship and propulsion systems dimensions. Moreover, Ro-Ro and Ro-Pax vessels, which serve regular services, have high docking frequencies. The most significant effect from propeller induced current can be found during manoeuvring situation in restricted waters due to the magnification caused by harbour structures. Therefore, larger vessels, more powerful propulsion systems along with higher frequencies can cause severe damages both to docking structures and basin manoeuvrability. The aim of this contribution is to design new manoeuvres of a regular maritime service to minimize their effects on erosion and sedimentation and avoid adverse impacts resulting from ship manoeuvring.

This paper describes the results of scouring processes caused by manoeuvres of a particular Ro-Pax vessel without the help of a tugboat. The erosion action is studied based on Automatic Identification System (AIS) data. The AIS is an automatic tracking system for identification and location of vessels by exchanging data via VHF communication to other nearby vessels. The AIS information received contains mainly, time, latitude and longitude, ship speed and ship course (IMO, 2003). The use of AIS data permits to understand the effect of changes to the fairway and vessel manoeuvring. However, AIS data alone are not enough. AIS data are combined with Acoustic Dopper Current Profiler at a fixed dock close to the docking area. The parameters extracted from AIS data are used as input to a real-time full mission bridge simulator to mimic the behaviour of the real situation (Aarsæther, 2007). From the simulation of specific manoeuvres, main parameters of the vessel characteristics are obtained. Considering these parameters and the existing formulae in maritime engineering proposed by PIANC (2015) and R.O.M 2.1-11 (2012), the efflux velocities, the axial velocities along the propeller and the maximum bed velocities can be calculated. We can conclude that the used method, based on the study of a particular case starting from the reproduction of the manoeuvre, becomes adequate to establish the relation between the scouring forcing and its generator, which is the ship's manoeuvre near the docking.

The present article further analyses manoeuvre patterns to understand the effects of the sedimentation of the eroded sediment using real-time full mission bridge simulator. The final

acceptation of the best manoeuvring behaviour is chosen according to criteria of acceptable reduction of the effect in harbour basins. Authors propose alternative docking and undocking manoeuvres with the same ship and in the same navigation area in order to reduce the effect of the toe scouring induced by vessel propeller. Docking and undocking manoeuvres assessed are: alternative berthing without tugs (controlling the speed of the main engine), berthing with one tug assistance and finally, manoeuvres with the assistance received from two tugs (without ship propulsion system). Results obtained show less sediment erosion close to toe of the docks and less stability problems to the docking platforms with the proposed tug-assistance manoeuvres.

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The wash produced by a ship's propeller is known to cause erosion on the seabed. This problem affects several harbours around the world with different configurations, morphologies and tidal ranges (Lam et al. 2012). Moreover the eroded sediment is deposited along the harbour reducing the water depth level and operative zones for several vessels manoeuvring. To reduce infrastructural costs for the adaptation of these harbours, the knowledge of ship manoeuvring behaviour is crucial. The outcomes of the presented case study can be extrapolated to other harbours to improve their management and reduce the scouring actions induced by the ship propellers.