DISCUSSION

VERTICAL AND SLOPED BANK EFFECTS ON DIFFERENT SHIP TYPES

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COMMENT

Dr Evert Lataire, **Prof Marc Vantorre** and **Dr Maxim Candries**, Ghent University, Belgium

The Author describes how the bank effects that occur when a ship sails in confined waters can be studied with a numerical method. Being involved in the *Knowledge Centre "Manoeuvring in Shallow & Confined Water"* (Ghent University & Flanders Hydraulics Research, Antwerp, Belgium), we have read the paper with interest.

A few questions arose when reading the paper, in particular concerning the finite difference method that was used for solving the time-dependent variation of flow field velocities and pressures. It would be useful to the reader to know whether the applied numerical code is commercially available or has been developed in-house. As no details have been mentioned about the grid convergence study for the two models (i.e. Ship 1 and Ship 2) discussed in the paper, we would be grateful for any clarification on this topic?

As it is not mentioned in the paper whether a validation against experimental data has been performed for a case that includes bank effects, we would like to draw the author's attention to the set of open access benchmark data made available by the Knowledge Centre mentioned above which deal specifically with bank effects and which can be obtained on request [15]. These data are a selection of a very elaborated test series comprising more than 10,000 experiments on bank effects that were carried out in the Towing Tank for Manoeuvres in Shallow Water at Flanders Hydraulics Research [16, 17].

Could the authors also specify how exactly the parameter d2b is defined?

The Author mentions in the conclusions that the bank effects were influenced by the under keel clearance and water depth, yet these are not discussed in Section 3. Could the Author elaborate on this very important topic? Finally, it would be interesting to see some figures of the forces and motions for different positions.

AUTHOR'S RESPONSE

Dear **Dr Evert Lataire**, **Prof Marc Vantorre** and **Dr Maxim Candries**

I am happy to receive your comments and discussions. Thank you very much for your interest on our paper. I try my best to answer your points of view as follows:

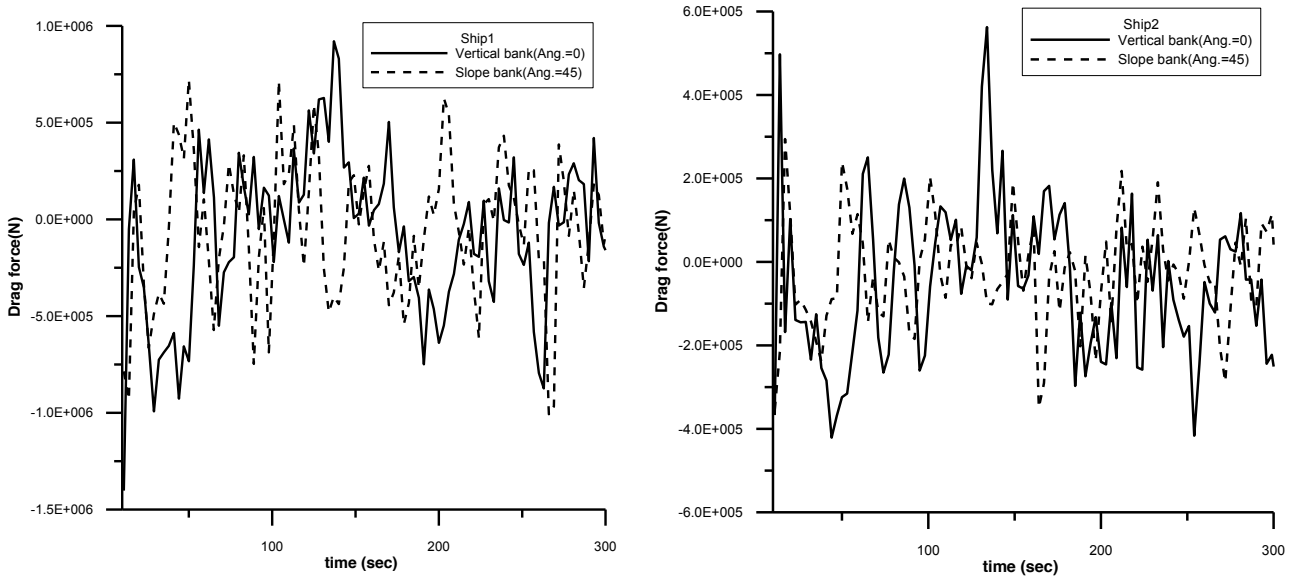
1. This study uses a commercial FLOW-3D computational fluid dynamics (CFD) software and the two ship models to examine the effects of the vertical and sloped bank and distance to bank on the magnitude and time-based variation of the yaw angle and sway force. As far as grid size is concerned, the resistance of an Azimut yacht was calculated for two computational cells grid and compared with the experimental data. In order to demonstrate this property of the present model and verify the consistency in the numerical accuracy with refinement of mesh, a mesh dependence study is carried out using the case of the bank effects of a container ship (Ship 1). Present study adopts the grid size of $\Delta h=0.2$ m and $\Delta h=0.1$ m near the ship boundary. Good agreements with other results obtained from the different numerical schemes are assured for both grid systems. Accordingly, the grid size of $\Delta h=0.2$ m near the ship boundary is adopted for all the cases study.

2. I am appreciated the references [15-17] provided by you for my further research. These references have presented in a clear and coherent manner. The experimental results obtained are very useful for further comparisions with the numerical results.

3. Could the authors also specify how exactly the parameter d2b is defined? d2b (d2b=BS) is the distance between the ship and bank as shown in the paper (Figure. 2).

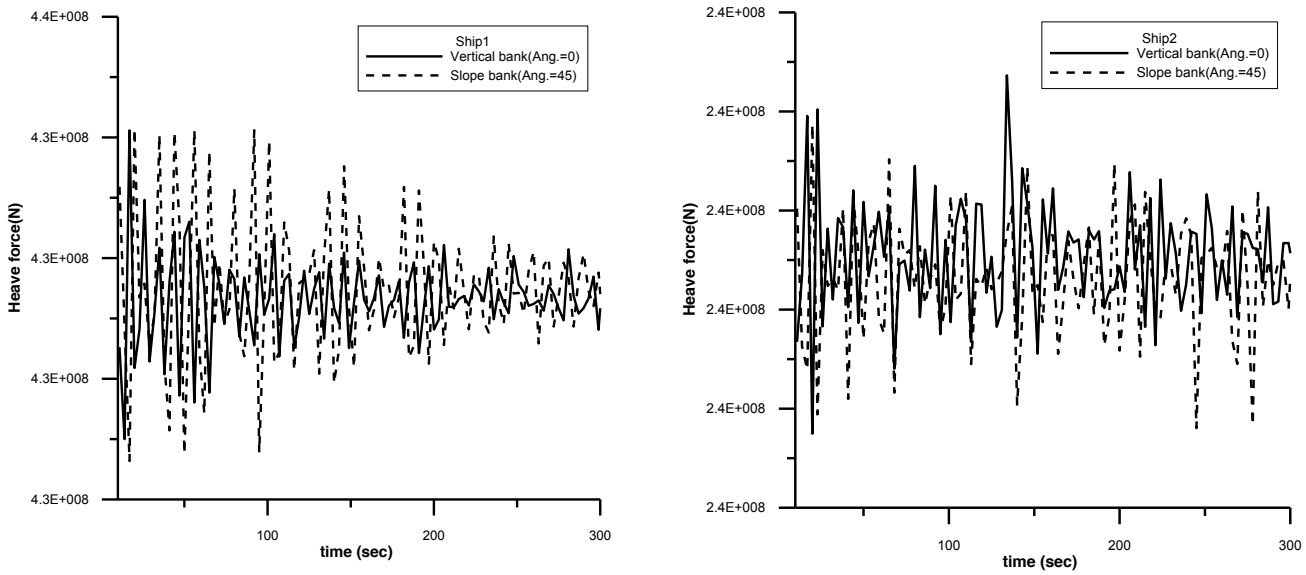
4. When operating in restricted water and forced to deviate from the center of the channel under vessel meeting and passing conditions, a suction effect is induced toward the stern of the vessel, while a cushioning effect is induced at the bow. This phenomenon is known as the bank effect. Although the bank effects produced during the navigation of ships were influenced by the following factors: ship type, draft, under keel clearance, trim, list, navigation speed, water depth, channel geometry, distance to bank(BS), and wind pressure. This study only investigated two types of

ships navigating at at a low navigation speed set at 3 kn along banks(vertical and sloped types) with a BS of 0.5 B and 1.0 B for all the cases study. Irrespective of sway force shown in the paper, here the forces for different positions are depicted as the discussion. Figures 1 and 2 show the variance of drag and heave force with respect to vertical and slope bank for (a) ship1 (b) ship2.



(a) (b)

Figure 1. Variance of drag force with respect to vertical and slope bank for (a) ship1 (b) ship2



(a) (b)

Figure 2. Variance of heave force with respect to vertical and slope bank for (a) ship1 (b) ship2

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