International Journal of Offshore and Polar Engineering (ISSN 1053-5381)
http://www.isope.org/publications/publications.htm

Vol. 25, No. 3, September 2015, p. 239–240; http://dx.doi.org/10.17736/ijope.2015.sh15d

Discussion

CFD CFD Simulation of Bow and Stern Slamming on a Containership in Random Waves
by C-R Chen, H-C Chen (IJOPE, Vol 25, No 3, pp 185–193, 2015)

Jan Oberhagemann (DNV GL, Hamburg, Germany).

The paper presents a study of bow and stern slamming from simulations of a ship in short irregular wave sequences using a RANS method. The use of CFD in ship design and hydrodynamic load assessment of ship structures is of current interest. Therefore, it will be useful to address a few topics where the paper could provide more information.

The first point for discussion is a rather technical comment and concerns the fluid domain size and the effectiveness of wave damping through transverse cell stretching. It is apparent from inspection of Figs. 9 and 11 that the wave pattern in the whole fluid domain is three-dimensional despite the unidirectional incident waves. This means disturbances caused by the ship are not dampened out until they reach the sideward and downstream boundaries. Radiated waves even travel to the upstream inlets and will be reflected there as well. Thus, wave reflections from the domain boundaries are likely to interact with the ship. This, in turn, will impair the ship motions and loads and may explain why comparisons of ship motions with experimental data reveal discrepancies (see the presented validation study). Wave damping through cell stretching can only be effective if the cell sizes are not much smaller than the lengths of the waves, which is clearly not the case for the presented grids. Have the authors investigated the effects of increasing the domain size and using larger cell stretching?

The second question is rather straightforward to answer. I assume the referenced method of fixed-point analytic wave calculation is equivalent to using the dispersion relation for gravity waves according to Airy theory. Is that correct?

The third question is: Have the authors investigated the influence of grid resolution in space and time on the local flow and the pressures during slamming impact?

The last issue addresses the identification of the critical scenarios. The authors should briefly explain their criteria for identifying a slamming event based on time series of wave elevation. It remains unclear to the reader why the wave elevation at $t = 6{,}014$ s was considered critical. Furthermore, it should be explained why the pre-selected event was not considered at all during evaluation of the simulation results.

The authors are encouraged to discuss their work further in the context of previous research on CFD simulations in random waves and identification of critical events. CFD can be a powerful tool to investigate local flow phenomena related to strong nonlinearities, but it requires some thought on the input. As a starting point, the authors may consider the following for their future work:

- Sampling of statistical information about slamming severity (e.g., in terms of bow pressures) from long-duration simulations in random waves. Because this will require simulations of several hours to cover a sufficient number of random events, available computer resources become an issue. See, e.g., discussions and applications in Oberhagemann et al. (2012).
- Alternatively, identification of critical wave events based on the ship reaction instead of the wave elevation. Just to name a few examples, refer to Jensen (2009), Schellin et al. (2013), and some of the literature given in the introduction.

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AUTHOR'S REPLY

The references given by Mr. Oberhagemann are for ship structural design under lifetime loading conditions and use a stochastic approach to create short wave profiles, which yield the extreme responses of a ship. Our interest is entirely different, which is to study the detailed physics of fluid-structure interaction involved in slamming events as a ship cruises in a realistic rough sea environment. This paper demonstrates that, given a relatively short wave sequence, complete CFD simulation of random wave and structure interaction involving multiple slamming events may be achieved without any simplified approaches. About 10 impacts over a 120-s duration are shown in Figs. 12 and 18 in Chen and Chen (2015). The long-term stochastic assessment of lifetime loading conditions on ship structure is outside the scope of this study. However, the present CFD method can be readily employed for the simulation of various critical wave events, as described in Jensen (2009), Schellin et al. (2013), Oberhagemann et al. (2012), and Ley et al. (2013).

Regarding Mr. Oberhagemann's point 1: In our code, a damping beach may be used on the downstream boundary and sidewalls to minimize wave reflection from the domain boundaries. In addition, an absorbing beach may also be implemented for the wave maker boundary through concurrent simulations of wave fields with and without the structure (Chen and Huang, 2004; Chen et al., 2004). In this study, we activate only the downstream damping beach. In order to see if the waves are reflected from the side boundaries, it is necessary to compare the wave fields along the sidewalls with and without the ship. Figure 1 below (for the same time instants presented in Fig. 9 in Chen and Chen (2015)) shows that the incident wave is not significantly affected by the radiated waves induced by the ship motion, especially when the ship is cruising with constant forward speed into the undisturbed wave field. Minor wave reflections are observed along the sidewalls behind the ship stern, which should not significantly affect the ship motions as the ship-generated waves continue to travel downstream after being reflected from the side boundaries. If it becomes necessary to eliminate the wave reflection completely, the computational domain