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EDITORIAL

Wave Loads and Motions of Ships and Offshore Structures

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The special issue on wave loads and motions of ships and offshore structures is the outcome of a workshop on the same topic that was organised in Harbin Engineering University in November 2017 with the objective of bringing together recent work done on the subject area and providing a forum for discussing these results.

Some Keynote Lectures have been invited from some experts that would cover different aspects of the problem under consideration and contributions have been made by Faltinsen, Yeung, Sen, Temarel, Teng, Duan and Guedes Soares covering different aspects of interest from the present state of the art. The first two dealt with new types of offshore structures, namely fishing cages and renewable energy floaters, while the others addressed special problems related to ship and offshore structures, i.e. the coupling of sloshing with wave-induced motions, the hydroelastic response, the response of offshore structures and the response of ships to abnormal waves.

Faltinsen presented an updated account on wave loads in floating fish farms, an important topic in Norway and few other countries that are investing heavily in aquaculture offshore. The problem has several aspects of special interest such as the dynamics of the flexible nets of the fish cages, the dynamics of the flexible cages coupled with the nets, the interaction between the cages and the mooring systems and the effect of fish dynamics on the loads on the nets. These aspects have been discussed in Faltinsen and Shen (2018), who provided a brief literature review on the initial developments in the dynamics of nets and flexible fish cages. They also discussed the practical problems arising in the interaction of workboats and the cages, an operational situation that cannot be disregarded.

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Yeung addressed another important area of present interest, which is floating renewable energy devices, although presenting a general method applicable to axisymmetric floating bodies (Yeung and Wang 2018). A highly efficient "hybrid integral-equation method" for computing hydrodynamic added-mass, wave-damping and wave exciting force of general body geometries with a vertical axis of symmetry is presented. The hybrid method utilises a numerical inner domain and a semi-infinite analytical outer domain separated by a vertical cylindrical matching boundary. Both radiation and diffraction potentials can be solved efficiently while satisfying the far-field radiation condition exactly.

Sen presented an overview of various developments in the hydrodynamic boundary value formulation of motions and loads in ship-like floating and then concentrated on their developments in the coupling of sloshing (Saripilli and Sen 2018). A coupled ship motion and slosh load algorithm has been developed for this purpose, which combines a potential flow-based ship motion solution method with a viscous CFD solver for the interior slosh loads. The ship motion solver is formulated using transient Green function. The CFD solver for the sloshing is fully nonlinear.

Temarel concentrated on the hydroelastic behaviour of ship-like structures and presented an introductory study on the feasibility of adopting weakly compressible smoothed particle hydrodynamics to analyse the 3D behaviour of a barge-like flexible structure (Ramli et al. 2018).

Teng et al. (2018) have presented an overview of the latest developments of nonlinear time-domain theory for simulation of moored floating body motion. For the analysis of the nonlinear response of an offshore platform under the action of irregular waves, a modified Cummins method was proposed.

Duan has presented a novel numerical model based on image Green function and first-order Taylor Expansion Boundary Element Method (TEBEM), which can improve the accuracy of hydrodynamic simulation for non-smooth body. It has been developed to calculate the side wall effects on first-order motion responses and second-order drift loads upon offshore structures in wave tank (Chen et al. 2018).

Guedes Soares presented a review of recent developments in modelling abnormal or rogue waves and the response of ships and offshore structures to this type of waves. However, the paper was not completed in time of publication of this special issue, so it will be published in a later issue of this journal.

Several regular contributions to the workshop have either complemented some of the areas covered by the keynote papers or expanded to new ones. The contributions of Ning et al. (2018) and Wang et al. (2018a) have addressed problems more representative of offshore structures while the other papers dealt with ship-like responses.

Ning et al. (2018) have presented a nonlinear simulation of focused wave group action on a truncated surface-piercing structure. A two-dimensional fully nonlinear numerical tank based on the higher-order boundary element method is developed. The amplitude of wave components of the focused wave group is determined by the JONSWAP wave spectrum. The effects of the presence of a surface-piercing structure on characteristics of focused wave group are discussed. The largest amplitudes of run-up and horizontal force on the structure occur when the front surface of the structure is at the focal location.

Wang et al. (2018a) have presented a viscous-flow-based analysis of wave near-trapped in a four-cylinder structure. The wave diffraction problem of a fixed vertical four-cylinder structure in regular waves is simulated systematically in time domain based on a numerical viscous wave tank. The run-up around the structure and the corresponding wave forces acting on the structure are illustrated and analysed in detail. More attention is then paid on the investigation to waves near-trapped inside the four-cylinder structure in the viscous fluid, and comparative study between the viscous- and potential-flow solutions is carried out.

The rest of this special issue dealt with the study of ships in waves. Wang et al. (2018b) deal with a standard seakeeping analysis but studied an unconventional ship, a river sea going containership, which has the special characteristic of being very slender and being thus susceptible to hydroelastic behaviour, a response that does not occur in the conventional containerships of similar size. The experimental results presented showed good agreement with the response amplitude operators calculated by a strip theory but also allowed the identification of a vibratory response that recommends further study to be accomplished.

Mikulić et al. (2018) have studied the behaviour in waves of a damaged ship, following up the various recent studies that have addressed ship responses with flooded compartments. They have used published experimental results and conducted calculations with an established 3D boundary element code, normally used for offshore structures because it does not account for forward speed effects, a feature that would not be relevant for a damaged ship that in principle would not be navigating.

Slamming and deck wetness has been dealt in various papers. Lin et al. (2018) presented a field approach to the study of bow flare slamming analysis for large container ships in parametric rolling condition. A 6-DOF weakly nonlinear time domain model was adopted to predict the ship motions of parametric roll. The relationship between slamming pressure and 3-DOF motions namely roll, pitch and heave in the real-time simulation is calculated to elaborate the mechanism of flare slamming phenomena in parametric rolling condition.

Dhavalikar et al. (2018) developed empirical formulations for bow flare slamming and deck wetness for displacement vessels. Bow flare pressure is derived in terms of flare and waterline angles. Deck wetness is derived in terms of static and dynamic swell-up and the relative motion. It was found that IACS UR S21A (2018) governing minimum pressure for deck scantlings is conservative in few of the presented cases.

Pal et al. (2018) have combined a boundary element code, calculating ship motions with a CFD and a FEA code that would use the relative motion between ship and waves to calculate the green water pressures and the deck response during large amplitude motions. The impact due to shipping of water on the deck of the vessel is computed using commercial CFD software and used as an external force in coupled BEM-FEM solver.

Finally, Wang and Wan (2018) have used a CFD code to study the manoeuvring of ships in waves. The solver is based on open source platform OpenFOAM and has introduced dynamic overset grid technology to handle complex ship hull-propeller-rudder motion system. A manoeuvring control module based on feedback control mechanism is also incorporated. RANS computations are carried out for several validation cases of free running ship manoeuvre in waves including zigzag, turning circle and course-keeping manoeuvres.

We hope that this set of papers provide an up-to-date overview of present ongoing research and of several of the relevant formulations being used for the various aspects of assessment of wave-induced motion loads.

References

Chen JK, Wang LJ, Duan WY (2018) Side wall effects on hydrodynamics of a floating body by image Green function based on TEBEM. J Mar Sci Appl 17(3):353–361. https://doi.org/10.1007/s11804-018-0046-0

Dhavalikar S, Dabbi PN, Poojari D, Joga R, Awasare S (2018) Development of empirical formulation for bow flare slamming and deck wetness for displacement vessels. J Mar Sci Appl 17(3): 414–431. https://doi.org/10.1007/s11804-018-0045-1

Faltinsen OM, Shen Y (2018) Wave and current effects on floating fish farms. J Mar Sci Appl 17(3):284–296. https://doi.org/10.1007/s11804-018-0033-5

Lin Y, Ma N, Gu XC (2018) Approximation method for flare slamming analysis for large container ships in parametric rolling conditions. J Mar Sci Appl 17(3):406–413. https://doi.org/10.1007/s11804-018-0048-y

Mikulić A, Parunov J, Guedes Soares C (2018) Wave-induced vertical motions and bending moments in damaged ships. J Mar Sci Appl 17(3):389–405. https://doi.org/10.1007/s11804-018-0050-4
Ning DZ, Li X, Zhang CW (2018) Nonlinear simulation of focused wave group action on a truncated surface-piercing structure. J Mar Sci Appl 17(3):362–370. https://doi.org/10.1007/s11804-018-0041-5
Pal SK, Kudupudi RB, Sunny MR, Datta R (2018) Numerical investigation of green water loading on flexible structures using three-step CFD-BEM-FEM approach. J Mar Sci Appl 17(3):432–442. https://doi.org/10.1007/s11804-018-0032-6
Ramli MZ, Temarel P, Tan M (2018) Hydrodynamic coefficients for a 3-D uniform flexible barge using weakly compressible smoothed particle hydrodynamics. J Mar Sci Appl 17(3):330–340. https://doi.org/10.1007/s11804-018-0044-2
Saripilli JR, Sen D (2018) Sloshing-coupled ship motion algorithm for estimation of slosh-induced pressures. J Mar Sci Appl 17(3):312–329. https://doi.org/10.1007/s11804-018-0031-7
Teng B, Cong PW, Gou Y (2018) Nonlinear time-domain theory for the simulation of moored floating body motion. J Mar Sci Appl 17(3): 341–352. https://doi.org/10.2534/jjasnaoe1968.1998.184_139
Wang JH, Wan DC (2018) CFD investigations of ship maneuvering in waves using naoe-FOAM-SJTU Solver. J Mar Sci Appl 17(3):443–458. https://doi.org/10.1007/s11804-018-0042-4
Wang ZK, He GH, Zhang ZG, Meng YH (2018a) Viscous-flow-based analysis of wave near-trapped in a four-cylinder structure. J Mar Sci Appl 17(3):371–379. https://doi.org/10.1007/s11804-018-0047-z
Wang YW, Wu WG, Guedes Soares C (2018b) Experimental and numerical studies of the wave-induced responses of a river-to-sea ship. J Mar Sci Appl 17(3):380–388
Yeung RW, Wang L (2018) Radiation and exciting forces of axisymmetric structures with a moonpool in waves. J Mar Sci Appl 17(3):297–311. https://doi.org/10.1007/s11804-018-0043-3