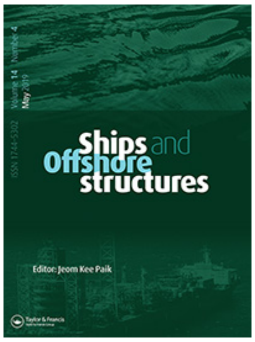

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Special issue on ‘coupled dynamic analysis of floating structures with concept technologies: current status and emerging future trends’

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EDITORIAL

Special issue on 'coupled dynamic analysis of floating structures with concept technologies: current status and emerging future trends'

Floating structures are important and strategic engineering structures. The modern engineering designs of floating structures (such as ships, semi-submersibles, 'Floating, Production, Storage and Offloading Systems [FPSOSs]', etc.) are becoming increasingly more complex because of the pressing demands of economies of scale, higher speed, lower motions, operational ability in adverse weather conditions, energy efficiency, clean environment, and advancements in material science and technologies. Floating structures are complex engineering structures whose design and analysis time run in months.

Dynamic analysis of floating structures focuses on the combination of recent advances made in the field of structural engineering, fluid mechanics and computer science. This combination allows engineers the flexibility and freedom for a better understanding of structural and hydrodynamic behaviour of floating structures with various materials and non-linear behaviour and loading uncertainties. However, each field (e.g. structural engineering, fluid mechanics and computer science, etc.) has its own computational model and associated software and there is a clear lack of information integration between various fields/software tools. This restricts the development of efficient design methodologies as it is important to modify the various data models and perform re-analysis for each design revision. Additionally, when different information and design models are created in various fields with software tools, the design is prone to quality problems, more so when the design is based on a globally distributed working environment. We believe that in the dynamic analysis of floating structures, coupled analysis with concept technologies from 'Computer Aided Design (CAD)/Computational Fluid Dynamics (CFD)/Finite Element Method (FEM)' can be highly efficient in all life cycle phases, as the same concept model can be used for different complexities.

With the above-mentioned background, the guest editors along with the editorial and administrative members of the 'Ships and Offshore Structures (SAOS)' agreed to come with a special issue on 'Dynamic Analysis of Floating Structures' and this issue is the culmination of all these efforts.

We believe that the coupling, integration, and 'concept technologies from CAD/CFD/FEM' are the key elements for future success in the area of dynamic analysis. Also, the focus of research needs to be on important industrial-problems while going 'very deep' into their related mathematical and physical aspects to devise optimal algorithmic solutions for the analysis and design of offshore structures. We note the following problems and areas of high relevance:

- Efficient design for economies of scale, higher speed, lower motions, operational ability in adverse weather conditions, energy efficiency, clean environment, and advancements in material science and technologies by coupled analysis with concept technologies from CAD/CFD/FEM,
- Coupled hybrid 'Boundary Element Method (BEM)' – FEM models,
- Integration of FEM with CFD and CAD,
- Coupled analysis in frequency domain,
- Computational models for wave and wake induced loading in ships, offshore and floating structures,
- Geometric and structural form optimisation with CAD and CFD for ships and floating structures,
- Strength, buckling and fatigue analysis of stiffened plates and shells with concept technologies from CAD/CFD/FEM, and
- Computational models for hydro-acoustic analysis with concept technologies from CAD/CFD/FEM.

This issue opens with an article on 'Coupled dynamics of deepwater structures – Issues and Challenges' by C. P. Vendhan who has been a great teacher, researcher and mentor to a large number of researchers, including the first two guest editors from the listed below. This article offers an impressive overview of the coupled analysis techniques employing both time-domain and frequency-domain approaches and focuses on the basic modelling issues and challenges. It highlights the importance of compact formulations and examines the consequences of truncation errors of numerical integration schemes in the long-term time-domain simulations. Furthermore, it studies the need to standardise the statistical linearisation approaches applied to dynamic responses spreading over large frequency spectrum. On this article, we note that there is an urgent need to develop suitable add-on software solution systems that are integrable with the existing software solution systems used by the offshore community.

Second article is: A method to estimate the hydroelastic behaviour of VLFS based on multi-rigid-body dynamics and beam bending by Da Lu, Shixiao Fu, Xiantao Zhang, Fei Guo and Yun Gao. Ocean hydro-elasticity is an analysis of the time-dependent interaction of hydrodynamic and elastic structural forces in oceanic environment and this area is relevant for studying the vibration of floating and submerged offshore structures. In this paper, the authors introduce a new method which is based on multi-body hydrodynamics and

Euler–Bernoulli beam assumption to study the hydro-elastic behaviours of very large floating structures (VLFSs). The model is built upon the potential flow theory and Euler–Bernoulli beam hypothesis and their computed results have been compared with experimental results and numerically computed data by three-dimensional hydro-elastic theory and these comparisons show a fair agreement. On this paper, we note that the Euler–Bernoulli beam is a simplification of the 'Linear Theory of Elasticity (LToE)' and the LToE computes the load-carrying and deflection characteristics of beams. It is a special case of Timoshenko beam theory and is applicable to only small deflections and homogeneous materials, i.e. the VLFSs can have large deflections and in offshore structures composite materials are used. An extension of this work to include the Timoshenko beam theory and viscous effects will be an investigation of high industrial importance.

Third article is: A semi-coupled methodology for the motion analysis of floating production systems by Aldo Roberto Cruces-Girón, Fabrício Nogueira Corrêa and Breno Pinheiro Jacob. Hydrodynamics is the study of liquids in motion and the solution to a hydrodynamic problem normally involves the computations of different properties of the fluid and structure, e.g. flow velocity, pressure, density, temperature, motion, loads, etc., as functions of space and time. In this paper, the authors describe a hybrid, semi-coupled methodology for the motion analyses of 'Floating Production Systems (FPS)' by combining coupled and uncoupled models. Their model aims towards the reduction of high computational costs associated with the fully coupled analyses and the model is applicable at the preliminary design stages. An impressive strength of the work is that it is with minimal user interference, represents all nonlinear effects associated with the mooring lines and risers and considers their influence on the dynamic behaviour of the hull. Presented results show an adequate accuracy with reductions of computational costs. On this paper, we note that the challenge is to develop computationally efficient models that are coupled because the sensitive effects can only be captured through the coupled analyses and the possible solution techniques are: efficient functional approximations, dual uses of the time and frequency domain methods and using the same geometric CAD definitions from one analysis to another.

Fourth article is: Deformation and stress distribution of floating collar of net cage in steady current by Yun-Peng Zhao, Xiao-Dong Bai, Guo-Hai Dong and Chun-Wei Bi. Stress expresses the internal forces that the neighbouring particles of a material exert on each other when a force is applied. Similarly, the strain is the measure of the deformation. In this paper, the authors present a numerical model to investigate the deformations and stress distribution of floating pipes of fish cage subjected to the flow. They use a combinatorial approach that combines the FEM with hydrodynamic model. The presented model is validated through comparison with the data obtained from corresponding physical model tests and the results show fair agreement. On this paper, we note that there is an important but relatively unexplored area of the fishing crafts, nets and cages; and these are to be studied at high craft's speed, current speed and different weather conditions. More studies on these structures will allow the design and development of efficient crafts, nets and cages and these will serve a large fishing community improving their lives and livelihood.

Fifth article is: First principle approach to the design of an open sea aquaculture system by Nitai Drimer. A first principle is a basic, foundational, self-evident proposition or assumption and distinctly it cannot be derived from any other proposition or assumption. In the engineering science, an approach is from the first principles (i.e. 'ab initio') if it is derived directly from the fundamental principles of science and avoids simplifications/assumptions, etc. In this paper, the author describes a procedure for designing the flexible aquaculture structures at open sea. The presented approach is iterative and explores the role of wave kinematics with respect to the structural design. The presented results include a conceptual design of an offshore aquaculture structure that has been deployed since 2006 in offshore at the eastern coast of the Mediterranean Sea. On this paper, we note that there is an urgent need to link analysis with design and analysis needs to be based upon fundamental principles while avoiding simplifications/assumptions. The focus needs to be on design and development of new and novel aquaculture systems that are driven by sound and detailed analysis founded on sound principles, e.g. open water structures for farming of fish, crustaceans, molluscs, aquatic plants, algae, and other organisms. We need to study them in open water including the fresh and salt water, i.e. lake, river, canal, sea and ocean, etc.

Sixth article is: Experimental investigation and CFD simulation of heave damping effects due to circular plates attached to spar hull by Nimmy Thankom Philip, S. Nallayarasu and S. K. Bhattacharyya. Heave is the linear vertical motion of the offshore structure and an excessive heave can swamp an offshore structure. Although, the heave is heavily stiff 'degree of freedom (dof)', because of the possibility of swamping it is to be damped effectively, efficiently and accurately. In this paper, the authors present the experimental measurements of hydrodynamic damping, inertia forces and responses that are carried out to establish the relationship between wave frequency and damping ratio. They study the flow pattern around the damping elements with CFD and the flow visualisation and velocity measurement using the 'Particle Image Velocimetry (PIV)' technique. Specifically, their results note that the damping varies with wave period in a nonlinear fashion, it varies linearly with wave height, and an increase in the added mass combined with viscous damping is a key factor for the effectiveness of heave plates. On this paper, we note that the damping mechanisms are important for offshore structures and till today no industrially relevant, applicable and acceptable solutions are available. The plates increase the drag, reduce the payload, enhance the algae growth and bio-fouling and increase the mooring line loads significantly. Furthermore, the relatively un-damped dofs like surge and sway are more difficult to control. But their control is needed too and addressing these are critically important challenges.

Seventh article is: Hybrid composites with discarded fishnet and polyester: a novel boat-building material by K. P. Vinod Kumar, F. Michael Raj, S. Sahaya Elsi and M. M. G Jersy. A hybrid composite material is made of composites that consist of two constituents at the nanometre or molecular level. As the recent efforts are on the design and development of sustainable materials, normally one of these compounds is inorganic and the other is organic in nature. In this paper, the authors present a study on hybrid composites made of multifilament discarded fishnets of various mesh sizes and these fishnets are substituted as an alternate material for glass fibre in the polyester matrix for composite manufacturing of fishing boats. Their results showed the compatibility of discarded fishnet as a partial substitute for glass fibre in composite manufacturing. Importantly, the reuse of discarded fishnet in the manufacturing of composites mitigates the problem of waste disposal, hence environment friendly. On this paper, we note that there are specific needs regarding material properties in offshore engineering and composites certainly have some role to play, e.g. in the applications related to signature reduction, sacrificial elements/members, impact resistant, corrosion resistant, compression intensive, etc. Furthermore, material production needs to be sustainable and have low carbon foot print. Because of these reasons, hybrid composites – combination of organic and inorganic – are of critical important and application potential in offshore engineering.

Finally, the editors of this special issue thank the editor-in-chief, editorial staff members, supporting staff members, the reviewers and all the other members who have helped us during different stages, i.e. from conception to submission to review to production, etc. We are thankful to them and extend our heartfelt gratitude to them and state that without them this issue would not have been possible. We believe that the readers will enjoy this issue and we look forward to receive their inputs.

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