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Editorial

Theory, Method and Engineering Application of Computational Mechanics in Offshore Structures

Jun Yan [1,*], Wanhai Xu [2], Zhiqiang Hu [3] and Min Lou [4]

1 Department of Engineering Mechanics, Dalian University of Technology, Dalian 116024, China
2 Department of Design and Management for Ship and Offshore Engineering, Tianjin University, Tianjin 300072, China; xuwanhai@tju.edu.cn
3 School of Engineering, Newcastle University, Newcastle upon Tyne NE1 7RU, UK; zhiqiang.hu@ncl.ac.uk
4 School of Petroleum Engineering, China University of Petroleum, Qingdao 266580, China; shidaloumin@163.com
* Correspondence: yanjun@dlut.edu.cn

Oceans cover approximately 71% of the planet's surface, and 97% of the Earth's water is contained within the ocean. Not only is the ocean rich in mineral resources, but it also presents an inexhaustible source of marine energy. Marine energy development is the trend of energy development in the world. The development of marine energy is inseparable from the design, manufacture, and application of offshore structures.

In order to systematically report the theoretical calculation methods of offshore structures in the process of design, manufacturing, testing, and application in the process of marine energy development, this Special Issue aims to collect the research work related to the theory, method, and engineering application of computational mechanics in offshore structures. Through this Special Issue, the application scope, frontier, innovative research results, and key technical achievements of computational mechanics in ocean engineering will be presented.

Flexible pipe end fitting, serving as a connector between the flexible pipe and floating platform, is a critical component for structural failure. Zhang et al. [1] develop numerical and experimental models to study the progressive failure behavior of flexible pipes end fittings in the anchorage system under axial tension. The influencing factors that affect the load-bearing capacity and failure behavior of the anchorage are discussed. Two-stage and three-stage failure behavior are, respectively, common in end fittings consisting of high-strength and low-strength tensile armor steel wires.

Pipe-in-pipe flowlines have been widely arranged for transportation in offshore oil and gas fields. Wang et al. [2] studied the mechanical behavior of lateral indentation for the pipe-in-pipe structure by the wedge-shaped indenter through experimental and numerical methods. The study observes three stages of deformation behavior, considering the combined actions of the inner and outer pipes.

Zhang et al. [3] proposed an improved method, using a multi-algorithm combined model based on motion parameters obtained from automatic identification system data for predicting vessel locations. The results of the predictions are derived from the predicted points of ships within the time range of short-term prediction. This research contribution provides a method for improving the accuracy and efficiency of short-term ship trajectory prediction.

Efficient design of the configuration of the mooring anchor chain and analysis of its dynamic response characteristics are crucial for the preliminary design of the catenary anchor leg mooring system. Sun et al. [4] established a rapid optimization framework for a mooring anchor chain with the objective of minimizing costs. They introduced the radial basis function to construct the approximate model and the genetic algorithm to optimize the approximate model globally. The quadratic function is determined to be a suitable adaptive function for anchor chain optimization.

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Deep-sea risers are susceptible to high-order and multi-modal coupled vortex-induced vibration responses, which can result in significant structural fatigue damage. Zhou et al. [5] carried out a model test to research the vortex-induced vibration characteristics under bidirectional shear flow. They found that the dominant frequency of the vortex-induced vibration of the model under bidirectional shear flow is locked in the natural frequency of the riser and does not increase with an increase in flow velocity. The obtained results provide basic data for the prediction of vortex-induced vibration and research into the fatigue analysis method of a riser under an internal wave flow field.

The seafloor geodetic network is a critical component of the marine geodetic network due to its high positioning accuracy and good stability. Therefore, Ma and Zhao [6] developed the principle of the seafloor positioning, navigation, and timing network, and they provided a combined measurement method that includes the absolute and the relative positioning. Moreover, they studied the optimal design of the geodesic network based on Grafarend's four orders.

The subsea wellhead (SW) system is one of the crucial components that connects between blowout preventors and subsea oil and gas wells. Li et al. [7] proposed an efficient probability approach based on the Bayesian Regularization Artificial Neuron Network to predict the fatigue failure probability of SW during its entire life. They concluded that the fatigue failure probability of SW nonlinearly increased nonlinearly with the increase in fatigue damage, which is helpful in ensuring the operational safety of SW in deepwater oil and gas development.

To determine if the punch-through potential of a generic spudcan is applicable to a cubic spudcan of a BH12# jack-up rig in a layered seabed with an interbedded strong-over-soft layer, Zhao et al. [8] developed a series of large deformation finite element models on dense sand overlying non-uniform clay using a generic spudcan and a cubic spudcan. It was found that the post-peak resistances of the cubic spudcan were higher than those of the corresponding generic spducan.

Wang et al. [9] introduced numerical simulations to research the lateral dynamic bearing capacity of a deepwater conductor. The contact surface model and the Goodman contact model are considered for pile–soil interactions to assess the effect on lateral deformation, deflection angle, and von Mises stress. They recommend that the Goodman element model should be considered for the analysis of the stability of the subsea wellhead.

To ensure the safety of the nuclear power platform, mooring, and personnel during the disconnect operation, Guo and Wu [10] conducted a quantitative risk analysis of the disconnect operations, according to the reverse Bayesian inference rule. They concluded that human error is the most likely factor leading to the failure of the disconnection process, and a collision between the yoke and hull has the greatest impact on the disconnect failure.

Shi et al. [11] researched the nonlinear responses of the first two primary resonances of the L-shaped multi-beam structure with nonlinear joints by the development of a reduced-order analytical model under three-to-one internal resonances conditions. This analytical method can not only quickly and comprehensively analyze the influence of joint nonlinearity on the nonlinear response of the system, but it also better helps the design of the joint in such structures.

Konoplin et al. [12] investigated the design, software implementation, and field tests of the new multipurpose system for the smart support of activities of remotely operated vehicle (ROV) operators. Experimental field studies conducted during deep-sea research expeditions to the Bering Sea and Pacific Ocean confirm that the system can provide operators with intellectual and informational support, missing planning, and also recommendations and warnings about the possible emergency situations.

To research the buckling instability of lining bellows of floating liquefied natural gas (FLNG) cryogenic hoses, Yan et al. [13] introduced experimental and finite element models for the post-buckling analysis of linin bellows under torsional loads and summarized the influence of structural design parameters on stability performance of linin bellows. The results have important reference value for the advanced design of FLNG cryogenic hoses.

Wei et al. [14] established a finite element model with initial ovality to study the collapse pressure of the submarine hose, and they considered the influence of the geometric and material parameters of the helix wire on the collapse pressure. A reasonable prediction formula for the collapse pressure of the submarine hose is fitted according to a large number of the simulated results. This research can help improve the design and safety of submarine hoses.

In order to meet the requirements of mobile marine seismometers to observe and record seismic signals and solve the contradiction between high speed and high accuracy of seismic signal recognition methods, Jiang et al. [15] developed a fast and accurate identification model of seismic signals, according to wavelet analysis. They successfully verified the feasibility of this method by identifying natural seismic P-waves from the data observed by the Dolphin seismometer.

Due to the anisotropy of the composite materials for a glass fiber-reinforced unbonded flexible pipe, accurately describing the tensile behavior of these pipes is difficult. Sun et al. [16] investigated the mechanical behaviour of the glass fiber-reinforced unbonded flexible pipe subjected to axial tensile loads by theoretical, numerical, and experimental methods. The numerical model is validated by a comparison analysis of the mean fiber direction strains between numerical and experimental results. This research can help improve the understanding and design of glass fiber-reinforced unbonded flexible pipes.

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