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Editorial

Coastal Geohazard and Offshore Geotechnics

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1. Introduction

With the rapid development in the exploration of marine resources, coastal geohazard and offshore geotechnics have attracted a great deal of attention from coastal geotechnical engineers and has achieved significant progress in recent years. With the complicated marine environment, numerous natural marine geohazard have been reported in the world, e.g., South China Sea. In addition, damage of offshore infrastructures (monopile, bridge piers, etc.) and supporting installations (pipelines, power transmission cables, etc.) have occurred in the last decades. A better understanding of the fundamental mechanism and soil behavior of the seabed in the marine environments will help engineers in the design or planning of the coastal geotechnical engineering projects. The purpose of this Special Issue is to present with the recent advances in the field of coastal geohazard and offshore geotechnics. This Special Issue will provide researchers updated development in the field and possible further developments.

In this Special Issue, eighteen papers were published, covering three main themes: (1) mechanism of fluid–seabed interactions and its associate seabed instability under dynamic loading [1–5]; (2) evaluation of stability of marine infrastructures, including pipelines [6–8], piled foundation and bridge piers [9–12], submarine tunnel [13], and other supported foundations [14]; and (3) coastal geohazard, including submarine landslide and slope stability [15,16] and other geohazard issue [17,18]. More details of each contribution are summarized in the following subsections.

2. Mechanism and Processes of Seabed Response under Dynamic Loading

The phenomenon of fluid–seabed interactions has attracted attentions among coastal and geotechnical engineers involved in the offshore geotechnical projects. A better understanding of the phenomenon and its associate processes will help practitioners and engineers in the design stage. The pore-water pressures and associated seabed liquefaction are key factors for the design of the foundation of offshore structures. The first theme of this Special Issue consists of five papers for the mechanism and processes of fluid–seabed interactions.

Liao et al. [1] proposed a coupling model for wave (current)-induced pore pressures and soil liquefaction in offshore deposits, based on the COMSOL Multiphysics. Unlike previous studies, both wave model and elastoplastic seabed model were established within COMSOL and coupled together, rather than through the data transformation at the fluid–seabed interface as the previous models. The numerical examples demonstrated the difference of the liquefaction depth between decoupling and coupling models. An alternative approach was proposed by Tong et al. [4] who integrated the commercial software FLOW-3D and COMSOL Multiphysics for a similar problem, but with strong non-linear wave impact and uniform currents. More detailed discussions about the impact of current on the seabed response were provided.

Silty sand is a kind of typical marine sediment widely distributed in the offshore areas of East China. Guo et al. [3] investigated the wave-induced soil erosion in a silty sand seabed through a three-phase soil model (soil skeleton, pore fluid, and fluidized soil particles) within COMSOL Multiphysics. Based on their parametric study, it was found that the wave-induced erosion mainly occurred at the shallow depth of the seabed. Their study also found that the critical concentration of the fluidized soil particles has an obvious effect on the evolution of wave-induced erosion, including erosion rate and erosion degree. However, the erosion depth of seabed is not affected by the critical concentration of the fluidized soil particles.

Li et al. [5] integrated the hydrodynamic model (developed by OpenFOAM) and seabed model (developed by FEM) to investigate the effects of principal stress rotation (PSR) on the wave(current)-induced seabed liquefaction. The hydrodynamic model describes the process of the wave–current interactions. Meanwhile, the seabed model was based on the modified elastoplastic model with principal stresses. Based on their parametric study, it was found that PSR has significant impact on the development of liquefaction potential of a seabed foundation.

Earthquake-induced soil deformation is an important factor in the design of marine structures in the earthquake active regions. Numerous empirical or semi-empirical approaches have considered the influence of the geology, tectonic source, causative fault type, and frequency content of earthquake motion on lateral displacement caused by liquefaction. Pirhadi et al. [2] added an earthquake parameter of the standardized cumulative absolute velocity to the original dataset for analysis. They proposed a new response surface method (RSM) approach, which is applied on the basis of the artificial neural network (ANN) model to develop two new equations for the evaluation of the lateral displacement due to liquefaction.

3. Foundations of Marine Infrastructures

The stability of marine infrastructures is an important parameter in the design of offshore engineering projects. In this Special Issue, numerous marine infrastructures including pipelines, piled foundations, and submarine tunnels were investigated.

Offshore pipelines have been commonly used for the transportation of oil and gas. Therefore, safety of the pipeline route is one of the key factors in oil and gas projects. Unlike previous studies with FEM modeling, Wang et al. [6] proposed a meshfree model for the seabed, together with an OpenFOAM model for flow domain to examine the wave-induced transient soil response around an offshore pipeline. Both fully buried and partially buried pipelines in a trench layer were considered. Numerical examples demonstrated the capacity of their new meshfree model in the prediction of the wave-induced soil response. Foo et al. [7] adopted the FLOW-3D model together with poro-elastoplastic seabed model (within COMSOL) to examine the soil response around a fully buried pipeline under combined wave and current loading. They considered the residual soil response. In addition to wave and current loading, Zhang et al. [8] further considered earthquake loading for the wave–seabed–pipe interaction problem. In this study, they considered both oil pipe and gas pipe in the model and concluded that the difference between the two cases was minor.

Monopiles have been adopted as the supporting structures for various marine structures such as platforms, offshore wind turbine foundations, cross-sea bridge piers, etc. Liu et al. [9] conducted a series of laboratory tests for the dynamic response of offshore open-ended pile under lateral cyclic loading. They also used a discrete element model for numerical simulation and compared their results with the experimental data. Based on the numerical examples, they found that both the soil plug and outer friction contributed significantly to the pile lateral resistance; the “developing height” of the soil plug under lateral loading is in the range of two times the pile diameter above the pile end.

He et al. [11] employed ABAQUS to establish the interaction between rock-socketed monopile and layered soil–rock seabed. Based on a combined finite–infinite element model, the dynamic impedances and dynamic responses of large diameter rock-socketed monopiles under harmonic load are analyzed. When rock-socketed depth increases, the dynamic stiffness of pile increases, while the sensitivity to dimensionless frequency decreases. This indicates that the ability of pile to resist deformation increases under dynamic load, which is consistent with the results obtained from monopile deformation analysis.

In addition to geotechnical issues, the scouring of soil around large-diameter monopile will alter the stress history, and therefore the stiffness and strength of the soil at shallow depth, with important consequence to the lateral behavior of piles. The role of stress history was investigated for a larger diameter monopile [10]. Their study concluded that scour significantly increases the over-consolidation ratio and reduces the undrained shear strength of the remaining soil, which contributes to the significant difference in pile behavior between considering and ignoring the stress history effect.

Xiong et al. [12] developed a scour identification method, based on the ambient vibration measurements of superstructures. The Hangzhou Bay Bridge was selected to illustrate the application of the proposed model. Their study found that the high-order vibration modes are insensitive to the scour.

In addition to pipeline and pile foundation, based on COMSOL Multiphysics, Chen et al. [13] developed a two-dimensional coupling model of a wave–seabed–immersed tunnel for the dynamic responses of a trench under wave action in the immersing process of tunnel elements. Both liquefaction and shear failure are examined in this paper.

The buoyancy of the bottom-supported foundation is a critical issue in platform design because it counteracts parts of the vertical loads. In [14], a model box is designed and installed with earth pressure transducers and pore pressure transducers to simulate the sitting process of the bottom-supported foundation.

4. Coastal Geohazard

In this Special Issue, there are four papers related to other marine geohazard issues. Among these, Zhu et al. [15] reported the evidence of submarine landslide in South China Sea, and analyzed the causes of these events, based on their long-term field observations. Three concurrent events (the shoreward shift of the shelf break in the Baiyun Sag, the slump deposition, and the abrupt decrease in the accumulation rate on the lower continental slope) indicate that the giant Baiyun–Liwan submarine slide in the PRMB, South China Sea, occurred at 23–24 Ma, in the Oligocene–Miocene boundary. This landslide extends for over 250 km, with the total affected area of the slide up to 35,000–40,000 km^2. Their research suggests that coeval events (the strike–slip movement along the Red River Fault and the ridge jump of the South China Sea) in the Oligocene–Miocene boundary triggered the Baiyun–Liwan submarine slide. Zhu et al. [16] developed a simple approach to investigate the stability of an unsaturated and multilayered coastal-embankment slope during the rainfall, in which a Random Search Algorithm (RSA) based on the random sampling idea of the Monte Carlo method was employed to obtain the most dangerous circular sliding surface, whereas the safety factor of the unsaturated slope was calculated by the modified Morgenstern–Price method. It was found that the fluctuation of the groundwater level has a significant influence on the location of the most dangerous sliding surface. The associated minimum safety factor and the sliding modes of unsaturated-soil slope gradually change from deep sliding to shallow sliding with the rise of groundwater level.

The stability of hydrate-bearing near-wellbore reservoirs is one of key issues in gas hydrate exploitation. A thermo-hydro-mechanical-chemical (THMC) multi-field coupling mathematical model considering damage of hydrate-bearing sediments is established in [17]. As reported in the paper, with continuous hydrate dissociation, the cementation of the sediment gradually decreases, and the structural damage gradually increases. This will lead to the partial softening and stress release of the stratum and will result in the decline of the bearing capacity of the reservoir. Therefore, damage of hydrate-bearing sediments has an adverse impact on the stability of the near-wellbore reservoir.

Li et al. [18] conducted a series of pumping well tests for the coastal micro-confined aquifer (MCA) in Shanghai to investigate the dewatering-induced groundwater fluctuations and stratum deformation. With the field tests, a numerical method is proposed for the estimation of hydraulic parameters and an empirical prediction method is developed for dewatering-induced ground settlement. The proposed prediction method worked well in most of the test site except in the far-field and the central parts. The parameters used in the method can be obtained by performing fitting with observation data, avoiding the dependence on precise hydrogeological parameters.

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References

1. Liao, C.; Jeng, D.S.; Lin, Z.; Guo, Y.; Zhang, Q. Wave (Current)-Induced Pore Pressure in Offshore Deposits: A Coupled Finite Element Model. *J. Mar. Sci. Eng.* **2018**, *6*, 83. [CrossRef]
2. Pirhadi, N.; Tang, X.; Yang, Q. New Equations to Evaluate Lateral Displacement Caused by Liquefaction Using the Response Surface Method. *J. Mar. Sci. Eng.* **2019**, *7*, 35. [CrossRef]
3. Guo, Z.; Zhou, W.; Zhu, C.; Yuan, F.; Rui, S. Numerical Simulations of Wave-Induced Soil Erosion in Silty Sand Seabeds. *J. Mar. Sci. Eng.* **2019**, *7*, 52. [CrossRef]
4. Tong, D.; Liao, C.; Chen, J.; Zhang, Q. Numerical Simulation of a Sandy Seabed Response to Water Surface Waves Propagating on Current. *J. Mar. Sci. Eng.* **2018**, *6*, 88. [CrossRef]
5. Li, Z.; Jeng, D.S.; Zhu, J.; Zhao, H. Effects of Principal Stress Rotation on the Fluid-Induced Soil Response in a Porous Seabed. *J. Mar. Sci. Eng.* **2019**, *7*, 123. [CrossRef]
6. Wang, X.; Jeng, D.S.; Tsai, C. Meshfree Model for Wave-Seabed Interactions Around Offshore Pipelines. *J. Mar. Sci. Eng.* **2019**, *7*, 87. [CrossRef]
7. Foo, C.; Liao, C.; chen, J. Two-Dimensional Numerical Study of Seabed Response around a Buried Pipeline under Wave and Current Loading. *J. Mar. Sci. Eng.* **2019**, *7*, 66. [CrossRef]
8. Zhang, Y.; Ye, J.; He, K.; Chen, S. Seismic Dynamics of Pipeline Buried in Dense Seabed Foundation. *J. Mar. Sci. Eng.* **2019**, *7*, 190. [CrossRef]
9. Liu, J.; Guo, Z.; Zhu, N.; Zhao, H.; Garg, A.; Xu, L.; Liu, T.; Fu, C. Dynamic Response of Offshore Open-Ended Pile under Lateral Cyclic Loadings. *J. Mar. Sci. Eng.* **2019**, *7*, 128. [CrossRef]
10. He, B.; Lai, Y.; Wang, L.; Hong, Y.; Zhu, R. Scour Effects on the Lateral Behavior of a Large-Diameter Monopile in Soft Clay: Role of Stress History. *J. Mar. Sci. Eng.* **2019**, *7*, 170. [CrossRef]
11. He, R.; Ji, J.; Zhang, J.; Peng, W.; Sun, Z.; Guo, Z. Dynamic Impedances of Offshore Rock-Socketed Monopiles. *J. Mar. Sci. Eng.* **2019**, *7*, 134. [CrossRef]
12. Xiong, W.; Cai, C.; Kong, B.; Zhang, X.; Tang, P. Bridge Scour Identification and Field Application Based on Ambient Vibration Measurements of Superstructures. *J. Mar. Sci. Eng.* **2019**, *7*, 121. [CrossRef]
13. Chen, W.; Liu, C.; Duan, L.; Qiu, H.; Wang, Z. 2D Numerical Study of the Stability of Trench under Wave Action in the Immersing Process of Tunnel Element. *J. Mar. Sci. Eng.* **2019**, *7*, 57. [CrossRef]
14. Fang, T.; Liu, G.; Ye, G.; Pan, S.; Shi, H.; Zhang, L. Field Test on Buoyancy Variation of a Subsea Bottom-Supported Foundation Model. *J. Mar. Sci. Eng.* **2019**, *7*, 143. [CrossRef]
15. Zhu, C.; Cheng, S.; Li, Q.; Shan, H.; Lu, J.; Shen, Z.; Liu, X.; Jia, Y. Giant Submarine Landslide in the South China Sea: Evidence, Causes, and Implications. *J. Mar. Sci. Eng.* **2019**, *7*, 152. [CrossRef]
16. Zhu, J.; Chen, C.; Zhao, H. An Approach to Assess the Stability of Unsaturated Multilayered Coastal-Embankment Slope during Rainfall Infiltration. *J. Mar. Sci. Eng.* **2019**, *7*, 165. [CrossRef]

17. Zhang, X.; Xia, F.; Xu, C.; han, Y. Stability Analysis of Near-Wellbore Reservoirs Considering the Damage of Hydrate-Bearing Sediments. *J. Mar. Sci. Eng.* **2019**, *7*, 102. [CrossRef]
18. Li, J.; Li, M.; Zhang, L.; Chen, H.; Xia, X.; Chen, J. Experimental Study and Estimation of Groundwater Fluctuation and Ground Settlement due to Dewatering in a Coastal Shallow Confined Aquifer. *J. Mar. Sci. Eng.* **2019**, *7*, 58. [CrossRef]