STUDY ON DYNAMIC RESPONSE OF SEABED UNDER WAVES BASED ON DEM-PFV COUPLING METHOD

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INTRODUCTION

The stability of nearshore/offshore structures will be affected by wave loads. The deformation, softening and liquefaction of the seabed under the action of cyclic wave will result in loss of the self-bearing capacity, which endangers the safety of the structure.

The seabed response around structures under wave action is a very complex process, which involves the coupling of wave-structure-soil, rheological fluid (in liquefied area) and solid (in non-liquefied area) (Ye et al., 2015; Zhang et al., 2018). The existing mathematical models can hardly describe the movement of sediment particle after liquefaction.

In this study, based on the open-sourced discretization method software Yade, the numerical model is established by coupling discrete element method (DEM) and porescale finite volume method (PFV). The dynamic response of porous seabed under wave is analyzed.

NUMERICAL MODEL

An open-source framework for DEM, Yade (Chareyre, and Cortis, 2011) is used to simulate the interaction between solid particles. The flow of an incompressible pore fluid is simulated by PFV based on the pore-network approach to reduce the computational cost generally associated to the direct simulation of flow in porous media (Catalano, et al., 2014). Verification and comparison results show that the time-duration curve of excess pore water pressure simulated by DEM-PFV model under the standing wave action has good agreement with the experimental values.

NUMERICAL RESULTS

On the basis of verifying the numerical coupling model, the dynamic response of seabed under the action of regular and irregular waves is studied (Fig.1). The effect of the porosity and the elastic modulus of seabed on the liquefaction of the seabed are analyzed.

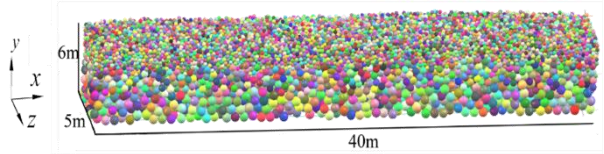

Figure.1 – The diagram of numerical model

CONCLUSIONS

The dynamic response of unsaturated porous seabed under wave action is simulated by DEM-PFV coupling model. The results show that the anti-liquefaction ability of sand under wave action can be effectively improved by decreasing porosity and increasing modulus of elasticity. The compaction process and liquefaction process occur respectively in the seabed soil under the action of waves (Fig.2). In the liquefaction state, the seabed porosity fluctuates violently with the waves without an obvious decreasing trend. In the liquefaction state, the particle movement is more violent than the compaction process.

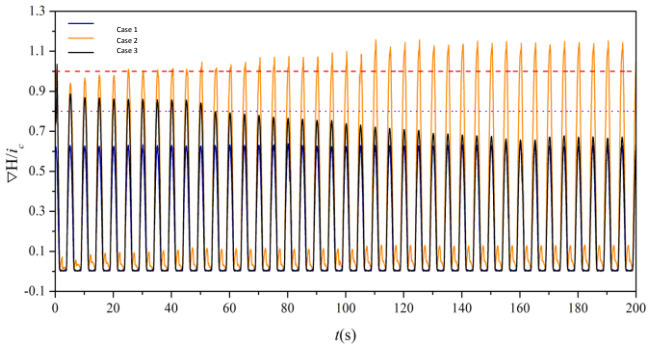

Figure.2 – A time-dependent distribution diagram of the maximum value of $\nabla H/i_c$ on the vertical line of the seabed for each example

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