

Numerical Analysis for Understanding Mechanisms of Wave-induced Seabed Liquefaction and Solidification

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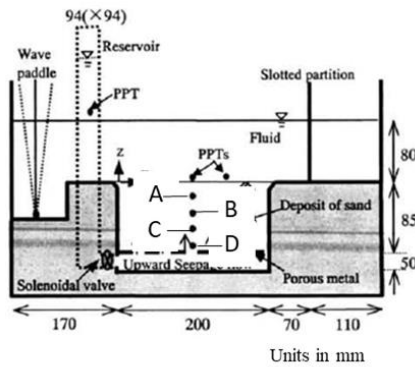
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ABSTRACT

Miyamoto et al. [1] conducted 30g centrifugal experiments in which loosely deposited sand bed was subjected to cycles of progressive wave loading using the apparatus depicted in Fig.1. They measured pore water pressure u_w at the vertically different four locations, which are labelled A-D in this study, so that they could make time histories of excess pore water pressure u_e , which is defined as the gap between u_w and hydrostatic pore water pressure u_s , for the four locations as described in Fig. 2a. From Fig. 2a, they found that the sand bed experienced sequential behaviour including liquefaction and afterward consolidation (solidification) under continuous wave loading. In addition, the following three features of the wave-induced elastoplastic seabed behaviour were also discovered: quick and downward progress of liquefaction, gradual and upward progress of solidification, and great degree of compaction through solidification. The knowledge of this sequential wave-induced seabed behaviour could be useful to understand physical conditions, e.g. density, of actual seabed.

Meanwhile there have been no numerical study to reproduce both the seabed liquefaction and afterward solidification using an elastoplastic constitutive model. Therefore, in this study, we aimed to reproduce the seabed behaviour observed in the experiment by Miyamoto et al. using the soil-water coupled finite deformation analysis code **GEOASIA** incorporating SYS Cam-clay model [2]. Using a numerical model aligned with experimental conditions, we could reproduce the identical seabed behaviour to the experimentally observed one as time histories of excess pore water pressure in the numerical analysis described in Fig. 2b are quite similar to the ones in Fig 2a.

Therefore, we confidently investigated mechanisms of the seabed liquefaction and afterward solidification by assessing the numerical result. Although details will be given in our presentation, we found that accumulation of plastic volume strain during loading is the key trigger of both phenomena.



A, B, C, D denotes locations where pore pressure transducers were installed

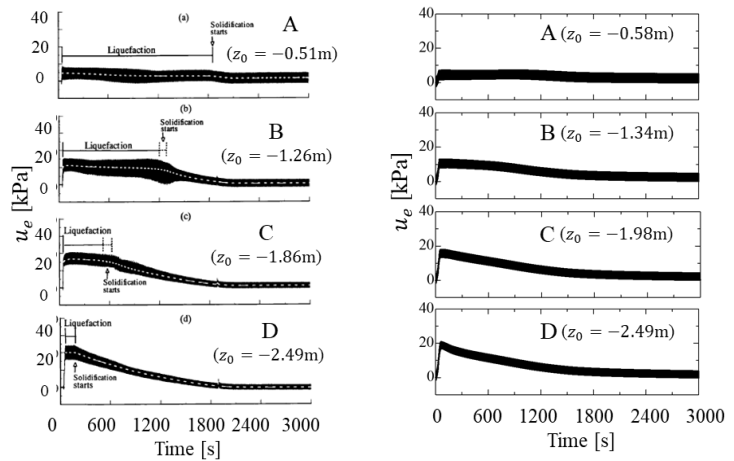


Fig. 1.* Sketch of experimental apparatus [1]

a)* Experimental result [1]

b) Our numerical result

Fig. 2. Time history of excess pore water pressure u_e at the four vertical locations A-D

* modified from the original figures

REFERENCES

- [1] Miyamoto, J., Sassa, S., and Sekiguchi, H. 2004. Progressive solidification of a liquefied sand layer during continued wave loading. *Géotechnique*, 54 (10), 617-629.
- [2] Noda, T., Asaoka, A., Nakano, M. 2008. Soil-water coupled finite deformation analysis based on a rate-type equation of motion incorporating the SYS Cam-clay model, *Soils Found.*, 48 (6), 771-790.