NUMERICAL MODELLING OF WAVE-INDUCED LIQUEFACTION AROUND PIPELINES

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The present study aims at reproducing the wave flume experimental findings[1] on the generation of pore water pressure through a plane strain elasto-plastic analysis. The constitutive soil model namely Pastor-Zienkiewicz Model Mark-III (PZ3 model) is implemented in a Finite element program namely SWANDYNE II to predict the momentary and residual liquefaction of a seabed subjected to a two-dimensional progressive wave system. The applicability of SWANDYNE II was validated by comparing with the linear elastic analytical solution and the predictive capability of PZ3 model on the generation of pore water pressure and the occurrence of liquefaction was validated by comparing with the experimental data. [2]

This study is the extension of the work presented by Vun *et al.* [2] by taking into account the actual silt bed thickness prepared in the tests and the weight of the pipeline on the silt bed surface. The limestone silt bed of the test TA04 with the dimension of 1.6m×0.25m was subjected to a progressive wave with a wave height and a wave period of 0.095m and 1.25s respectively. The pipeline was simply modeled as a point load acting on the bed surface. The far field pore water pressures at different depths were predicted using finite element analysis and then compared with those experimental measurements. Some of the unknown physical properties of the tested silt were determined by a series of parametric study using both Linear Elastic and PZ3 models and they are presented in Table 1. The predicted soil parameters were then validated by another set of experimental data in test TA03, which used the same method of bed preparation as TA04 but with a higher wave height of 0.15m.

Table 1: Soil Parameters

K_0 (MPa)	G_0 (MPa)	M_g	M_f	Sr
4	1.5	1.42	0.9	0.95
H_0	H_u (MPa)	P'_0 (kPa)	G_s	e
900	40	10	2.71	0.808

*Symbols explanation can be found in Ref.[2]

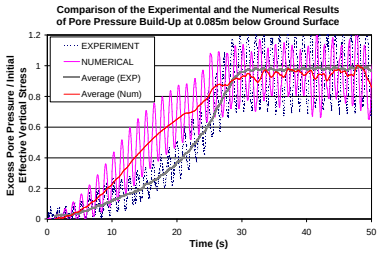

Figure 1: TA04

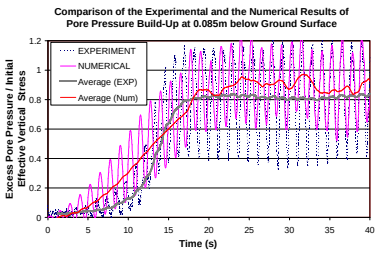

Figure 2: TA03

Figures 1 and 2 show the comparisons between the experimental and the numerical results for TA04 and TA03. It can be seen that the numerical solutions have very good agreement with both experimental data. The amplitude of the pore water pressure can be affected significantly by the degree of saturation of the soil.

References

[1] T. C. Teh, A. C. Palmer and J. S. Damgaard, "Experimental Study of Marine Pipelines on Unstable and Liquefied Seabed," Accepted by Coastal Engineering, 2003.
[2] P. L. Vun, A. H. C. Chan and S.Dunn, "Numerical Analysis of Wave Induced Liquefaction of Silt Beds," *Proceedings of the 11th Annual ACME Conference*, p.9-12, 2003.