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3D NUMERICAL MODELLING OF DYNAMIC SATURATED SOIL AND PORE FLUID INTERACTION

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ABSTRACT

In order to have a better understanding of the mechanism of earthquake-induced liquefaction, a series of three dimensional numerical analyses has been performed using the 3D finite element program DYNE3WAC, which is based on the same numerical scheme as the 2D version DIANA-SWANDYNE II [1]

The program is based on the fully coupled dynamic Biot [2] equation, incorporating the finite element subroutine library provided by Smith and Griffith [3], and employs the single-step Generalized Newmark (GNpj) method [4].

In order to verify the computer code in handling earthquake-induced liquefaction problems, the numerical tests previously performed by Zienkiewicz et al [1] was repeated using DYNE3WAC and the results were compared with previous 2D numerical results. This test is to simulate the liquefaction of a saturated sand bed subjected to E-W component of the El Centro earthquake of May 1940. The constitutive model namely Pastor-Zienkiewicz mark III (PZ3) Model was adopted so that the soil behavior under both loading and unloading stage can be modeled.

After the verification, numerical analyses were performed to investigate the earthquake-induced liquefaction of the soil beneath the foundation. The test are based on the model No.12 of the VELACS (VErification of Liquefaction Analysis by Centrifuge Studies) project[5], in which the foundation of a simple structure was placed on a saturated sand layer overlaid by a thin silt layer and subjected to horizontal earthquake-like base motion. Since the foundation did not cover the entire width of the container, thus the model requires a full 3D analysis rather than a plane strain approximation. Constitutive models namely Mohr-Coulomb and PaZ3 Model were adopted to model silts and saturated sands respectively. The behaviour of the residual liquefaction is the main interest of this study. The time histories of settlement, acceleration, and excess pore pressure at different depth of the soil layer are calculated and compared with the experimental results [5].

Besides the unidirectional earthquake, further investigations regarding the liquefaction resistance of soil layer under multi-directional earthquake were also performed. Out-of-

phase earthquake was adopted in both the soil column test and VELACS 12 analyses. The results showed that the liquefaction resistance of soil layer is much lower when subjected to multi-directional earthquake loading.

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