LIQUEFACTION-INDUCED EXCESS PORE PRESSURE GENERATION UNDER FOUNDATION AND FREE-FIELD WITH DYNAMIC CENTRIFUGE MODELLING

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Keywords: Liquefaction, Pore pressure, Dynamic centrifuge analysis, Shallow foundation

Historically, earthquakes have been perceived as one of the most damaging natural hazard. Seismic Liquefaction of saturated sand is one of the major sources of damage and reason of the foundation's failure. Settlement of shallow foundations resting on saturated sand has been repeatedly observed throughout the world as a consequence of liquefaction. The main factor of occurrence of this phenomenon, is the tendency for cohesionless soil to contraction. This contraction occurs when the soil is exposed to dynamic loading. As a result, the tendency to contraction causes an increase excess pore pressure (EPP) and subsequently an effective stress reduction. In liquefy situation soil tend to drown in soil and this causes a dense soil compaction in the lower parts and loosening in the upper parts. If there is foundation on the soil, the effective confining stress acting on the soil has been observed to influence its potential for EPP generation. In liquefied soil a reduction of the measured excess pore pressure ratio () with depth (i.e. with increasing) was observed. According to the available result, the probability of liquefaction occurrence in the presence of foundation is more less than free field, as the pore fluid moving up and trap under foundation and create a weak area in the upper part of the soil. (Dashti, 2009).

A reduction of the measured excess pore pressure ratio () is believed to depend on two main factors: first, the additional confinement stress caused by the presence of the foundation results in a reduction of the pore pressure ratio (), as the EPP required to cause initial liquefaction is higher. Second, the additional shear stresses due to the foundation may cause dilation in the soil, with the consequent generation of negative excess pore pressures, acting toward further reducing the (), under the foundation. The non-uniform stress distribution underneath the foundation results in non-uniform excess pore pressure generation and subsequent flow of pore fluid driven by the resulting pressure gradients generating between different zones of the foundation soil. Depending on their direction, these pore fluid flows may lead to reduction in the effective stress beneath parts of foundation, resulting in further soil softening. The effect of static shear stress on the cyclic resistance to liquefaction has been investigated by several authors. Most of the experimental work on this topic is based on soil element testing, in particular cyclic triaxial testing.

In this article a series of centrifuge test, with presence of foundation on saturated sandy soil for investigating different between excess pore pressure generation in different zone of soil such as under the foundation and free field. Dynamic centrifuge shaking table that produce for generating dynamic shake with PGA about 0.3 g. With dynamic centrifuge shaking table, scaled version of earthquake motions were reproduced in the models tested, enhancing the reliability of experimental results. The soil models tested in this study were constituted of Firoozkooh sand.

The model was prepared by wet tapping method with relative density of 30%. In order to study the dynamics of geotechnical models, laminar box was designed and constructed. The main criteria for designing of laminar box were low friction between layers of laminar box. For saturated progress and so on increase the viscosity of pore fluid, hydroxypropyl methylcellulose was used. Thanks to existence laminar box and increasing viscosity of pore fluid, error in dynamic centrifuge test minimized. Particular attention was given to the effect of key parameters on the excess pore pressure. Pore pressure transducer was used in this test for determining pore pressure in any height of model.

Results suggest that the excess pore pressure generation in the soil under foundation is significantly influenced by the stress distribution due to the presence of the foundation itself. In particular, high excess pore pressure where measured in soil subjected below the axis of footing. For investigating difference between EPP in free-field and under foundation, in two arrays of sensors were deployed to determine excess pore pressure. Figure 1 shows the EPP generation in model. All of the recorded excess pore pressures show their maximum absolute value after 5 s from the start of earthquake shaking; during this time interval a maximum pressure difference of approximately 15 kPa exists between PPT2 (footing axis) and PPT4 (B/2 meters outside footing).

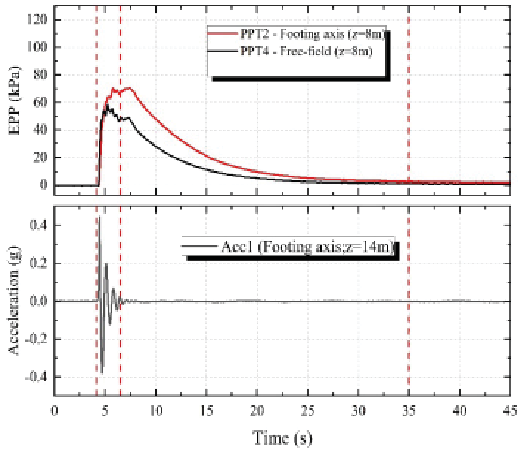

Figure 1. Excess pore pressure generation between free-field and under foundation.

As a consequence of such a gradient, drainage occurs from the area below the center of the footing towards the soil below the footing edge, leading to an equalization of excess pore pressure in the foundation soil.

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