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可液化场地地震振动孔隙水压力增长研究的大型振动台试验及其数值模拟

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摘要　基于数值模拟基本假设，运用有效应力原理以及振动孔隙水压力增长经验模式，采用应力循环孔压增量计算方法，直接针对非自由可液化场地基地震反应的大型振动台试验建立数值计算模型，并据此进行可液化场地基孔压动力增长数值模拟。数值模拟结果表明：分别在0.15g和0.50g El Centro波输入下，孔压在13 s之前无明显变化，至13 s瞬时增长，20 s左右达到最大值，并且自下而上峰期孔压比逐步增大；其中0.5g El Centro波输入下整个土层达到全部液化的孔压比，而0.15g El Centro波输入下仅上部土层具有局部液化的孔压比。同时由数值模拟结果可发现：由于桩－土动力相互作用，致使近桩区孔压较远桩区孔压高且在桩周附近形成一定孔压梯度，但对孔压增长趋势无太大影响；数值模拟获得的地基振动孔隙水压力增长规律与试验记录基本保持一致。总的来讲，这种孔压动力增长的数值模拟方法，在强震输入下基本能够刻画土层中孔压的动力增长过程，而弱震输入下的计算误差较明显。

关键词　土力学；可液化场地；地基地震反应；大型振动台试验；孔压动力增长；数值模拟

分类号

LARGE-SCALE SHAKING TABLE TEST AND ITS NUMERICAL SIMULATION OF RESEARCH ON BUILD-UP BEHAVIOUR OF SEISMICALLY-INDUCED PORE WATER PRESSURE IN LIQUEFIABLE SITE

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Abstract

Based on the effective stress principle and empirical mode of dynamic increase of pore water pressure，adopting computation method for increment of pore water pressure by stress cycle，the numerical simulation model directly aiming at large-scale shaking table test of earthquake response of ground in non-free liquefaction site is established to numerically simulate and analyze the dynamic increase of the pore water pressure of ground. The

result of numerical simulation indicates that，under the condition of El Centro earthquake ground motion with amplitudes of 0.15g and 0.50g，the pore water pressure changes prominently before 13 s，increases instantaneously at 13 s，and reaches to a peak value at 25 s；and the pore water pressure ratio at the point of the peak value gradually augments from bottom to top. The sand layer in upper part gains the pore water pressure ratio of local liquefaction under the condition of El Centro earthquake ground motion with the amplitude of 0.15g and the entire sand layer all arrives at the pore water pressure ratio of full liquefaction under the condition of El Centro earthquake ground motion with the amplitude of 0.5g. Besides，it is shown that the pore water pressure in the area close to the pile is higher than that in the area far from the pile，and a certain gradients of pore water pressure appear around of the pile as a result of the dynamic interaction of pile-soil；and it is gained that the change regularity recorded in the shaking table test is almost consistent with that obtained from numerical simulation. In a word，this numerical simulation method for dynamic increase of pore water pressure basically reflects the dynamic increase course of the pore water pressure under the condition of strong earthquake ground motion，but the computing error by means of this method is rather obvious under the condition of weak earthquake ground motion.

Key words soil mechanics；liquefaction site；earthquake response of ground foundation；large-scale shaking table test；dynamic increase of pore pressure；numerical simulation

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