World Academy of Science, Engineering and Technology
International Journal of Geotechnical and Geological Engineering
Vol:17, No:06, 2023

Experimental Evaluation of Foundation Settlement Mitigations in Liquefiable Soils using Press-in Sheet Piling Technique: 1-g Shake Table Tests

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Abstract : The damaging effects of liquefaction-induced ground movements have been frequently observed in past earthquakes, such as the 2010-2011 Canterbury Earthquake Sequence (CES) in New Zealand and the 2011 Tohoku earthquake in Japan. To reduce the consequences of soil liquefaction at shallow depths, various ground improvement techniques have been utilized in engineering practice, among which this research is focused on experimentally evaluating the press-in sheet piling technique. The press-in sheet pile technique eliminates the vibration, hammering, and noise pollution associated with dynamic sheet pile installation methods. Unfortunately, there are limited experimental studies on the press-in sheet piling technique for liquefaction mitigation using 1g shake table tests in which all the controlling mechanisms of liquefaction-induced foundation settlement, including sand ejecta, can be realistically reproduced. In this study, a series of moderate scale 1g shake table experiments were conducted at the University of Nevada, Reno, to evaluate the performance of this technique in liquefiable soil layers. First, a 1/5 size model was developed based on a recent UC San Diego shaking table experiment. The scaled model has a density of 50% for the top crust, 40% for the intermediate liquefiable layer, and 85% for the bottom dense layer. Second, a shallow foundation is seated atop an unsaturated sandy soil crust. Third, in a series of tests, a sheet pile with variable embedment depth is inserted into the liquefiable soil using the press-in technique surrounding the shallow foundations. The scaled models are subjected to harmonic input motions with amplitude and dominant frequency properly scaled based on the large-scale shake table test. This study assesses the performance of the press-in sheet piling technique in terms of reductions in the foundation movements (settlement and tilt) and generated excess pore water pressures. In addition, this paper discusses the cost-effectiveness and carbon footprint features of the studied mitigation measures.

Keywords : excess pore water pressure, foundation settlement, press-in sheet pile, soil liquefaction
Conference Title : ICEES 2023 : International Conference on Earthquake Engineering and Seismology
Conference Location : San Francisco, United States
Conference Dates : June 05-06, 2023