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A Critical Review on Soil Reliquefaction Resistance Using Physical Modelling Experiments

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Abstract

Liquefaction and associated ground deformations are one of the major causes of the devastating damage to the foundations and structures during earthquakes. Past research works focused on understanding the liquefaction mechanism and behavior subjected to the initial/independent seismic loading events. Henceforth, research related to understanding the reliquefaction mechanism and resistance of sand deposits was limited. The instance of historical earthquakes witnessed occurrence of reliquefaction, soil liquefied more than once when subjected to successive earthquakes (e.g., the main shock associated with foreshocks and aftershocks). The recent historic earthquakes (2010 – 2011 Canterbury earthquakes series, 2011 Tohoku, 2016 Kumamoto, and 2019 Vancouver among many) illustrated the destructive nature of the reliquefaction phenomenon. Multiple liquefaction was spotted during these repeated earthquakes/earthquake swarms, despite the earthquake magnitude being less than the previous shaking. Some of the field observations reported an increase in reliquefaction resistance due to the previous liquefaction occurrences and the beneficial effect of preshaking. In contrary to this, some studies reported a significant reduction in the resistance to reliquefaction. The present study critically reviews the complex nature of reliquefaction characteristics in increasing/decreasing the resistance of sand deposits to future liquefaction events. Physical modelling experiments have been used for simulating the liquefaction and reliquefaction phenomenon and in understanding the factors influencing the reliquefaction resistance. Factors such as method of sample preparation, initial relative density, input motion characteristics (acceleration amplitude, dynamic frequency and shaking duration), effect of preshaking on reliquefaction resistance was critically reviewed. It is concluded that all the above-mentioned parameters are critical in influencing the reliquefaction resistance to a certain extent. This study will be useful in understanding the reliquefaction mechanism and factors influencing liquefaction resistance when sand deposits subjected to repeated shaking events. This review will be highly useful in achieving the efficient design of ground improvement system to mitigate reliquefaction and associated deformations.

Keywords: Reliquefaction, Physical modelling experiments, Preshaking, Ground improvement system