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Guidelines and codes for liquefaction mitigation by ground improvement

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Abstract

Ground improvement has become one of the most effective tools of geotechnical engineering, being adopted for an always larger variety of civil engineering applications. To reduce the role of subjective choices of operators, the use of different techniques tends to be codified by specific guidelines. In the European Union there is an ongoing effort to standardize execution and design within codes continuously reviewed by designated committees. A widespread and systematic standardisation on the ground improvement as a mean to mitigate the effects of liquefaction on buildings and infrastructures is missing. The paper presents and overview of traditional and new ground improvement technologies suitable for this application. The methods are firstly classified by considering their effects on the ground (e.g. densification, stabilization, drainage, desaturation, etc.). Design principles are then outlined for new or pre-existing buildings and infrastructures, considering the ongoing review process of the design Eurocodes.

Keywords: Liquefaction, critical infrastructures, ground improvement, standardisation, Eurocodes.

1. Introduction

Liquefaction is among the most devastating effects induced by earthquakes, being capable of producing severe damages on buildings and infrastructures and thus undermine the whole life of the communities (NASEM, 2016). Despite observations show that compared to ground shaking, landslides and tsunamis, liquefaction is likely to cause less conventional collapse of structures or fatalities (Bird and Bommer, 2004), the economic losses coupled with this phenomenon are typically huge as the restoration of damaged structures is costly and time consuming. A reliable assessment of risk should consider not only the repair cost of the physical goods exposed to this phenomenon (built asset, lifelines, productive units), but also the losses consequent to their reduced functionality, proportional to the time necessary to restore original conditions and to the criticality of the considered structure for the life of the community. Normally, the functions of urban systems are heavily injured by liquefaction and the process to restore original life conditions is long and toilsome in a way that populations are often discouraged to undertake recovery and stimulated to migrate elsewhere.

Dramatic events like those occurred recently in Izmir 1999 (Sancio et al., 2002), Christchurch 2011 (Canterbury Development Corporation, 2014), Tohoku Oki 2011 (Yasuda et al., 2012), Emilia Romagna 2012 (Fioravante et al., 2013), have demonstrated the gravity of liquefaction

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