ABSTRACT PhD PROJECT

Multidisciplinary and multiscale approach for the liquefaction induced by earthquakes and experimental blast tests in different geological settings

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Liquefaction typically occurs during earthquakes in saturated loose granular soils (fluvial, eolian or marine deposits). This phenomenon consists in the transformation of a granular deposit from a solid state into a liquefied state as a consequence of the increased pore-water pressure determined by cyclic shaking (Youd, 1977; Galli, 2000). Because of the potential destruction and damage to buildings and infrastructures, liquefaction requires thorough studies to define the main geotechnical and geological features that influence its occurrence.

The aim of this project is to carry out a complete characterization of liquefiable soils, defining both the geotechnical parameters and the petrographic-textural features, in order to: (i) update the pre-existing liquefaction project database (Minarelli et al., 2022), (ii) define the role played by the non-liquefiable deposits that confine the sandy bodies in the subsurface and (iii) assess an original model to identify liquefiable zones in regions with similar geological/geotechnical characteristics. The areas where liquefaction effects, with diffuse damage of buildings and significant human casualties, are well documented, also in terms of geotechnical data, will be the main object of the present study: the Emilia plain (Italy), Boca De Briceño (Ecuador), Petrinja (Croatia) and Canterbury (New Zealand).

The first step of this work will consist of a review of existing literature to contextualize the different liquefaction sites starting from the geological settings, the geotechnical data and the methodologies used to analyse the co-seismic events. The second step will be aimed to improve the dataset of the grain size, petrographic, and textural characteristics of liquefiable sandy samples previously collected in the study sites. This will lead to the identification of the liquefied source layers in the subsurface and, as regards, fluvial deposits to detect the related paleo-channels. In addition, the sedimentary structures and texture may provide information on pulse ejection mechanisms of liquefied sands along fractures (Nichols et al. 1994; Hurst et al. 2011; Ross et al. 2014; Fontana et al. 2015, 2019). The study of grain size is particularly interesting because, although the phenomenon mostly occurs in sandy deposits, some authors showed that even gravelly sediments can be susceptible to liquefaction (Chen et al., 2008; Cao et al., 2013; Rollins et al., 2020; Roy & Rollins, 2022; Salvatore et al., 2022), but this phenomenon is still poorly documented. The laboratory results will be compared with the geotechnical and geophysical characteristics of liquefiable deposits previously obtained from field investigations. An innovative contribution to quantify the effects of liquefaction is the blast test, an experiment that artificially induces liquefaction. It will have significant implications that will be potentially useful to test the reliability of the current liquefaction triggering maps in order to avoid or mitigate liquefaction-induced damage through improved hazard and risk assessment.

The multidisciplinary approach adopted in this study will allow us to better understand the liquefaction process at macro, micro and field scales, using integrated study methods.

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