ABSTRACT OF THE RESEARCH PROJECT

Liquefaction typically occurs during earthquakes in saturated loose granular soils; 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 multidisciplinary approach adopted in this project will allow us to better understand the liquefaction process from laboratory to field scale, using information obtained from the results of stratigraphic and sedimentological analyses, textural and petrographic studies, and geotechnical and geophysical tests. First of all, it would be interesting to see how the review of the existing literature may help to contextualize the different liquefaction sites including the geological settings, the geotechnical data and the methodologies used to analyse the co-seismic events. This can be supplemented by an update of the available pre-existing soil liquefaction database (e.g. Minarelli et al., 2022) and by an analysis of the existing data from experiments and earthquakes related to liquefaction. The analysis of data obtained by laboratory and in situ geotechnical and geophysical tests will allow to obtain more information on stratigraphy, morphologies and geometries of buried bodies in the investigated area. In addition, the sedimentary structures and texture may provide information on pulse ejection mechanisms of liquefied sands along fractures (Hurst et al. 2011; Fontana et al. 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), but this phenomenon is 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 areas where liquefaction effects, with diffuse damage of buildings and significant human casualties, are well documented, also in terms of geotechnical data, and these are: Emilia (Italy; Fontana et al. 2019; Minarelli et al., 2022), Petrinja (Croatia; Minarelli et al., 2023), Pedernales (Ecuador; Salocchi et al., 2020) and Canterbury (New Zealand). The experience made in Emilia, conducted by applying the experimental blast test technique to see the source layers of the sands, has produced several detailed results that can be extended to other case. However, the role of the non-liquefiable crusts remains to be defined. The 2020 Petrinja earthquake provided many examples of liquefaction that mainly occurred in the alluvial plains, with ejecta composed of sands and/or gravels of different grain size and mineralogy. In this area, there is a wide geotechnical and petrographic database to analyse in order to study non-liquefiable deposits and to identify source layers. In the case of Pedernales earthquake, the study of texture and petrographic composition of sand boils allows us to identify a source layer for liquefaction. In New Zealand, following the 2010-2011 Canterbury seismic sequence, the collected data have allowed the development of a wide database, in which the information needs to be contextualized according to the depositional environments of the sediments.

Further case studies would be possibly added in relation to the recent 2023 Maraş earthquakes and to Central Apennines (Italy).

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