Research Project Highlight

Next Generation Liquefaction: Japan Data Collection

Project # NCTRKA

Principal Investigator
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Research Team
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Start-End Dates:
2/16/2014-10/31/16

Abstract
This project is based on the use of case histories where ground motions have been recorded on the surface of soil deposits that liquefied. This new type of case history allows evaluation of the accuracy of existing and proposed procedures for evaluation of liquefaction potential. A series of liquefaction-influenced ground motion recordings from the 2011 Tohoku earthquake was carefully examined to evaluate which were most likely to provide insights into aspects of liquefaction that are not well represented in existing liquefaction case history databases. After considering the potential benefits of each, and practical considerations of site access and cost, three sites were investigated for detailed investigation. The sites, all part of the K-Net strong motion instrumentation system, had some available subsurface data, but some subsurface data required for liquefaction potential evaluation procedures commonly used in the U.S. were not available and other data was reported with insufficient resolution for detailed analyses. The three sites were investigated with the aid of Dr. Akio Abe of Tokyo Soil Research. The IBR014 site is located in Tsuchiura, Fukushima prefecture, Japan, about 60 km north of Tokyo, appeared to have potentially have experienced liquefaction of relatively deep strata. Two other sites, MYG010 and MYG013, were located in Ishinomaki, Myagi prefecture, Japan, about 40 km northeast of Sendai. MYG010 appeared likely to provide data on liquefaction of relatively dense soils, and MYG013 appeared likely to have exhibited liquefaction of gravelly soil. All three sites were investigated by drilling and sampling with SPT measurements, and by CPT testing, in late 2015. Laboratory tests were performed on samples obtained from each of the sites. Detailed analyses of the response of the sites are being performed to confirm and document the conditions under which liquefaction was triggered in the critical layers of each soil profile.

Deliverables
A PEER report and several conference and journal papers describing the sites, their performance during the Tohoku earthquake, the site investigations, the results of site response analyses, and the interpretation of how liquefaction occurred at each site.

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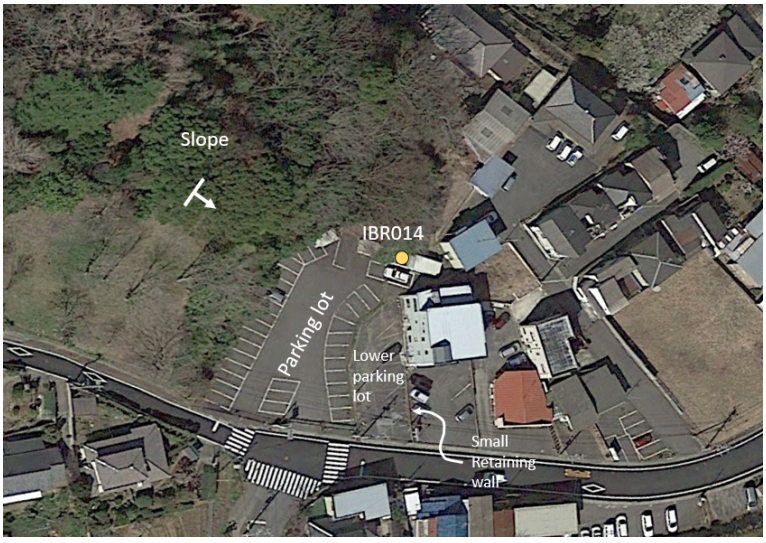
Research Impact

Soil liquefaction causes damage to buildings, bridges, pipelines, and other elements of the built and natural environments during earthquakes. Because few sites underlain by liquefiable soils are instrumented with strong motion seismographs, ground motions at liquefaction case history sites must usually be estimated from nearby recordings, ShakeMaps, or GMPEs. Sites at which ground motions were recorded on the surface of profiles that liquefied offer the potential, through careful interpretation of time-frequency analyses, to determine the level of shaking at the time liquefaction was triggered. These case histories are fundamentally different than most case histories, which offer a binary indication of whether liquefaction did or did not occur under an estimated level of shaking. Existing case history databases are incomplete with respect to many conditions for which geotechnical engineers are often required to evaluate liquefaction potential. These include liquefaction at depth, liquefaction of relatively dense soils, and liquefaction of gravelly soils. The three case histories investigated as part of this project will add to the sparse existing data for those conditions and their interpretation will aid in the validation/development of predictive procedures for liquefaction potential evaluation.

Project Images



a) Location of IBR014 instrument relative to sand boils observed in lower parking lot.

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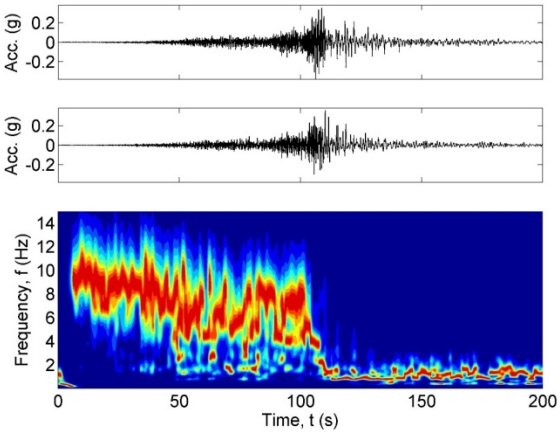
b) Sand ejecta observed in lower parking lot.



c) Normalized Stockwell spectrogram

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