DRISI
Caltrans Division of Research, Innovation and System Information

Research Notes

Shaking Table Testing to Evaluate Effectiveness of Vertical Drains for Liquefaction Mitigation

Geotechnical/ Structures

MARCH 2022

Project Title:
Shaking Table Testing to Evaluate Effectiveness of Vertical Drains for Liquefaction Mitigation

Task Number: 2401

Start Date: May 1, 2013

Completion Date: September 30, 2018

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WHAT IS THE NEED?

Although blast liquefaction studies have shown that vertical drains greatly increase the rate of drainage under field conditions, they have not prevented liquefaction. In addition, it is difficult to compare pore pressure development during blasting and an earthquake. At present, no direct field or laboratory data is available to confirm whether or not the drains have the ability to limit pore pressures and resulting settlement to acceptable levels. This lack of performance data under full-scale conditions has been a major impediment to expanding the use of vertical drains for liquefaction mitigation.

WHAT ARE WE DOING?

This study will perform shaking table tests on sandy soils with vertical drains installed to confirm whether or not the drains have the ability to limit pore pressures and resulting settlement to acceptable levels during the earthquake event. The study will conduct full-scale tests with vertical drains in liquefiable sand using the laminar shear box and high speed actuator system at NEES-Univ. at Buffalo.

The vision for this study is to determine the viability of large diameter (100 mm) prefabricated vertical drains for preventing liquefaction and associated settlements or lateral spreading under full-scale conditions. If viable, drainage alternatives offer substantial advantages in comparison to conventional densification approaches. In production, drains can often be installed at 25% to 40% of the cost of stone columns. In addition, the drains can be installed in about one-third to one-half of the time required for stone columns.

WHAT IS OUR GOAL?

Three objectives of the study are as follows:

1. Evaluate the ability of earthquake drains to reduce excess pore pressure and settlement for level ground conditions at progressively higher acceleration levels.
2. Define the influence of drain spacing on the effectiveness of the drains for mitigating liquefaction hazard.
3. Provide well-documented case histories which can be used to calibrate/validate numerical models for predicting the performance of vertical drains.

WHAT IS THE BENEFIT?

This study promises to yield practical results. Vertical drains offer the potential to deal with liquefaction problems at 30 to 50% of the cost and time required with conventional densification techniques. Drains could also be used in combination with other improvement techniques where it might be difficult or too expensive to completely prevent liquefaction through densification. Drains are particularly attractive for marginal liquefaction problems or for locations where it might be economically difficult to justify the conventional densification procedure.

In an era when construction budgets are becoming increasingly tight and projects are increasingly placed on fast-track schedules, innovative alternative solutions are required to deal with liquefaction hazards.

WHAT IS THE PROGRESS TO DATE?

Over the past several months, the lead DOT (UDOT) worked with internal finance and FHWA to close this TPF project.

The lead Department of Transporation (DOT) worked on format editing of the project's two final reports:

- Shaking Table Tests to Evaluate Effectiveness of Vertical Drains for Liquefaction Mitigation (Final Test Report)
- Reliability of FEQDrain for Modeling Performance of Sand Treated with Large Diameter Prefabricated Vertical Drains for Liquefaction Mitigation (Final Analysis Report)

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