CALIFORNIA STATE SCIENCE FAIR
2012 PROJECT SUMMARY

Name(s)

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Project Number

S0309

Project Title

Surviving Seismically-Induced Liquefaction: The Development and Validation of a Novel Hybrid Floating Foundation System

Abstract

Objectives/Goals

The goal of this project was to develop and validate the effectiveness and performance of a novel hybrid floating foundation during liquefaction through model testing on a shaking table and compare the results to those obtained from experiments conducted on conventional footing foundation and mat foundation.

Methods/Materials

A shaking table, a model building, a mat foundation, a footing foundation, and a hybrid floating foundation. 100 kg of sand.

1. Place model building in a container pre-filled with sand and water.
2. Place the model set-up on shaking table. Measure initial positions of soil and foundation.
3. Subject the model set-up to shaking and liquefaction. Videotape the process.
4. Measure the final positions of soil and foundation. Calculate soil and foundation settlements.

Results

The hybrid floating foundation settles 40 to 90% and 45 to 95% less than mat foundation and footing foundation, respectively. The normalized foundation settlement (against soil thickness) of the hybrid floating foundation is 45 to 91% and 46 to 94% less than mat foundation and footing foundation, respectively. The normalized foundation settlement (against soil settlement) of the hybrid floating foundation is 52 to 98.6% and 57 to 98.7% less than mat foundation and footing foundation, respectively. The normalized foundation settlement (against initial soil density) of the hybrid floating foundation is 36 to 91% and 49 to 94.7% less than mat foundation and footing foundation, respectively.

Conclusions/Discussion

The geofoam providing both the support needed for static loading and the buoyancy during liquefaction is adopted in the novel hybrid floating foundation. The results of liquefaction experiments on model buildings subjected to shaking up to 0.82G clearly demonstrated the feasibility and advantage of the novel hybrid floating foundation. When buoyant force from geofoam offsets the entire building load, an average settlement reduction of 75 to 80% over mat foundation, which already settles less than footing foundation, could be expected. Even when a building supported by the hybrid floating foundation settles and is damaged by liquefaction, the required restoration will be considerably less in comparison to a building supported by either a mat foundation or a footing foundation, as the hybrid floating foundation will settle less than the surrounding soil.

Summary Statement

While conventional footing and mat foundations are prone to large settlement during liquefaction, a novel hybrid floating foundation using buoyancy from EPS geofoam has been shown to significantly reduce settlement.

Help Received

Use lab space at Associated Soils Engineering, Inc. under the supervision of Mr. Lawrence Chang