CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)
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Project Number
S0303

Project Title
Surviving Seismically-Induced Liquefaction: Dynamic Centrifugal Modeling of a Novel Hybrid Floating Foundation System

Abstract

Objectives/Goals
To validate the feasibility and advantage of the novel hybrid floating foundation (NHFF) system in better surviving liquefaction than footing foundation (FF) and mat foundation (MF)at prototype-scale stress state utilizing a dynamic geotechnical centrifuge.

Methods/Materials
Construct model building and NHFF, FF, and MF foundations. Place them in model box filled with saturated sand. Assemble and secure dynamic geotechnical centrifuge. Place completed model box onto model platform and connect with shaker. Place counterweight on the other platform and balance. Measure initial positions of model building, foundation, and soil. Connect shaker with power through slip ring. Affix rotator to centrifuge. Install in-line camera and side camcorder. Perform dynamic centrifugal tests and videotape the process. Measure post-test positions of model building, foundation, and soil. Determine G-level.

Results
Rotational speeds for 15 tests ranged from 126 rpm to 144 rpm, equal to centrifugal accelerations from 12.05G to 15.73G, with an avg. of 13.89G.
Shaker cyclic speeds for 15 tests ranged from 204 rpm to 222 rpm, equal to cyclic accelerations from 0.66G to 0.79G, with an avg. of 0.72G.
At 13.89G, a model foundation of 104 cm2 and 812.8g supported by 13.51 cm-thick sand represents a prototype of 2 m2 and 21.35KN supported by 1.88 m-thick sand.
Avg. soil settlement for 5 FF tests was 0.5 cm, equal to 6.62 cm for prototype. Avg. max. FF model settlement was 2.72 cm, equal to 36.06 cm for prototype.
Avg. soil settlement for 5 MF tests was 0.5 cm, equal to 7.07 cm for prototype. Avg. max. MF model settlement was 1.12 cm, equal to 5.87 cm for prototype.
Avg. soil settlement for 5 NHFF tests was 0.46 cm, equal to 6.63 cm for prototype. Avg. max. NHFF model settlement was 0.34 cm, equal to 4.92 cm for prototype.

Conclusions/Discussion
1.The concept/design of the NHFF has been proven feasible through dynamic centrifugal modeling.
2.NHFF is very effective in reducing liquefaction-induced foundation settlement and maintaining the post-liquefaction functionality and intactness of the building than FF and MF.
3.Buoyancy developed within geofoam during liquefaction reduces foundation base load and isolates NHFF from soil deformation.

Summary Statement
Validate the feasibility and advantage of a novel hybrid floating foundation in better surviving liquefaction than footing and mat utilizing a dynamic geotechnical centrifuge.

Help Received
Father helped checking safety during tests. Mother helped plugging power source. Run tests in the stoarge area of Associated Soils Engineering, Inc. with permission.