CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

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Project Number

34144

Project Title

The Effects of Bulk Density, Porosity, and Permeability of Land on Liquefaction, Year 2: Mitigation

Abstract

Objectives/Goals

The purpose was to investigate effective liquefaction mitigation methods. The hypotheses were: 1. If it is possible to increase bulk density and decrease porosity of the liquefiable ground (saturated fine sand), by compacting the soil or replacing part of the soil with concrete columns (solidifying), then volume of sinking will decrease. 2. If it is possible to increase permeability of the liquefiable ground, by replacing part of the soil with gravel columns, then volume of sinking will decrease.

Methods/Materials

First, five different mitigation methods were conducted on 10 liters of saturated fine sand (0.12mm - 0.20mm) which was used to simulate liquefiable ground. The five mitigation methods used were: Dynamic Compaction (weight drop), Vibro Compaction (vibrate), Concrete Columns (solidifying pore space), Vibro Replacement (small gravel columns), and Vibro Replacement(large gravel columns). Then, these improved grounds underwent a simulated liquefaction test. A brick, representing a structure, was placed on top of each saturated ground material. A simulated earthquake was created by placing a concrete vibrator probe on the outside of the container for one minute. The volume that the brick sank was measured. Next, sample ground materials used for each ground improvement were tested for bulk density, porosity, and relative permeability. This data was compared and analysed with the simulated liquefaction test results.

Results

1. Concrete columns, which had the highest bulk density and lowest porosity, had the lowest volume of sinking. 2. Large gravel columns, which had the highest permeability, had the second lowest volume of sinking even though it had the highest porosity.

Conclusions/Discussion

The results supported Hypotheses 1 and 2. Concrete columns solidify pore space with cement. This process will bond grains together and prevent water from entering the sand, therefore mitigate volume of sinking effectively. In addition, gravel columns create an additional drainage path in liquefiable land and prevent developing pore water pressure. This is another way to prevent liquefaction by increasing permeability.

Summary Statement

Investigated effective liquefaction mitigation methods by examining bulk density, porosity, and permeability of land.

Help Received

Parents helped with keeping time during experiments