CALIFORNIA STATE SCIENCE FAIR
2006 PROJECT SUMMARY

Name(s)
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Project Number
S0606

Project Title
Using Bacterial Biofilms to Reduce Liquefaction

Abstract

Objectives/Goals
Building foundations are usually made of steel and concrete, which in turn rely on a solid soil base beneath them for stability. During an earthquake the soil base undergoes liquefaction, which causes the soil to act like a viscous fluid due to compression caused by the shock waves. This in turn makes the soil unstable and allows the building to collapse. By using biofilms secreted from bacteria to create a complex matrix structure inside the soil, the compression strength of the soil increases, thus increasing the stability of the soil and eliminating liquefaction.

Methods/Materials
Three different tests were run to test the liquefaction and compression strengths of bacteria (Flavobacterium johnsoniae) enhanced sand against a control, which was wet sand.
1. Liquefaction Test-Fifteen mL of water was put into bacteria inoculated sand and then tested in an orbital shaker. After shaking for 24 hours, the amount of water that had risen to the top was measured. This test was conducted over a period of five days, with each sample being allowed to grow for a certain period of days.
2. The second test had bacteria growing in the sand at different concentrations for five days. Each sand sample was tested for its compression strength.
3. In the third test, bacteria inoculated sand was allowed to grow at a fixed concentration. The compression strengths of these samples were then measured daily for a period of five days.

Results
In the liquefaction tests, water came out of the sample with the biofilm matrix only on the first day of growth. No more water appeared thereafter. The water in the control (wet sand) samples came out consistently on every day for every test. For both of my compression tests, the samples with the biofilm matrix performed significantly better than the control (wet sand), with their compression strengths more than double that of the control.

Conclusions/Discussion
All of the objectives were met, and the sand samples with the biofilm matrix preformed significantly better than wet sand in every single test. This method of reducing liquefaction can have far reaching affects. During the 1906 earthquake in San Francisco, there was massive damage to buildings caused by liquefaction of the soil. Given that this year is the 100th anniversary of the earthquake, it is appropriate that we look for alternate methods to increase stability of foundations during earthquakes. This project is one such method.

Summary Statement
My project explores a solution to the expensive problem of liquefaction by using bacterial biofilm to fortify the sand.

Help Received
My mother helped create my board; my father gave me inspiration; my mentor guided me through my entire experiment.