CALIFORNIA STATE SCIENCE FAIR
2007 PROJECT SUMMARY

Name(s)
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Project Number
S0799

Project Title
Using Bacterial Anchor Molecules to Stabilize Saturated Soil

Abstract

Objectives/Goals
Liquefaction is a phenomenon that has been shown to cause dangerous problems in regards to structural dynamics and engineering of buildings during earthquakes.
One potential solution to this problem is with the use of Flavobacterium johnsoniae, a bacterium that secretes a sticky biofilm. The current project objective is to determine if the biofilm secreted by F. johnsoniae #when grown within sand, will bind sand together and thereby increase its compressive strength and decrease the liquefaction that consequently occurs. The engineering goals for this project are to increase the compression strength of sand and decrease the liquefaction that occurs by utilizing bacterial biofilms.

Methods/Materials
To test if the biofilm successfully fulfilled it's intended role, the following tests were conducted:
1) Differing concentrations of S. epidermis were cultured and injected into the sand. The samples were tested for compression strength over a period of 5 days.
2) A liquefaction test was conducted on the experimental samples which contained different concentrations to better understand the influence/effects of the biofilm on the liquefaction property of sand over a period of 5 days.

Results
For the concentration compression tests, there was a steady increase of strength as the concentration of bacteria was increased. For the fifth day, there was a 16,747% increase in compression strength compared to the control for the highest McFarland. Additionally, as the bacteria had more days to grow, it resulted in an increase of compression strength. For the concentration liquefaction tests, as the concentration of bacteria was higher and the bacteria had more days to grow, less water was being released from the sand indicating a higher compression strength.

Conclusions/Discussion
Because the biofilm-enhanced sand had increased compression strength and underwent less liquefaction, both engineering goals were achieved.
The bacteria enhanced sand underwent very little liquefaction at all three concentrations. Further the biofilm enhanced sand withstood a much higher compression force than normal sand. Normal sand withstood 50 grams before falling apart, but the Staphylococcus epidermis enhanced sand withstood 15,875.733 grams, clearly showing how the bacteria enhanced sand is much more stable than ordinary sand.

Summary Statement
The project utilizes bacterial biofilms to reinforce liquefaction prone areas to mitigate the damage caused by an earthquake.

Help Received
My mentor supervised while I was in the lab feeding and growing the bacteria.