CALIFORNIA STATE SCIENCE FAIR
2004 PROJECT SUMMARY

Name(s)
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Project Number
J1804

Project Title
The Ultimate Underground Structure: The Effect of Pillars Added to Structural Designs of Earth-Sheltered Buildings

Abstract

Objectives/Goals
My objective is to determine if pillars added to the structural design of an earth-sheltered structure will keep it from collapsing under the weight of dirt. I believe that all of the models with pillars will hold 1800g or more of sand applied to the roof of each model and all the models without pillars will hold less than 1800g.

Methods/Materials
After interviewing two geologists, a civil engineer, and a college senior in environmental engineering, I designed and constructed 20 individual models of earth-sheltered structures out of toothpicks and marshmallows. Each design for the model was built and tested six times. The designs for the models were divided into two groups: with pillars (three with only pillars; seven with pillars and braces) and without pillars (two with no braces; eight with braces). Each model was placed in a 37.85L fish tank partially filled with sand; and tested by placing 360g sand-filled plastic bags, one at a time, on top of each individual model until the model collapsed.

Results
The results were as follows: 100% of the models with only pillars and no braces, 57% of the models with both pillars and braces, not one of the models without pillars or braces, and 63% of the models with only braces and no pillars held 1800g or more of sand.

Conclusions/Discussion
My hypothesis was correct because every model with only pillars and no braces held 1800g or more. Unfortunately, my hypothesis was also incorrect because not every one of the models with pillars and braces held 1800g or more. This data is applicable to architects and structural engineers in designing earth-sheltered structures able to withstand larger amounts of dirt applied to the roof.

Summary Statement
My project determines whether pillars added to the structural design of an earth-sheltered structure will ensure the structure's capability to support more weight of dirt applied to the roof of the structure.

Help Received
Uncle helped connect two boards to make one large display board; Aunt proofread printed material.