CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
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Project Number
S0306

Project Title
Surviving Earthquakes: A Novel 2-D Magnetically Levitated Seismic Base Isolation System

Abstract

Objectives/Goals
The aim of this project was to develop a novel seismic base isolation system that utilizes magnetic levitation to isolate the building from the earth and compare its effectiveness to modern seismic base isolation systems.

Methods/Materials
Place model building on magnetically-levitated, fixed, seismic vibration reducing, or friction-reducing platform and place to shaking table. Set up video camera to next to model building so that model building is directly in front of gridpaper in the video and begin recording once experiment begins. Shake the model building for ten seconds. Analyze the video taken by the video camera by playing it in slow motion. Measure displacement relative to the gridpaper at corner positions of the model building.

Materials:
Poplar Wood Board to serve as base of model building
Pine Wood Board for the middle layer and top layer of model building
Reciprocating Saw for powering the shaking table
Neodymium Magnets for levitating the middle slab and the model building
Compression Springs for construction of model building

Results
The lateral displacement of structural members of the model building is reflected by the net change in phi-angle, which measures the angular deviation from initial, vertical position of a structural member when subjected to vibratory shaking, and is directly related to the shear force sustained by the structural member. The phi-angle was calculated by first measuring lateral displacement and then using trigonometric relationships to calculate the phi-angle. In general, magnetically-levitated buildings gain a 75%, a 67%, and a 50% reduction in change in phi-angle from buildings supported by fixed foundation, seismic vibration reducing system, and friction reducing system, respectively.

Conclusions/Discussion
The experiment validated the efficacy of the novel magnetic levitation seismic base isolation system. By levitating the building and maintaining points of friction with only the low friction reducers placed at the sides of the building, magnetic levitation is a viable method of passive vibration control. Experiments conducted along two directions additionally verified that magnetic levitation can be used to reduce structural damage in multiple directions of shaking.

Summary Statement
The project develops a novel seismic base isolation system utilizing magnetic levitation and compares its performance to that of current base isolation systems

Help Received
Father helped with cutting wood; mother and advisor provided significant motiviation