CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

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Project Number

33139

Project Title

Take the Shake of the Quake: Testing of Seismic Design of Structural Frames

Abstract

Objectives/Goals

Earthquakes are inevitable; however, people can seismically design and retrofit their homes to increase structure safety. Bracing is a widely used lateral resisting system. The goal of this project is to find out how effective a bracing system is for withstanding simulated earthquakes and which type of bracing system is more effective for wood structure frame.

Methods/Materials

A shake table was made of a wooden platform attached to a LEGO NXT motor and brain, which was programmed with "LEGO MINDSTORMS NXT 2.0" to simulate 15 levels of earthquakes. Every level, the strength of the motor is raised by 5. In the program, motion blocks and loops execute actions. The motion blocks make the motor shake the platform. The loops repeat the motion. Wooden Skill Popsicle sticks were used to make 18 wood structure frames. White glue was used to glue the frames' joints. Five types of bracing systems including Single Diagonal, Double Cross, Inverted V, Knee, and K Bracing were tested. Each frame was attached to the platform with rubber bands and weights. The table shook each frame for 20 seconds. If the frame did not collapse, the level increased by 1. Results were reported as levels of shaking and time that each bracing design withstood the simulated earthquakes.

Results

To standardize the measurement for each level, the product of sustained time and power is defined as Power-Time. The effectiveness of the structure is defined as the sustained Power-Time divided by the target Power-Time. In summary, Inverted V-Bracing was the most effective design. It was able to withstand up to an average of 12.7 levels on the shake table with 76.1% effectiveness. Knee Bracing was the least effective with 22.4% effectiveness and an average of 5.7 levels. The effectiveness of Inverted V-Bracing was more than 4.5 times the control. K, Double Cross, and Single Diagonal-Bracing had about the same effectiveness. The study cannot conclude which of the three is best because they were all within a range of 4% effectiveness.

Conclusions/Discussion

This study showed that all wood structure frame bracing systems are effective, compared to the control. In conclusion, Inverted-V bracing is the best for withstanding simulated earthquakes. It is 29.8% more effective than the next most effective types of bracing. Clearly, it is worthwhile for residents in the Bay Area to use bracing to reduce damage in future earthquakes.

Summary Statement

This project is to find out the effectiveness of five types of bracing systems on wooden structure frames for withstanding simulated earthquakes.

Help Received

Thanks to my mom for helping me with the photos and the supplies. Thanks to my teacher for her guidance.

Preliminary