CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

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Project Number

J0316

Project Title

To Bridge or Not to Bridge? Truss, Arch, Beam, or Suspension? Strength, Efficiency, and Seismic Safety of Bridges

Abstract

Objectives/Goals

My goal is to determine which bridge is the strongest, most structurally efficient, and most earthquake-resistant, thus safest for all.

Methods/Materials

To make the bridges, I used balsa wood strips, beads, thread, glue, an X-acto knife, weight scale, bucket, rope, an earthquake simulator, and stopwatch. To make the earthquake simulator, I used plywood, an air hockey table, skate wheels, brackets, rubber bands, screws, nails, and a 120-volt drill. I created and tested 4 types of bridges: a beam as my control, truss, arch and suspension. To test the bridges for strength, I found the maximum weight each type of bridge could hold before breaking. I put the bridge on top of an earthquake simulator, tied it to a bucket below, and added weights in increments of 1 lb. each to the bucket. The maximum weight when the bridge collapsed determined its strength. To test the bridges for efficiency, I weighed each bridge, and the maximum supported weight by the bridge on a weighing scale. I used the structural efficiency calculation by dividing the maximum weight supported by each bridge by the bridge#s own weight. To determine seismic safety, I tested the bridges on the earthquake simulator, and observed how long they stood before collapsing.

Results

The suspension bridge was the strongest, carrying the most weight of 32 lbs. or 32 times more weight than the beam bridge. It is also the most structurally efficient as it supported the most weight in proportion to its own weight, with the highest efficiency score of 88 grams, or 85% more efficient than the beam. It was also the most seismic resistant because it withstood the earthquake simulation for the longest time, with an average standing time of 488.41 seconds. This bridge#s stability substantially increased by 3,416% than the control bridge. This suspension bridge performed the best overall among all the bridges I tested.

Conclusions/Discussion

In conclusion, the suspension bridge is the strongest, most structurally efficient, and most earthquake-resistant than the other bridges. It is the strongest because it supported the most weight, and is best in seismic safety when it resisted earthquake forces for the longest time. It is also the most structurally efficient because it carried the most weight in proportion to its own weight. It performed the best in all 3 categories because it withstood the compression and tension forces more than the other bridge types.

Summary Statement

After conducting multiple tests, I found that the suspension bridge I created is the strongest, most structurally efficient and most earthquake-resistant than my control beam, truss and arch bridges.

Help Received

I thank my parents for their overall supervision and assistance in buying the bridge and experiment materials, and my grandfather who helped me build an earthquake simulator.