Curiosity Guide #208
Plate Tectonics

Accompanies Curious Crew, Season 2, Episode 8 (#208)

Make Earthquake-Resistant Structures and Test with a Shake Table

STEM Challenge

Description

Pretend that you are a structural engineer who has to build a building that must withstand an earthquake for at least 15 seconds.

Materials per team or structure

- 30 coffee stirrers
- 30 marshmallows
- 2 whiteboards
- Marker
- Stopwatch
- Shoebox, cardboard box, or basin
- Board or cardboard sheet, sized to fit inside the box with a one-inch gap on all sides
- 20 golf balls
- Ruler
- Tape
- Adhesive backed Velcro strips

Procedure #1: Making a shake table

1) Place the golf balls inside the bottom of the box or basin.
2) Lay the board or cardboard sheet on top of the golf balls.
3) Verify that the sheet will move around when the box is slid back and forth.

Procedure #2: Making earthquake-resistant structures

1) Design two building blueprints, one for a tall structure, and one shorter. Draft the buildings on whiteboards.
2) Build the structures.
3) Make walls, using coffee stirrers. Use marshmallows to join the corners.
4) Determine the volumes of the two buildings by measuring the length by height by width.
5) Each structure will be charged at $300 per square foot for the earthquake-resistant structure.

Procedure #3: Testing the structures

1) Lay two long strips of adhesive-backed Velcro across the shake-table base.
2) Cut short strips of the mate side of the Velcro to strap down each structure to the base. This represents a building's base foundation connecting it to the ground. You can use tape instead, but the Velcro is quicker to move structures on and off the table.
3) Test your structures on the shake table for periods of 15 seconds.
4) Record damage and redesign as necessary.
5) What changes will make your structure sturdier?
6) What would happen if you added weight to one or all of the floors?

My Results

My Results, continued

Explanation

Designing construction to withstand the earthquake vibrations emanating through the ground is complicated, but critical in cities like San Francisco or Tokyo. As seismic vibrations move through manmade structures, the buildings begin to sway. Surprisingly, shorter buildings are at greater risk of collapsing in an earthquake than are tall skyscrapers! Taller structures are more flexible than stiff, shorter structures. The taller structures can therefore handle the potential movement more efficiently than shorter, more rigid structures can.

Wood and steel are preferred building materials in regions with seismic activity because of their flexibility and construction techniques. Construction techniques that keep buildings flexible include wall and ceiling joints that can transfer vibrations back down toward the ground without compromising the building. The marshmallows, if used and

tested when soft, provide great joint flexibility during the shake table tests. Other construction safeguards include wide trusses at the base of the building. The trusses narrow as they go up.

Something else to explore: Shake tables are really cool. Engineers have even made giant ones that can hold full-size houses! Those tests have given designers solutions and new ideas for earthquake-resistant structures, like buildings built on a series of cushions. These cushions, which look like giant hockey pucks, can squish during an earthquake and help hold the base of the building still. Another idea is to build a structure on two flat platforms or plates. The bottom plate shifts around with the earth's vibrations. This allows the top plate and building to remain together. Amazing! **You can see some images of these giant shake tables online. Search for "giant shake tables and building additions."**

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