SparkLab, Sciencentre

Maker Space: *Shake it up!*

The Challenge

Design and build a three-storey structure that can withstand the force of an earthquake.
Through testing, identify weak points in your building's design and strengthen them by reinforcing or redesigning elements of your structure.
Add some weight to your structure to simulate the weight of building materials, such as roof tiles or furniture and other items inside real-life structures.

Learning Outcomes

- Increase participant's understanding and confidence of the testing and design process; observing areas of the design that need improvement, posing a new design solution, making a change and observing the impact of that change.
- Increase understanding of the properties of a variety of materials and how these materials can be manipulated to build and strengthen a structure
- Feel and recognise success in implementing creative solutions to real world challenges. Apply this approach in their everyday life.
- Express enjoyment in engaging in the challenge and sharing ideas and understandings.
- Appreciate the importance of structural design and engineering in our everyday life, with particular relevance to the types of buildings we regularly frequent (schools, home, the workplace, sports stadia, cultural institutions)
- Gain an awareness of the effects and power of earthquakes and how (dependant on where we live) they can have a daily impact on our lives, lifestyles and behaviours

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Equipment

- Scissors
- Hole Punch
- Test weights (try small zip-lock bags filled with pre-weighed amounts of either sugar, salt or flour)

Building Materials

- *Flooring* (cut to A6)
  - Card
  - Paper
- *Columns*
  - Straws
  - Wooden coffee stirrers
- *Connectors*
  - Masking tape
  - Elastic bands

Shake Table

On a table-top hold a sturdy flat object such as a baking tray or chopping board over either:

- An inflated balloon
- 3-4 cardboard tubes
- 3-4 tennis balls
- Marbles

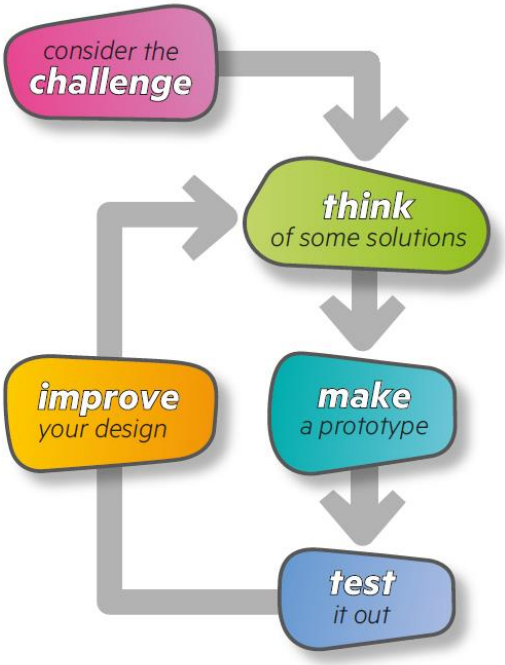
Your shake table platform can then be rolled or pushed in different directions with varying degrees of force

Optional

Smart phone with an *accelerometer* or *vibration meter* app to measure the intensity of the simulated earthquakes you create – tape it to your shake table platform!

Design process

This activity follows a design process. Below are some questions that will help at each stage of the process.



Think of some solutions

- What materials do you think will work well to protect your structure from the forces of an earthquake?
- What are some real world examples that you have seen before?
- What ideas do you have for a design?

Make a prototype

- What are the pros and cons of each of the materials available? (size, strength, flexibility, breaking points)
- Which flooring/connecting/column material will you select and why?
- Will you change the materials/design for each level of your structure?
- What part of your design are you finding tricky to build?

Test it out

- Tape the base of your structure to the shake table platform and slowly begin to shake the platform back and forward/side to side. Increase the magnitude of the simulated earthquake by applying more force and shaking the platform harder. For an added challenge add some test weights to firstly one, and then to all levels of your structure
- What did you observe during the testing stage? Did you structure survive or collapse?
- How did your structure respond to the varying levels of force being applied?
- How did the addition of weights affect the testing?
- What part of your design worked really well?

Improve your design

- How could you improve upon your original design?
- How could you strengthen any failure points identified?
- What ideas could you incorporate from someone else's design? Talk to a friend or search online.
- If you started again, what would you do differently? What would you do the same? Create a record of your design to guide future projects.

Background Information

An Earthquake is the sudden shaking of the ground caused by the movement of seismic waves through the surface of the Earth. Most earthquakes occur at the point where tectonic plates meet. Tectonic plates are constantly moving and pushing against each other, slowly building up a massive amount of pressure. When this energy is released an earthquake results. This sudden movement can cause a lot of damage to buildings, infrastructure (roads and bridges) and also pose a great threat to human safety. For this reason, structures in earthquake prone areas are designed to be earthquake-resistant and comply to stricter building codes. Whilst no structure can be guaranteed to be unaffected by an earthquake these structures will better withstand the largest earthquake probable at their location than their conventionally built counterparts. Strength and flexibility are key factors in the design and choice of materials for quake-resistant buildings. This enables structures to move and sway in response to ground shaking, therefore absorbing the energy of an earthquake.

Key Search Terms: Tectonic plates: Forces of Earthquake: Earthquake resistant