BrainStorm STEM EDUCATION

BEST IN STEM .ORG

STEM KIT

BUILD & LEARN
GUIDE

EARTHQUAKE ENGINEERING

SUSTAINABLE MATERIAL

NO GLUE OR MESS

SAFE AND EASY USE

STEMIO AUTHENTICATED

EARTHQUAKE ENGINEERING OVERVIEW:

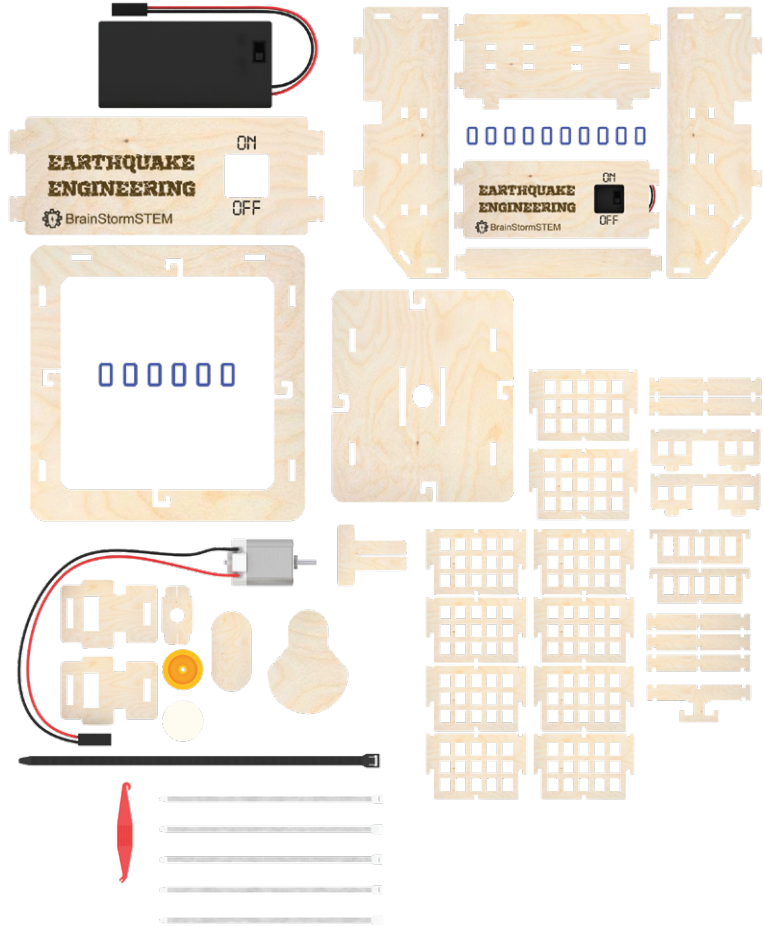
Today, you get to become an engineer! You'll build your very own earthquake simulator and test different building designs to see which ones can survive a big shake. As you work, you'll learn what earthquakes are, how we measure them, and how real engineers design buildings to stay standing during a quake. Everything you need is right inside your BrainStorm STEM Education Earthquake Engineering Kit!

⚠ SAFTEY WARNINGS:

Please read all safety warnings before use.

- Choking Hazard – This kit contains small parts. Not suitable for children under 6 years of age or any individual who may place non-food items in their mouth.
- Do not mix old and new batteries. Insert batteries with correct polarity.
- Eye Protection Required – Always wear protective eyewear while assembling or using this kit.
- Adult Supervision Required – An adult must be present during assembly and use.

PARTS

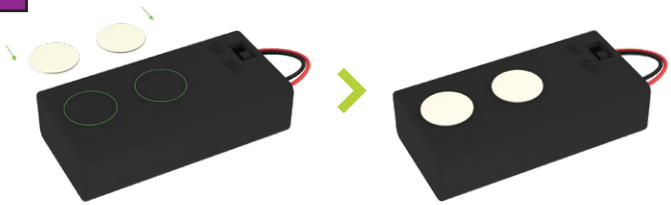


Disclaimer: Colors and parts may vary slightly from those shown in images or instructions, depending on available materials. All variations function the same and do not affect the performance or assembly of the kit.

1

NOTE: *If any wooden pieces are hard to remove, use a blunt tool to carefully punch them out, and ask an adult for help if needed. Use the sanding stick included in your kit (it looks like a small nail file) to smooth out any rough edges or spots where pieces don't fit together easily. Just find the tight spot and gently sand the edge until it fits just right.*

2



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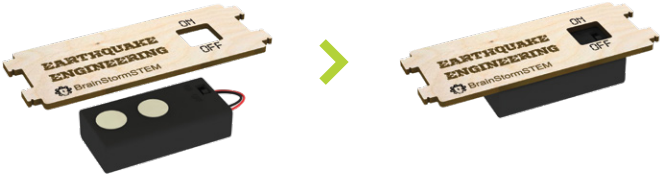

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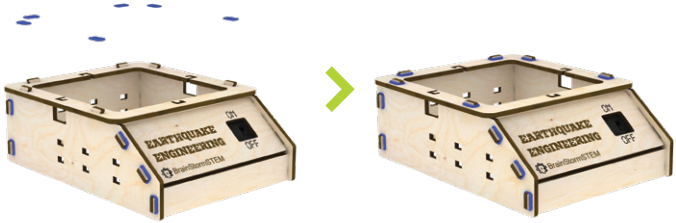
EARTHQUAKE
ENGINEERING
BrainStormSTEM
ON
OFF

5


EARTHQUAKE
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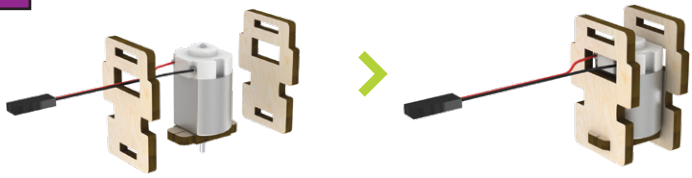
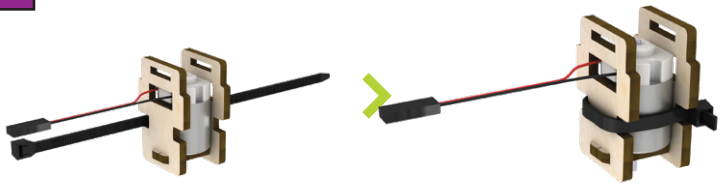


8

Use a zip tie to fasten the motor securely. Cut off the extra length.



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10

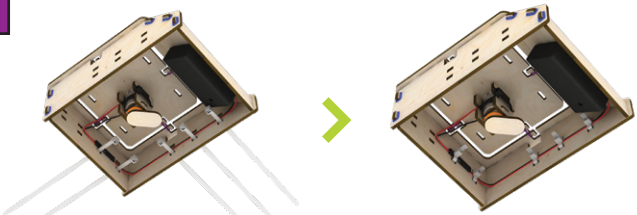
Note: Make sure to not push the pulley too far down the motor shaft. The pulley should still turn freely without rubbing on the wood motor mounts.

11

12

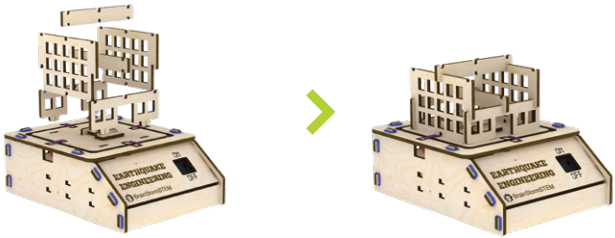
13

14

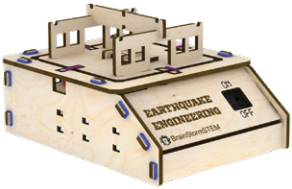


Note: Make sure that the motor and battery wires are secured to the side panels using the zip ties prior to operating. Ensure that the wire to the motor has some slack to avoid stressing the wire connection points when the motor vibrates.

15



HOW TO USE



HAVE FUN & BE SAFE

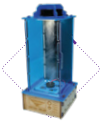
EXTENSION

Hang weights **Hang weights**

Use this piece to add weights to your building.

For example, place a metal washer onto the hooks. Get creative and use different objects and weights to observe how the different variables effect the stability of the building.

If you enjoyed this STEM Kit, check out some of our other Kits!



TORNADO

SEED SCIENCE

WIND TURBINE

AND MORE!

TERMINOLOGY

EARTHQUAKES

Earthquakes are tremors in the earth that is caused by movement in the crust or outer layer of the earth's surface.

TECTONIC PLATES

The 13 large pieces of Earth's crust which are composed of rock. Movement of these pieces, where they are rubbing against one another, is what causes earthquakes.

SEISMIC WAVES

When tectonic plates move, they create powerful vibrations. These vibrations are called seismic waves, or shock waves, and are what cause an earthquake.

SEISMOGRAPH

Device that measures the size and duration of earthquakes.

EPICENTER

The location directly above the hypocenter, on the Earth's surface.

HYPOCENTER OR FOCUS

The location below the Earth's surface where the earthquake starts.

FAULT LINE

A crack or break in the crust of the Earth near or along a plate boundary.

MAGNITUDE

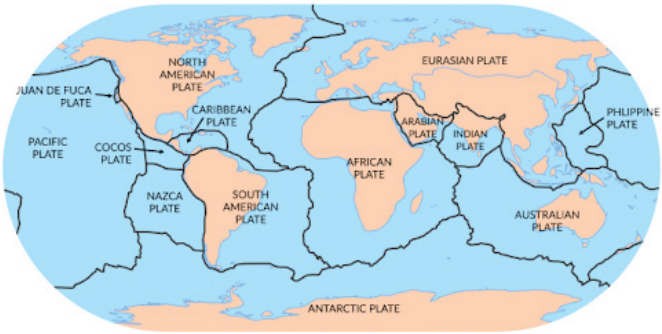
The size of the waves measured by a seismograph showing how much energy is released.

INTENSITY

How powerful the shaking of the earth is based upon the location from the epicenter of the earthquake.

TECTONIC PLATES

Tectonic Plates are the 13 large pieces of Earth's crust which are composed of rock. Movement of these pieces, where they are rubbing against one another, is what causes earthquakes. There are 7 major plates (African, Antarctic, Eurasian, Indo-Australian, North American, Pacific and South American) and 8 minor plates (Scotia, Nazca, Cocos, Caribbean, Juan de Fuca, Arabian, and Philippine).



The edges of the tectonic plates where they interact are called plate boundaries. Stress along the plate boundaries causes cracks in the surface of the earth. These cracks are called fault lines. The three types of fault lines are normal, reverse or strike-slip.

Normal Fault

Caused by pulling or stretching of each area away from one another.

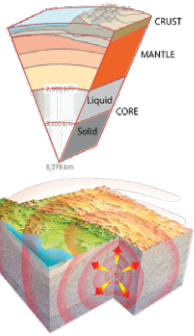
Reverse Fault

Caused by squeezing or pushing force between the two areas.

Strike - Slip Fault

Caused by a force applied along the surface of each area in the opposite direction.

EARTHQUAKE 101



Earthquakes are tremors in the earth that is caused by movement in the crust or outer layer of the earth's surface.

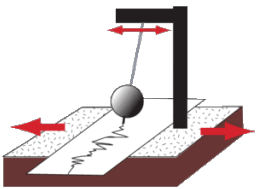
Every earthquake is broken down into 3 pieces: fault line, epicenter, and focus/hypocenter. The fault line is the pieces of land that are interacting with each other causing stress in the crust. The focus is the starting point of the earthquake in the crust of the earth. And the epicenter is the point on the surface of the earth that is directly above the focus.

Earthquake Fun Facts:

- The largest recorded earthquake in the United States occurred in Prince Williams Sound, Alaska, on March 28th, 1964. It was a magnitude 9.2 earthquake.
- It is estimated that there are 500,000 detectable earthquakes in the world each year. 100,000 of these can be felt, and 100 of these cause damage.
- Scientists that study earthquakes are called Research Seismologists. They are earth scientists, specializing in geophysics, who study how seismic waves move through geological materials.

How are Earthquakes measured?

Earthquakes are measured with a seismograph which uses a records the movement of the ground. The base of the seismograph sits on the ground and a pen is attached to a heavy weight suspended above it. When the earth shakes, the base moves underneath causing the pen to draw out the movement of the ground. This shows how much energy the earthquake released.



Earthquakes can either be measured by their magnitude or their intensity:

Magnitude **-** Energy released by earthquake

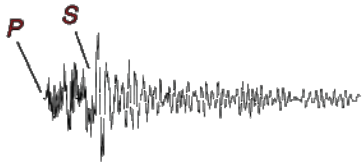
Intensity **-** measure of shaking in a location by the earthquake.

Because the intensity is based on the location from the epicenter of the earthquake, the more scientific way of measuring the earthquake is the magnitude.

EARTHQUAKE MEASUREMENTS

The powerful vibrations caused by movement of tectonic plates that cause an earthquake are called seismic waves. The type of seismic waves can be divided into two types.

- ***P waves*** - The primary seismic waves that travel through liquid, solids, and gases. P waves also travel faster than S waves, and are the first waves recorded by a seismograph.
- ***S waves*** - The secondary seismic waves that only travel through solids.



Moment Magnitude Scale (MMS) is the scale used by seismologists to tell the strength of an earthquake. The larger the number, the larger the earthquake. Unless an earthquake reaches at least a level 3 on the MMS, it likely won't be noticed.

	Magnitude	Effects of Earthquake
Micro	1.9 or less	Not felt; can be measured on seismograph
Minor	2.0 - 3.9	Might be felt; no damage.
Light	4.0 - 4.9	Often felt; only causes minor damage
Moderate	5.0 - 5.9	Slight damage to weak structures.
Strong	6.0 - 6.9	Damage in populated areas
Major	7.0 - 7.9	Serious damage
Great	8.0 or greater	Can completely destroy communities near epicenter.

EARTHQUAKE ARCHITECTURE

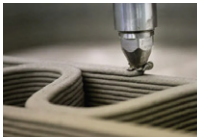
Earthquakes cause side-to-side motions that damage buildings. The vibration caused by these motion leads the top and bottom portions of the structure to become stressed, and ultimately break. The goal of designing structures to be "earthquake-proof" is to limit the damage done to these structures as well as to save as many lives and communities as possible.

Earthquake-Proof Building Techniques

Engineers can use a variety of techniques to shield buildings from damage in an earthquake. These techniques can include placing structures underground or in the foundation to absorb the vibrations before they can impact the building. Engineers also build with materials that are strong but can withstand bending to prevent damage. These materials include structural steel, wood, and in the future may even include 3D printed materials.

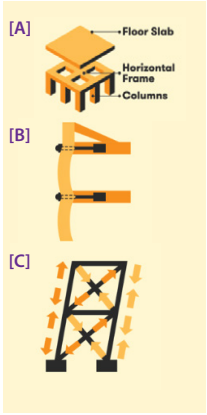
STRUCTURAL STEEL

WOOD



3D PRINTED

Buildings are often designed with special ways to redistribute the forces from earthquakes, and reinforce the frame to avoid collapse. These examples of reinforcing buildings will be useful in how the students use their earthquake STEM kit today! A few examples of building reinforcements include:



DIAPHRAGMS [A]

These horizontal frames keep tension from the floor and place the force on the vertical portions of the building.

MOMENT-RESISTING FRAMES [B]

These frames allow columns and beams to bend, while the joints remain rigid, allowing the building to resist forces from the earthquake.

SHEAR WALLS AND CROSS BRACES [C]

These walls are made from panels, supported by cross braces. These help to support compression and tension, keeping pressure off the building's foundation.

WORKSHEET (BEGINNER)

Name(s): _____

Date: _____

INSTRUCTIONS:

Once you have built your earthquake simulator, design a building that will best withstand an earthquake!

You will be performing 3 tests. For each test: build your building, draw it in the space below, and time how long it survives!

Test 1	Test 2	Test 3
How long did it last? _____	How long did it last? _____	How long did it last? _____

Circle the test number that lasted the longest.

Why do you think it lasted the longest?

_____

_____

STEM KIT

EARTHQUAKE ENGINEERING BUILD BOOKLET

For more information on our STEM Kits

Visit: www.brainstormedu.com

Have Questions? Contact us: info@BrainStormedu.com

BrainStorm STEM EDUCATION