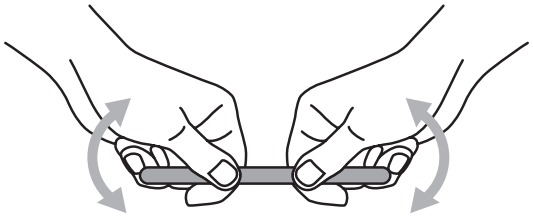
PROBLEM SOLVING OUT OF THE BAG

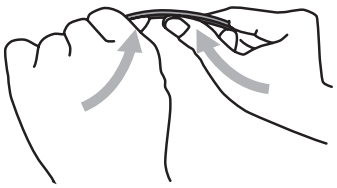
Background Information for Activity Leaders

Overview

Children will investigate how to use simple building materials to make structures that can withstand a simulated earthquake. This inquiry into building design will help children experience the importance of learning from unsuccessful models, as a way of achieving a successful design.



It is more difficult to break the craft stick along the narrow side.



Along the wide flat side the craft stick is easy to break.

Key Concepts

- Engineers use various simple concepts to choose their designs, and in this lesson the children will explore two of these concepts:

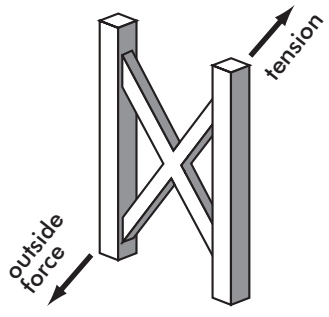
  1. **I-beams**
  I-beams are shaped like an "I" or an "H". I-beams help structures support the pressure of a lot of weight. The concept is illustrated with a craft stick. A craft stick is easy to break if you hold it along the wide flat side and then snap it, but it is very difficult to break if you hold it along the narrow side. The difference in force needed to break a craft stick depends on its shape and orientation Engineers depend on the shape and orientation of the I-beam to make buildings much stronger.

  2. **Cross-bracing**
  Cross-bracing refers to diagonal beams that form an "X" between levels of a building. Cross-bracing allows a structure to resist tension. Tension can be due to the weight of the building or can be the result of an outside force. Outside forces can include earthquakes and extreme weather conditions.

- **Tension** is a stretching force. For example, in a tug-of war contest the rope is in tension when the teams are pulling against each other. In cross-bracing when an outside force pulls in one direction, tension pulls back in the opposite direction. Earthquakes cause outside forces on buildings, sometimes making them sway. The tension provided by cross-bracing helps prevent the building from falling down.

- Detailed plans of buildings are called **blueprints**.

I-beams
As you can see in the picture, the wooden planks are placed so that the narrow side is facing up.



Cross-bracing

Background Information for Activity Leaders

What to Expect

- Some children will need to work with the materials a few times before they achieve a successful model.

- Some children will make a cube shape for each level, with one marshmallow at each corner. Other children will try a pyramid shape. If they begin with this shape as their initial level they will have difficulty going on to the next level, unless they plan to use the pyramid just for their top level and then work their way down.

- Some children will attempt to make a "solid" building. Remind them that the building must have room inside to accommodate living or working space.

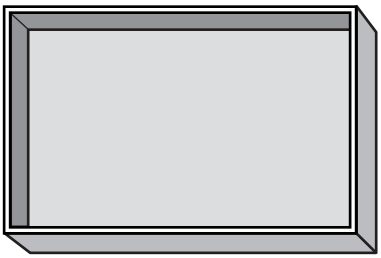
Common Misconceptions

- *Children may think, "Two-dimensional designs can stand on their own."*

  As children begin to build their initial structure, they will try to make a two-dimensional design. They will learn that it cannot stand on its own. The idea that they will need a three-dimensional structure develops after they have had the opportunity to try a few unsuccessful models and learn from their explorations.

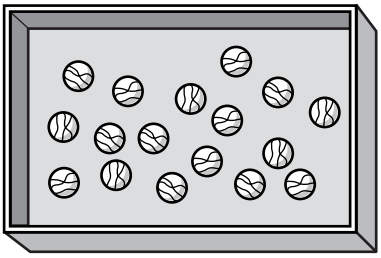
Earthquake Simulator Instructions

1. Use the lid of a box to create the base for the earthquake simulator.

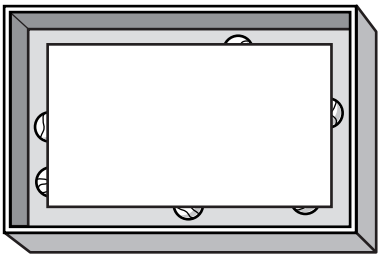


2. Cut a flat piece of cardboard 1 cm smaller on all sides so that it fits loosely inside the box lid.

3. Place about 20 marbles into the box lid.

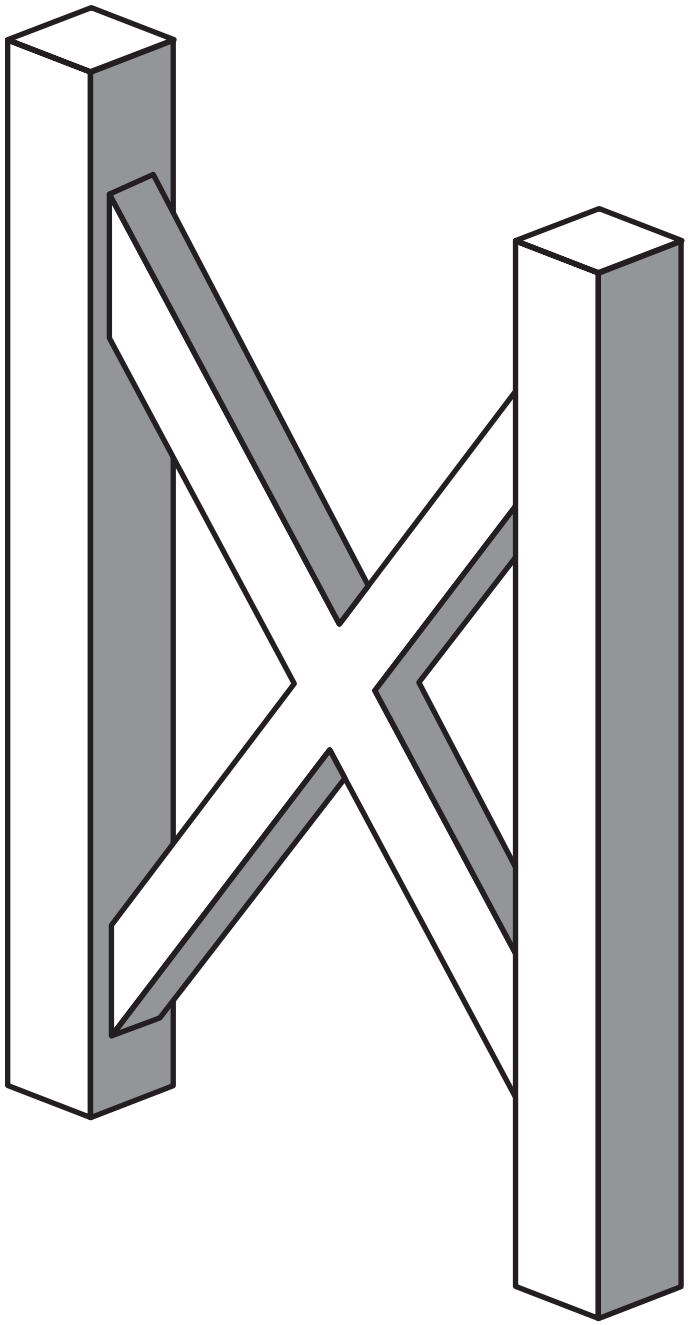


4. Place the flat sheet of cardboard on top of the marbles.

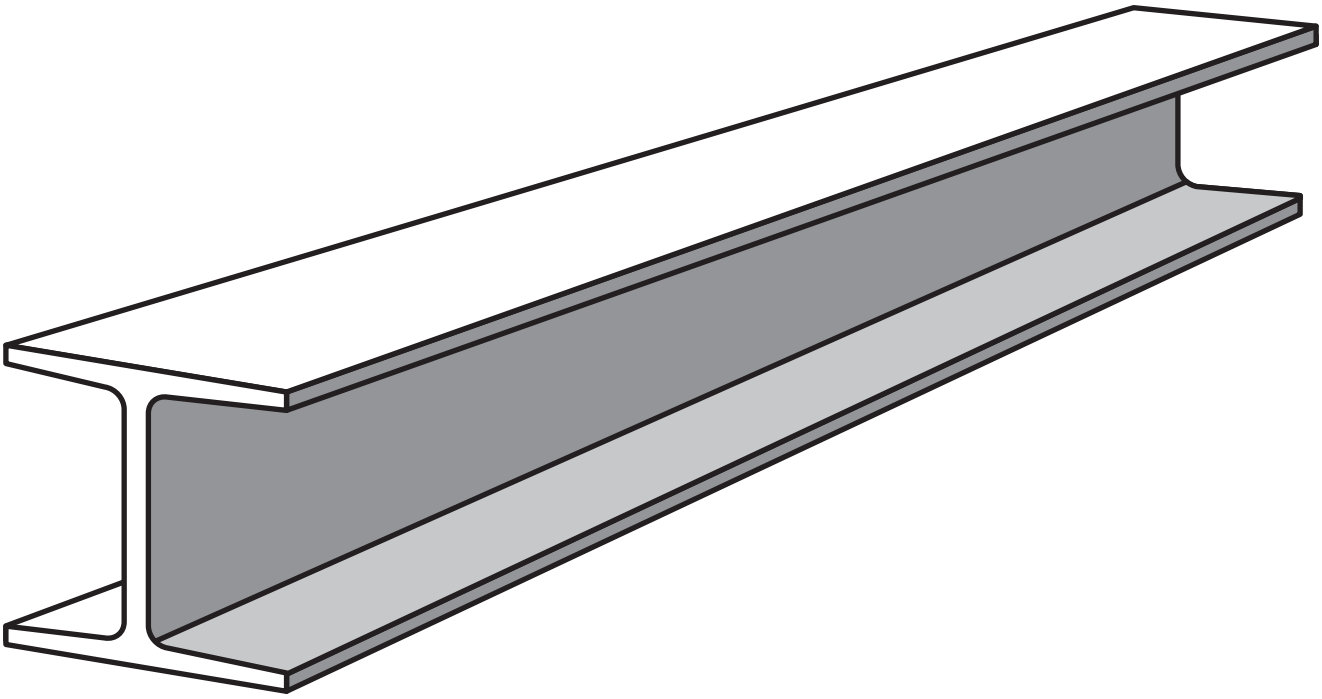


5. To operate the earthquake simulator, place the building on top of the flat sheet of cardboard and move the box lid back and forth. To increase the intensity, move the box lid back and forth more vigorously.

Cross Bracing Illustration



I-Beam Illustration



PROBLEM SOLVING OUT OF THE BAG

Data Collection Sheet

Name:_____ **Date:**_____

WONDER: How can you use marshmallows and coffee stirrers to make a sturdy structure? Draw your blueprint below—remember it must be at least three stories high.

side 1 side 2 top looking down

RECORD: Did your structure withstand an earthquake? What did you notice as you tried using different designs to make your building sturdy?

_____

_____

Draw your final structure:

CONCLUDE: What did you learn about designing sturdy buildings? How were you able to improve your building?

_____

_____

PROBLEM SOLVING OUT OF THE BAG

Activity Leader's Guide

Group Size: 4-6 children
Time: 30 minutes

Set Up the Expedition

Materials:

For the activity leader:
- ***Problem Solving Out of the Bag*** Learning Cards
- (1) cross-bracing illustration
- (1) I-beam illustration

For entire group:
- (1) earthquake simulator box (see the Trainer's Guide for specifications)

For each group:
- (1) bag of marbles (about 20 marbles)
- (12) large marshmallows
- (30) wooden coffee stirrers
- crayons

For each child:
- (1) ***Problem Solving Out of the Bag*** Data Collection Sheet
- (2) craft sticks
- drawing paper

Prepare the demonstration:
1. Assemble the earthquake simulator following the directions in the Trainer's Guide.
2. Place the earthquake simulator on a table that will serve as the testing station.
3. Pre-assemble a simple cube shape that demonstrates the use of I-beams and cross bracing. Instructions can be found in the Trainer's Guide.

Prepare the exploration:
1. Place a small bowl filled with 18 marshmallows at each station.
2. Place 30 wooden coffee stirrers at each station.

Engage

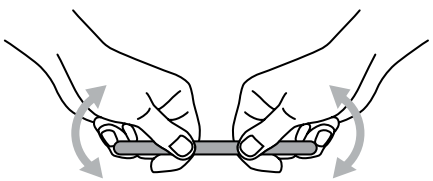
1 Gather the children together.

Ask:
"What kinds of natural events can damage a building?"
Hurricanes, tornadoes, floods, tsunamis, and earthquakes are some examples.

Say:
"Engineers are people who use what they know about science to solve real world problems. When engineers design buildings, they are required by building laws to make them safe and strong. Sturdy buildings can remain standing after a natural disaster, such as tornadoes and earthquakes."

2 Say:
"Let's explore two techniques that engineers use to make buildings sturdy."

1. Give each child two craft sticks.
2. Ask the children to break one craft stick by holding it along the flat, wide side.
3. Next, ask the children to break the other craft stick by holding it along the narrow side.



3 Ask:
"Which was harder to break?" Breaking the craft stick when holding it along the flat side is much easier than holding it along the narrow side.

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4 Say:
"Engineers take advantage of this principle by using I-beams to make buildings stronger."
Ask children to point out the picture representing I-beams.

5 Say:
"Engineers also use cross bracing to make a building stronger. Cross bracing can keep a building from swaying dangerously back and forth during an earthquake. Take a look at this picture. Why do you think they call it cross bracing?" Point to the picture representing cross-bracing.

Explore/Expand

6 If you are working with more than 4-6 children, divide the children into groups. Distribute the Data Collection Sheets and the Learning Cards.

Say:
"Follow the directions on the Learning Card to investigate what factors are important to consider when you design a building that can withstand an earthquake." Encourage children to experiment with their designs. Children should try using different methods to make the structure stronger.

7 Allow children enough time to complete the WONDER, EXPLORE, RECORD and EXPAND sections of their Learning Card.

Conclude

8 Gather the children together and ask the following questions:

"Why was it important to make the first floor very sturdy?" As buildings become taller, the bottom floor must be able to hold all of the weight above it.

"What ways did you find to make your structure sturdy?" I-beams and cross bracing can make structures sturdy. Allow the children to discuss other methods that they may have discovered.

"What changes did you make to your building design after you tested it in the earthquake simulator?" Encourage children to discuss how they improved their original design.

9 Say:
"Congratulations! You have earned your 'Ask Me About Design and Construction' stamp. You are ready to tell people about design and construction."

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PROBLEM SOLVING OUT OF THE BAG

Expedition Learning Card

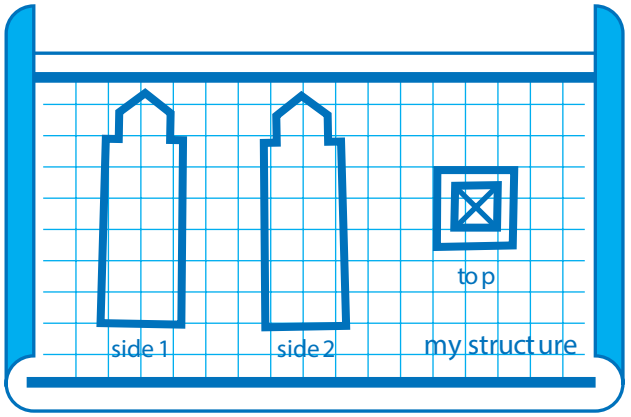
How can you build a sturdy structure?

I-beam cross-bracing engineer

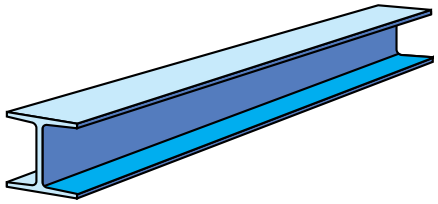
Explore ways to build a structure sturdy enough to survive an earthquake.

1 WONDER How can you use marshmallows and coffee stirrers to make a sturdy structure? It must be at least THREE STORIES HIGH!

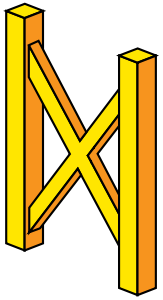
Draw your plan on your Data Collection Sheet. Detailed drawings of buildings are called blueprints.



2 EXPLORE Build the first story and make sure it is sturdy. Try using different methods to make your structure stronger before you add the remaining stories. It's OK to break the coffee stirrers if you need smaller pieces!



I-beam



cross-bracing

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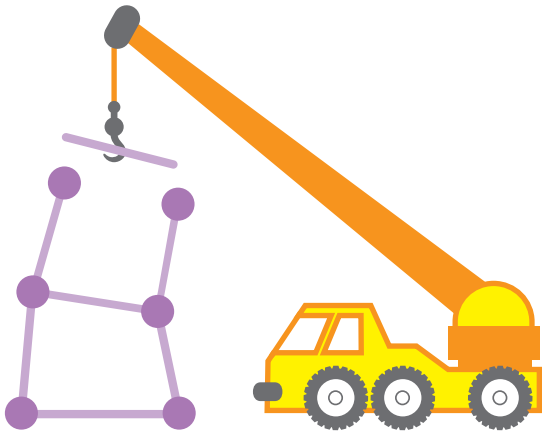
PROBLEM SOLVING OUT OF THE BAG

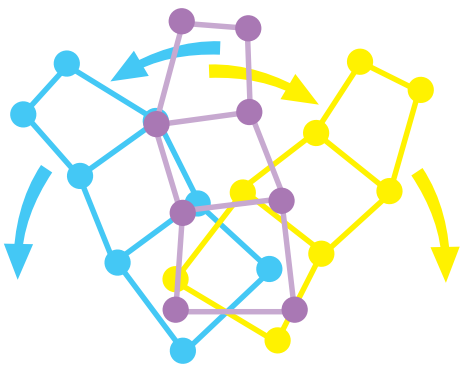
Expedition Learning Card

3 **TEST IT** on the earthquake simulator. Does your structure hold together during a simulated...

EARTHQUAKE?



4 **EXPAND** Try to improve your building design. Then try it out again in the earthquake simulator.



5 **RECORD**

Draw your final structure on your Data Collection Sheet.

6 **CONCLUDE** What did you learn about designing a sturdy building?

Draw or write about it on your Data Collection Sheet.

Discovery

Why did we do that?

- Different kinds of building techniques and materials can be used to make structures sturdy.
- I-beams and cross-bracing can add extra support to a tall building.
- Building techniques can be used to make buildings safer during an earthquake or storm.

Congratulations!

You have earned your "Ask Me About Design and Construction" stamp! Now you are ready to tell people about design and construction!

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