Earthquake Technologies

Home Connection

Dear Family,
During the last few days, the students designed models of buildings using earthquake-safety technologies. They acted just like engineers! They . . .

- identified and learned about a problem
- planned ways to solve the problem
- made and tested a model
- revised their design to make it better

In this challenge, students learned about earthquakes—what they are and where they can happen. They developed an understanding about engineering design and how engineers help keep people safe. They tested earthquake-safe technologies and adhered to a budget. They also practiced skills such as developing and using models, making claims based on evidence, and communicating technical information.

Let your child tell you about what his or her team did in this engineering effort and how the team used the model pieces and tools shown in the pictures. Prompt your child if he or she needs help.

- What was the problem you were solving?
- What were the criteria (goals or conditions) that your design had to meet?
- What constraints (limits) to costs and materials did you have to work with?
- How did you measure the success of your design?
- How did you improve your design? What information did you learn that led to your improvements?

On the back of this sheet, work with your child to extend his or her work in the challenge.

This STEM project has been developed in partnership with Texas A&M University.

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About Earthquakes

Earthquakes vary greatly in their severity. According to the United States Geological Survey (USGS), over 3,800 earthquakes occur each year in the United States. Most earthquakes are too weak to be felt. Yet, about 60 per year might cause damage. Ask your child about earthquakes.

- What is an earthquake?
- How does the energy of earthquakes move through the earth?
- What do scientists know about where earthquakes happen?
- Can scientists give warnings that an earthquake might occur like they do with tornadoes and hurricanes?

How is the severity of an earthquake measured? The USGS uses the Modified Mercalli (MM) Intensity Scale to measure the damage caused by an earthquake. The MM scale is a 12-level system based on how an earthquake affects the earth's surface. Review the chart with your child. Prompt your child to assign an MM value to the "earthquakes" produced in class.

I. Not felt.
II. Felt by people at rest or on upper floors.
III. Felt indoors—a vibration like the passing of light trucks.
IV. Vibration like the passing of heavy trucks.
V. Felt outdoors—small, unstable objects moved or upset
VI. Felt by everyone—furniture moved and weak plaster cracks
VII. Difficult to stand with damage to brick and concrete and chimneys.
VIII. Partial collapse of brick and concrete—frame houses move.
IX. Brick and concrete seriously damaged or destroyed.
X. Many buildings and bridges destroyed.
XI. Rails bent greatly and pipelines severely damaged.
XII. Damage nearly total.

Try It!

If you have access to the Internet, visit **earthquake.USGS.gov** to find out where earthquakes occurred recently. Then talk with your child about earthquake preparedness, even if you do not live in an earthquake-prone area. With your child, survey your home. How would your home fare if MM IV earthquake occurred? An MM VI? How could you make your home safer? Write a plan with your child.

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Compare Technologies

Name _____

Follow these steps.

1. **Record** the time it took the building with no technologies to stop moving.

   Test 1 _____ Test 2 _____

2. **Record** the time it took the building with each earthquake resistant technology to stop moving.

	Time for Building to Stop Moving (seconds)					
Technology Tested	**Team 1**	**Team 2**	**Team 3**	**Team 4**	**Team 5**	**Team 6**
Cross braces						
x-braces						
Mass damper (swinging along the shake table)						
Mass damper (swinging across the shake table)						
Building shape (extend one side)						
Building shape (extend both sides)						

3. **Draw conclusions** Rank the effectiveness of the technologies in reducing the effects of an earthquake's shaking. Write the most effective technology on line 1, below. Then list the others in order. Change the numbers if two or more technologies are equal in their effectiveness.

1. _____ 4. _____

2. _____ 5. _____

3. _____ 6. _____

Building Design Plan

Name _____

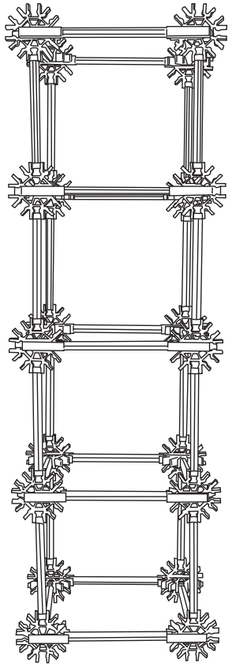
Follow these steps.

1. Think about the test results. How will you make Build Safe's apartment building more resistant to earthquakes?

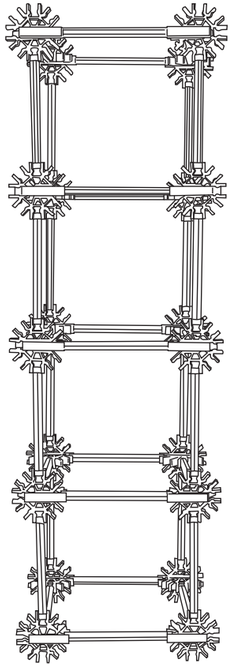
2. **Decide** Fill in the chart. You do not have to fill in all of the rows.

Technology in the building	Reason for choosing this technology

3. **Make a Model** Draw where you will put the technologies in your building.



Front



Back

Calculate Materials Costs

Name _____

4-story model	Piece	Number	Cost per piece	Total cost of pieces	Total cost of floor
First floor	Gray connector	8			
	Blue connector	8			
	Green rod	4			
	Yellow rod	8			
	Orange rod	4			
Each added floor	Gray connector	4			
	Blue connector	4			
	Yellow rod	4			
	Orange rod	4			

Technology	Piece	Number	Cost per piece	Total cost of pieces	Total cost of technology
Cross brace	Red rod	1			
x-brace	White connector	1			
	Blue rod	4			
Mass damper	Purple connector	2			
	Weight and string	1			
Widen first floor (1 side)	Gray connector	4			
	Blue connector	4			
	Green rod	2			
	Yellow rod	6			
	Orange rod	2			

Plan with Cost Constraint

Name _____

Follow these steps.

1. **Determine** how much of your budget will be spent on the building.

	Cost per floor	Number of floors	Total cost
First floor		1	
Added floors			
		Total cost of building	

2. **Subtract** to find out how much of your budget you have left for technologies.

Cost constraint: $ 3 2 5 , 0 0 0

Our total building cost: – $ ☐☐☐ , ☐☐☐

Available money for earthquake technology: $ ☐☐☐ , ☐☐☐

3. **Determine** what you are spending on the technologies.

Technology	Quantity	Cost per technology	Total cost
Cross-brace			
x-brace			
Mass damper			
Widen first floor			
		Total cost of all technologies	

4. **Compare** Fill in the amounts. Add >, < , or = to show how they compare.

$☐☐☐,☐☐☐ ◯ $☐☐☐,☐☐☐

Available money for earthquake technology — Total cost of all technologies

☐ We have enough money for our technologies. We are ready to build.

☐ We spent more than $325,000. We need to make changes.

Building Safety Test

Name _____

Follow these steps.

1. **Observe** other teams' testing. Mark which technologies each team used.
2. **Record** the time it took the building with technology to stop moving.

	Team					
Technology Used	**Team 1**	**Team 2**	**Team 3**	**Team 4**	**Team 5**	**Team 6**
Cross brace(s)						
X-brace(s)						
Mass damper (swinging along the shake table)						
Mass damper (swinging across the shake table)						
Building shape (extend one side)						
Building shape (extend both sides)						
Time for building to stop moving (seconds)						

3. **Analyze** Compare the results. Write <, >, or =.

_____ ◯ _____ ◯ _____

Team 1 — Team 2 — Team 3

_____ ◯ _____ ◯ _____

Team 4 — Team 5 — Team 6

4. **Explain** Which design do you think is safest? Explain. _____

_____

Reflect On It

Name _____

Use your plan, model, and test results to finish these sentences.

Building Plan

1. We chose: (circle) cross braces x-braces mass damper building shape
2. We chose these technologies because _____

_____

_____

_____

Model

3. Check the criteria your plan met.
   - ☐ Our building swayed for 8 seconds or less.
   - ☐ Our building included at least two different earthquake safe technologies
4. One part of our model that worked well was _____

   because _____

   _____
5. One part of our model that did not work well was _____

   because _____

   _____

Compare Models

6. We compared our model to Team _____. I observed that _____

   _____
7. The most successful model was made by Team _____. It was successful

   because _____

   _____