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Teacher's Guide

Plankton and Tube's

AMAZING SCIENCE ADVENTURES

PART 3: FORCES ACTING ON STRUCTURES

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Produced by
Mythic Productions

Video Synopsis:

Structures are all around us. Everywhere we go; everywhere we look. They come in all shapes and sizes. Some are made by people while others are natural. Structures provide us with shelter and protection. All structures have force acting on them. In this video, Professor Peter Plankton and Professor Tess Tube examine these forces. They specifically look at the impact of earthquakes and tornadoes. Footage from the recent earthquake and tsunami in Japan shows the devastating impact of these natural forces. Students will learn the difference between internal forces and external forces (live load vs dead load); the various types of forces including compression and tension; materials and their properties; and the environmental impact of these events.

Curriculum Connection:

Recommended for the elementary Physical Science curriculum. See provincial and territorial correlations on page 5.

Program Objectives:

Students will:

- understand that forces act on all structures
- examine internal and external forces
- examine forces such as compresssion and tension
- understand the difference between dead loads and live loads
- be able to describe the effects of forces on structures
- analyze the effects of natural phenomena such as earthquakes and tornadoes
- understand the effects of permafrost
- be able to identify structural features that increase the strength and stability of structures

Safety Notes

Emphasize the safety precautions you are taking before performing any of the experiments or demonstrations found in this teacher's guide or accompanying video and insist that students only attempt this demonstration under the strict supervision of an adult.

Before beginning any activity:

- Know what is expected
- Prepare a clear work environment
- Wait for permission to start

Safety Tips for you and your students:

1. Read the instructions twice before beginning the activity.

2. Explain the directions in your own words to your partner or team.

3. Get only the materials that are listed.

4. Wear safety goggles (protect eyes, face, hands and body)

5. Follow the instructions one step at a time.

6. If you make a mistake stop and ask for help.

7. Clean your area thoroughly.

8. Tie back all loose and long hair.

9. Don't wear jewelery while conducting eperiments.

10. Keep equipment safe and clean.

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Curriculum Correlations:

YUKON - Grade 5: Forces on Structures

NORTHWEST TERRITORIES - Grade 5: Forces Acing on Structures and Mechanisms

NUNAVUT - Grade 5: Forces on Structures

BRITISH COLUMBIA - Grade 5: Forces on Structures

ALBERTA - Grade 7: Structures and Forces

SASKATCHEWAN - Grade 5: Physical Science: Forces; Physical Science: Weather

MANITOBA - Grade 7: Forces and Structures

ONTARIO - Grade 5: Forces Acing on Structures and Mechanisms

QUEBEC - Cycle 3- Materials World: Forces adn Motion

PRINCE EDWARD ISLAND - Grade 5: Forces and Their Effects

NOVA SCOTIA - Grade 5: Forces and Their Effects

NEW BRUSWICK - Grade 5: Forces and Their Effects

NEWFOUNDLAND - Grade 5: Forces and Their Effects

Using the DVD: Forces Acting on Structures

Preview the video *Forces Acting on Structures* and select activities from this guide that will be most effective for you students. Note that the video is divided into chapters, allowing you easy access to specific points in the program as well as allowing you to use short clips to reinforce specific concepts.

Introduction and Concept Development: Discussion

- Discuss with the students:
- What are some structures inside your classroom?
- What forces might change their position or shape? (push, pull, load "if an elephant sat on your desk…"
- What structures made by humans are found on your school property? (school building, flagpole, playground equipment, etc.)
- Are there any natural structures? (birds' nests, trees, etc.)
- What forces might change their position or shape? (Wind, ice, earth tremor, vandalism, etc.
- What makes these structures strong and stable (identify materials, design and construction factors)

Vocabulary

Hand out a list of the vocabulary (terms only) found on page 7 of this guide.

- Ask students to place a check mark on words that they think they understand, and ask for volunteers to define these word for the class. Compare impression of what the words mean.
- Place a question mark in front of the words that are unknown.

Preparing to view the video program:

"Today we are going to watch a video called Forces acting on Structures. If you were going to make a video about this topic, what kind of images or footage would you plan to include?"

During Viewing:

Ask students to circle the unknown words and raise their hands when they occur in the video. Pause the video after each chapter to review the words they have heard. Replay the chapter if the meaning is still not clear.

Post Viewing Discussion:

Review the list of words identified in the introduction as words that the students already understood. Ask for volunteers to recall information they learned in the video that added to their previous understanding of these words.

Review the list of words students did not understand before viewing the video. Ask for volunteers to define these words now that they have viewed the video.

Extended learning activities:

Assign follow-up activities from this guide to expand the comprehension of the concepts presented in the video. These activities provide a way of relating the concepts to everyday life.

VOCABULARY LIST

Bending forces - a combination of tension and compression forces.

Compression - a pushing force

Deformation - the change of shape that occurs after an external or internal force has been applied on a structure.

Dead Load (Static Load) - is a permanent force acting on a structure. eg. gravity

Dynamic (Live Load) - changing or non-permanent forces acting on a structure. This includes things like wind, water, vehicles or people. Dynamic forces are hard to predict.

Earthquake - a vibration or motion in the earth's crust that results from a release of built up energy within the Earth.

External Force -forces that act on a structure from the outside. eg., wind

Force - a PUSH or PULL that tends to cause an object to change its movement or shape

Foundation - a base which supports and secures a structure

Fujita Scale - used to rate the severity of tornadoes as a measure of the damage they cause. This scale ranks tornadoes from an F0 to a F5 event.

Gravity - the natural force of attraction between two bodies. The gravitational pull of the earth draws all objects towards the centre of the planet.

Internal Force - forces that act on a structure from the inside.

Live Load (Dynamic Load) - is a changing or non-permanent force that acts on a structure. eg., snow on a roof

Load - an external force on a structure. There are two types: dead loads and live loads.

Natural Occurrence - an event caused by nature, not by humans.

Permafrost - the layer of soil or rock in arctic regions that remains frozen throughout the year.

Richter Scale - a range of numbers used to measure the force or total energy of an earthquake.

Shear - a force that bends or tears a matyerial by pushing parts of it in different directions.

Static Load (Dead Load) - a permanent force acting on a structure. It is the weight of the structure itself and also includes anything permanently attached to the structure like columns, beams, nuts and bolts.

Structure - something that will support an object or load.

VOCABULARY LIST

Tension - the force produced by pulling a material.

Torsion - the twisting of a material by turning it in opposite directions.

Tornado - a rotating funnel cloud whirling at extremely high speeds, dropping down to the earth during a storm. It can uproot trees and lift buildings.

Tsunami - a series of waves, made in an ocean or other body of water by an earthquake, landslide, volcanic eruption, or meteorite impact. Tsunamis can cause huge destruction when they hit coastlines.

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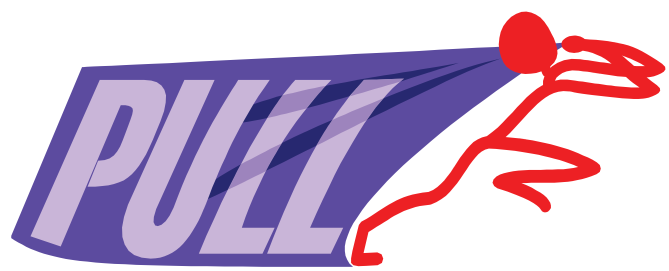
Types of Forces



Type of Forces

Teacher Information: In this section, students are going to examine ways in which different forces can affect the stability of a structure (e.g., certain forces may cause a structure to shear, twist, or buckle).

Forces:

- Structures must be designed to resist forces acting on them
- A force is anything that can cause a change in an object

Engineers and designers divide the forces that act on structures into two types: External Forces and Internal Forces:

Internal Forces:

- External forces create internal forces within a structure
- There are four basic types of internal forces: tension, compression, shear and torsion.
  - Compression
  - Tension
  - Shear
  - Torsion

Compression is a pushing force that compacts or squeezes a material together

Tension is a pulling force that pulls material apart

Shear is a force that bends or tears a material by pushing parts of the material in opposite directions

Torsion is a force that acts on a material by twisting its ends in opposite directions

Bending is a combination of tension forces and compression forces that result in a structure temporarily curving e.g. a bow used to shoot an arrow

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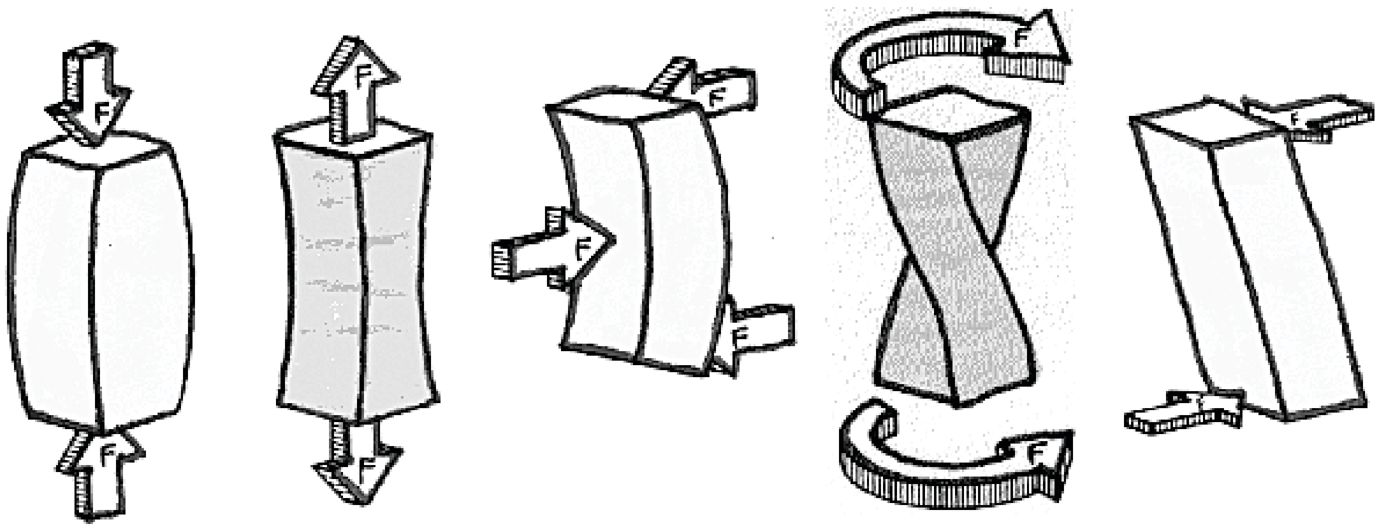
Internal Forces - Activity #1 (a)

Forces that act between two different parts of a structure are called internal forces. There are different types of internal forces. See diagrams below.



Compression **Tension** **Bending** **Torsion** **Shear**

Materials: sponges

Activity:
1 a) Use the flat of your hand to press down firmly on the sponge. Identify the type of force acting within the sponge.
b) Grasp each end of the sponge and pull firmly in opposite directions. Identify the type of force acting within the sponge.
c) Grasp each end of the sponge and push the two ends together. Identify the type of force acting within the sponge.
d) Hold one end of the sponge and twist the other end one complete turn. Identify the type of force acting within the sponge.
e) Use a pair of scissors to cut the sponge into two pieces. Identify the type of force acting within the sponge.

2. In question 1, you carried out different actions on a sponge and you identified the internal force caused by each action. Now you will be describing the changes in the sponge caused by each action.

Follow the instructions on the Internal Forces Chart - Activity #1 (b) found on page 12.

Internal Forces - Activity #1 (b)

Every building or structure that made is subject to forces that are destructive to it. It's important for designers and builders to be very familiar with those forces in order to make structures that can withstand those forces for many years.

Action carried out on the sponge	Scientific Name	Explain what happened
Squeezing		
Stretching		
Bending		
Sliding		
Twisting		

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External Forces

Teacher Information: External forces are another type of force that acts on structures. Gravity is one such force, acting on all things all the time. External forces produce internal forces, or stresses, within the materials from which the structure is made. These internal stresses can change the shape or size of a structure and is called deformation.

External Forces:
They include such things as:

- The weight of the structure itself
- Wind blowing
- Snow load
- The weight of objects or people on or within the structure
- Structures are generally designed to withstand external forces two or three times larger than normal e.g., The CN Tower is designed to withstand wind speeds of up to 418 km/hr

Theses forces are called Loads. There are two types:

- Live Load
- Dead Load

Load is another word for weight.

A ***dead load*** is a permanent force, acting on a structure. This includes the weight of the structure itself and its non-moving parts like columns, beams, nuts and bolts.

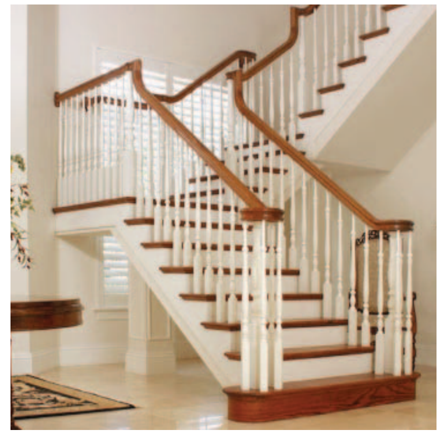
A ***live load*** is a changing, or non-permanent force acting on a structure. This includes things like the force of the wind and the weight of things that are in, or on a structure. This can include people, furniture, cars driving on a bridge, or a person sitting on a chair. Over time, live load can cause the structure to sag, tilt, or pull apart.

All structures must be built to bear loads otherwise they would fall part.

An example is a bicycle. The weight of the bicycle's wheels, frame, gears, cables, seats, and handlebars, are called the dead load (this weight never changes). The rider sitting on the bicycle is the live load (this weight varies depending on the live load). Sometimes there is no live load.

External Forces - Activity #1

Look at the diagram below and in the space provided, write in whether it is an example of a live load or a dead load.



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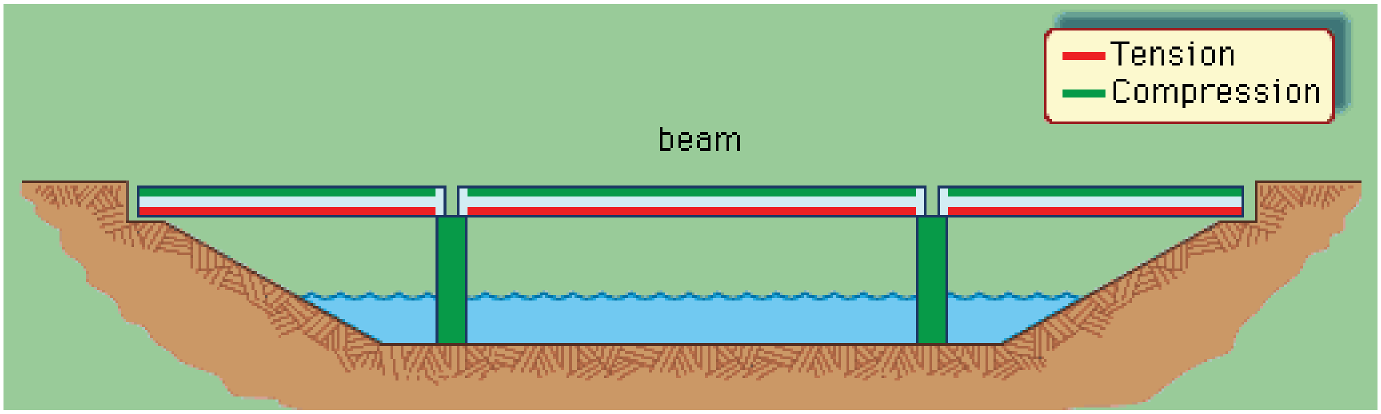
Bridges and Loads

Bridges and Loads

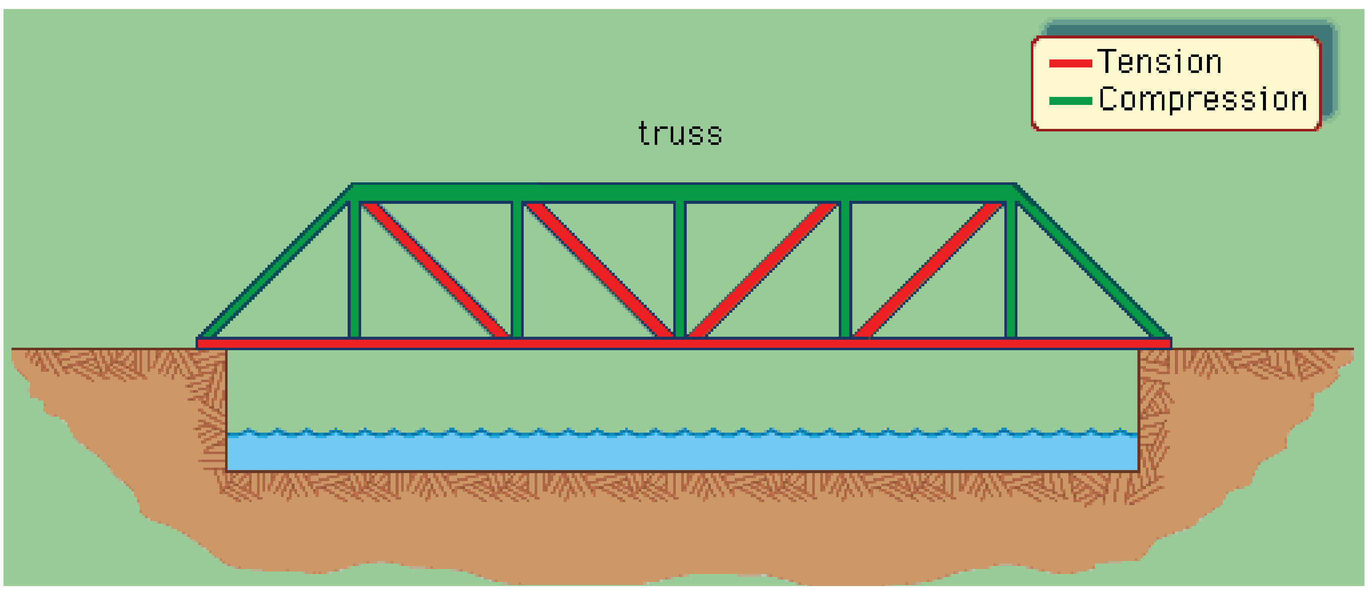
Teacher Information: Bridge construction has always presented engineers with their greatest challenges. Different bridges are built for different purposes.

Type of Bridge:

Beam Bridge - most common bridge and simplest type of bridge used; flat beam supported at each end



Truss Bridge - lightweight, but strong bridge made of trusses; (triangle-shaped frames) along its sides



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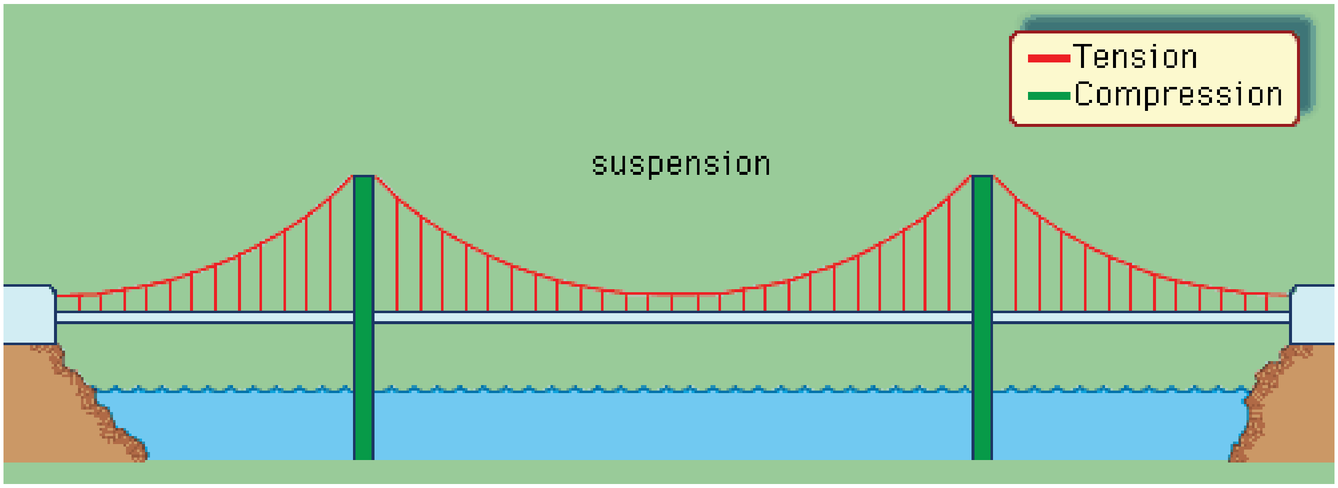
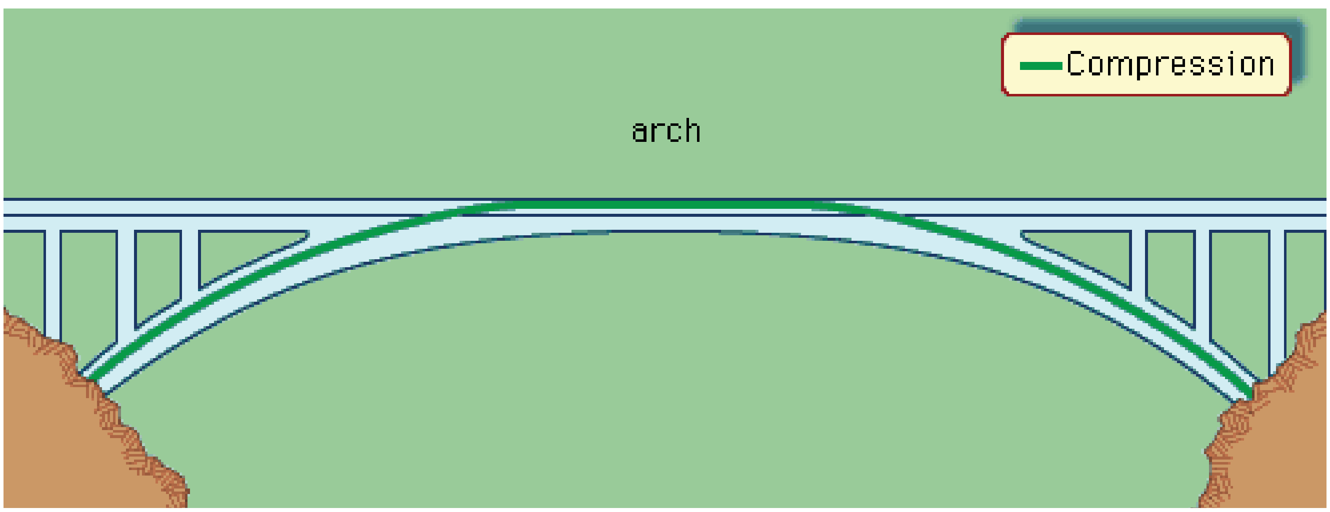
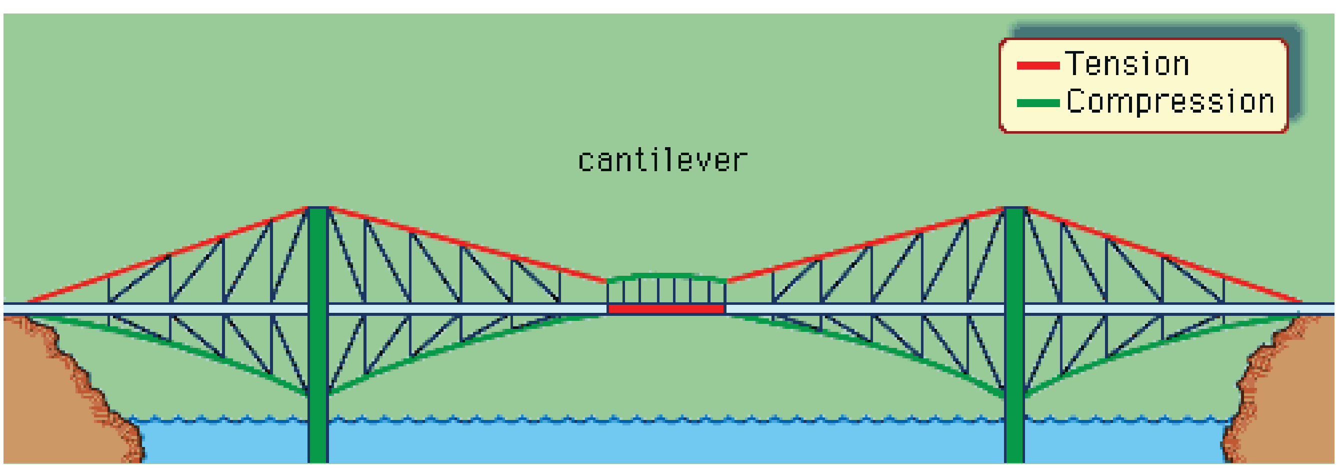
Suspension Bridge: hangs between two ends (towers) that hold it up; smaller cables attach the roadway to the hanging cables



Arch Bridge: is designed to withstand heavy loads; Roman aqueducts are good examples of this type of bridge



Cantilever Bridge: supported by a cantilever - a bean that is kept in balance by a counterweight



Bridges and Loads: Suspension Bridges

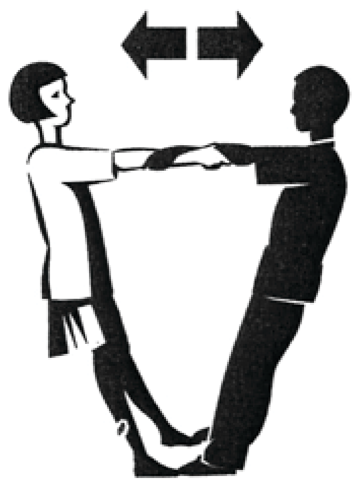
Using the internet, have students find examples (Canadian if possible) of the various types of bridges. Discuss how bridges are designed to support a load or weight.

Loads can be classified as live or dead. Dead loads are the weight of a bridge itself. Live loads are the people, equipment or other things that can be removed, changed or added to the bridge. Live loads can also be from wind, earthquakes, or other moving loads. A bridge has to support its own weight, the dead load, in addition to cars, people, etc. Loads applied to a bridge result in tension or compression in the components of the bridge.

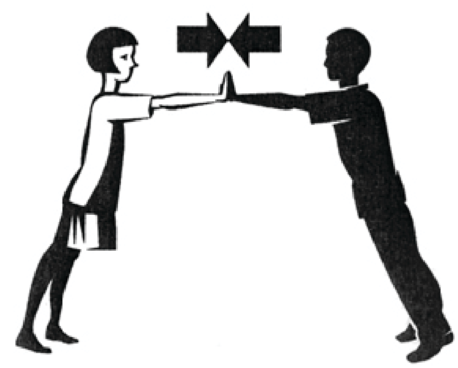
Loads can put objects in tension or compression. If you stand with your arms hanging at your side, are they in compression or tension? Why?

Have students determine what "loads" are applied to bridges. Write their answers on the blackboard. Be sure to discuss both natural and man-made forces.

Using the diagrams on pages 16 and 17, explain to students how and which components are in tension or compression when a load is applied. **Compression** is a pushing force that compacts or squeezes a material together. **Tension** is a pulling force that pulls material apart.



Demonstrate the forces of tension and compression. Ask students to select a partner, and stand facing each other. To demonstrate tension, have each team member grasp the other's forearms. Both students lean back. Their arms should stretch out between them. Go around to several pairs and lean gently on top of their arms to test their "structure". Explain that when you lean on them you are pushing down and causing their arms to stretch, or be put into tension. Have the students remain standing.

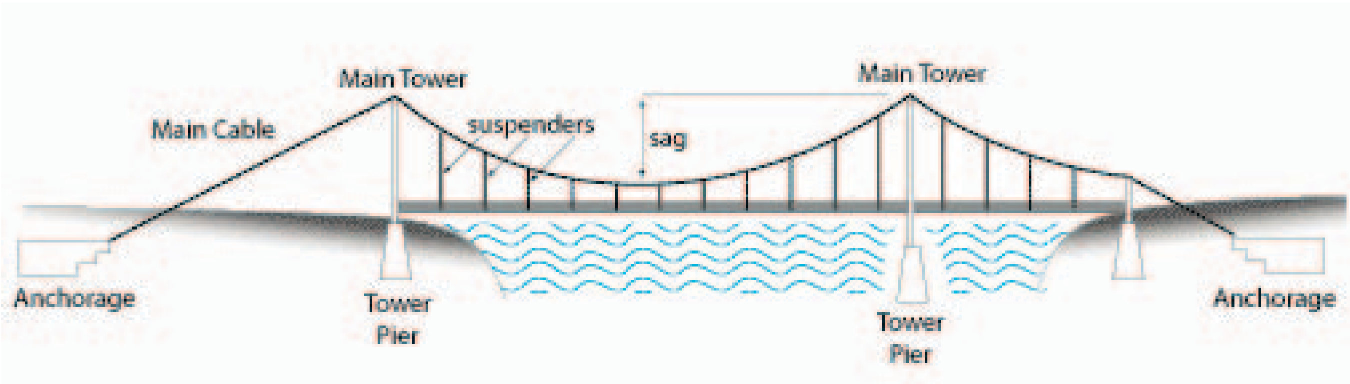


To demonstrate compression, have partners press the palms of their hands together and lean toward one another. The students will be making an arch with their bodies. Go around to each pair and push on top of the arches. Explain that when you are pushing down you are causing them to push together, or to be put into compression. If time permits, ask students to look for elements under tension and compression in their classroom.

Construction

Suspension bridges can span distances far longer than any other kind of bridge, as much as almost 2000 metres - that's almost 2 kilometres ! And perhaps they'll be even longer in the future. Suspension bridges, however, are the most expensive bridges to build.

The Akashi-Kaikyo Bridge, also known as the Pearl Bridge, has the longest central span of any suspension bridge, at 1,991 metres (6,532 ft). It is located in Japan and was completed in 1998. The bridge links the city of Kobe on the mainland of Honshū to Iwaya on Awaji Island by crossing the busy Akashi Strait. It carries part of the Honshū-Shikoku Highway. The bridge was designed with a two-hinged stiffening girder system, allowing the structure to withstand winds of 286 kilometres per hour, earthquakes measuring to 8.5 on the Richter scale, and harsh sea currents.

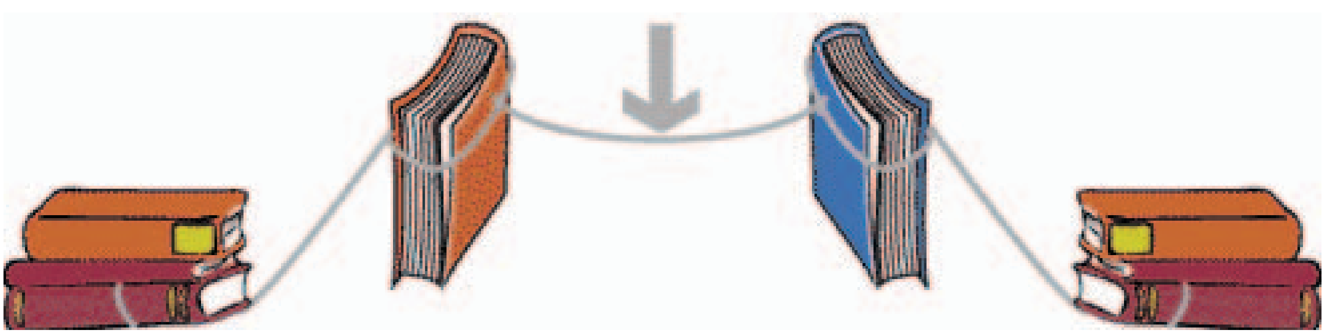


A suspension bridge “suspends” the roadway from its huge main cables, which extend from one end of the bridge to the other. These cables rest on top of high towers and are secured at each end by anchorages. The towers enable the main cables to be draped over long distances. The cables, which are embedded in either solid rock or massive concrete blocks, carry most of the weight of the bridge. Inside the anchorages, the cables are spread over a large area to evenly distribute the load and to prevent the cables from breaking free.

We are going to try an experiment to show how the anchorages help support the bridge. We need some books and some string. I will tie two loops of string around the tops of these two big books, which will act as our towers. Then I will tie a third piece of string to each loop so that it hangs between the books—like the main cable. Tie the strings as you explain or have the teacher or another student tie them.

Q: What do you think will happen if I press down on the center string?
A: The books tilt toward each other and fall.

Now if I put a heavy stack of books on each end of the trailing strings to act as anchors, notice what happens when I press on the center string. The anchors keep the towers and the cable stable.



Q: If I press down harder on the center string—some suspension bridges have to carry thousands and thousands of cars and trucks and buses all at once—what happens?

A: The books tilt toward each other.
Q: What do I need to do to keep the "towers" from falling?
A: Help the students discover they need more or heavier books—stronger anchorages.

The Challenge:
Your challenge is to create a human suspension bridge using ropes, a board and the members of your group as parts of the bridge. As you position yourselves to be part of the bridge, think about the loads that are acting on you. Do you feel compression or tension?

After you create the bridge and have the chance to feel the effects of the forces that act on it, you will be asked to determine whether some other common objects are in tension or compression.

Materials:
3 to 4 metre pieces of sturdy rope (2 per group), 1 piece of stiff cardboard per group, books to serve as weights, worksheets, markers

Procedure:
1. Divide students into five-person groups to construct their bridges.
2. Two students are the towers, standing tall with a rope draping over each shoulder. The rope will just sag and fall to the floor without something to pull it tight at each end, namely anchors.
3. Have a student on each end be an anchor, holding tight to the rope. The "anchors" may want to sit on the floor.
4. The remaining student in the group places the stiff piece of cardboard on the ropes in the middle of the span and carefully stacks books onto the board until the human bridge members feel the forces acting on their bodies. Keep the cardboard about 1 meter from the floor.
5. Then students trade positions and do the exercise again.
6. Prompt the students to consider each part of the bridge and identify whether it is in tension or compression. Do they feel pushed or pulled?
7. As a result of this exercise, students should be able to define "load" and distinguish between dead and live loads. They should also understand how a suspension bridge works, how loads are transmitted through the bridge, and be able to identify the parts of the bridge that experience tension and those that experience compression.

Variations & Follow-Up:
1. Weigh the number of books held by each "human suspension bridge." How much load can the bridge hold (before the students just can't stand or pull any longer)?
2. Does the size of the students forming the bridge have anything to do with how much load it can take? What can you change to make the bridge stronger?
3. Load the arms of one student with maximum number of books he/she can hold.
4. What is the ratio of the load carried to the weight of the student? How much more weight can the human bridge carry compared to a single student?

Natural Occurrences vs. Man-made

Emergency Preparedness

Natural Occurrences vs. Human Activity
Emergency Preparedness

Teacher Information: Have students watch the video "Forces Acting on Structures". Upon completion, discuss with students the difference between the built environment (buildings, bridges, roads – built by people) and natural environment (trees, landscape, land cover – occurring in nature) with students.

Students will have seen the damge caused by various natural occurrences in the video. Another good reference tool is the video "Geology of the Japan Earthquake" availble from McIntyre Media Inc. Either pause the video at various points or show students a picture of the damage caused by an earthquake (bridge and building collapse) and ask students if they know what type of natural disaster caused this damage. When the students know it was caused by an earthquake, ask them what other damage an earthquake can cause to the built environment. The answers should be recorded on the board under a heading of "Earthquakes – Built Environment".

Possible Answers: cracks in foundation/walls, collapsed buildings, broken windows, cracked/raised/sunken roadways, chimneys fallen off, fires due to cracked gas lines, power/telephone lines down etc.

Again either pause the video or show the students a picture of the damage caused by an earthquake (crack in earth) and ask students if they know what type of natural disaster caused this damage. When the students know it was also caused by an earthquake, ask them what other damage an earthquake can cause to the natural environment. The answers should be recorded on the board under a heading of "Earthquakes – Natural Environment".

Answers: trees down, a change in height of ground, pieces of the ground disappearing, ground not lining up with what it lined up with previously etc.

Ask the students how they knew what an earthquake could do to the natural and built environments, even if they have never been in an earthquake. The students should realize that they have an understanding of what an earthquake is and what it can do from various sources (news stories, movies, their own reading, from stories of friends/relative that have experienced an earthquake). Students should understand that they are able to confirm their understanding of what happens to the built and natural environments during an earthquake by researching the information in book, recognized information materials and/or the Internet.

Provide students with information about where to get reliable information about natural disasters (in this case earthquakes) on the Internet:

www.getprepared.ca
www. getprepared.ca/_fl/earthquakes-what-to-do-eng.pdf
www.earthquakescanada.nrcan.gc.ca/info-gen/prepare-preparer/index-eng.php

Discuss how to evaluate the reliability of internet information sites. Enter the keyword "earthquakes" into an internet search box, and look at the list of results. Ask students to pick what they think will be a reliable site for information, using the URL address as a clue. Ask them to explain the reasons for their choice.

Explain that the best way to avoid injury and sometimes reduce the damage to property is to know about the types of natural disasters that can happen in the community where you live and to prepare for them. Hand out a copy of the Earthquake information sheet and review it with the class very briefly. Point out to students that the information sheet describes what an earthquake is, provides information about the damage/danger that an earthquake can cause and provides information about how to stay safe in an earthquake.

Ask the students the following "quick-check" questions:

1. What is a "built" environment and what is a "natural" environment?
2. How can we analyse the impact of an earthquake on the built and natural environment
3. Where can we go to find out more about natural disasters?
4. Why is it important to know about the natural disasters that can happen in your community?

Tell students that tornadoes, floods and ice storms are a natural disaster that can happen in Canada. Students are to work in groups of three or four and design a poster for students in grade 5 and higher that explains:

1. What a tornado, flood or ice storm is.
2. What kind of damage these natural occurrences can do to the built and natural environment.
3. What you should do to stay safe in the event of one of these occurring in your community.

Students can use the pictures on page 24 to get them thinking about how an ice storm/flood or tornado impacts the built (eg., photo of buildings damaged by tornado) and natural (eg., photo of tree with car wrapped around trunk) environments. Also, you can photocopy the fact sheets on pages 25 to 27 and hand these out to students. Students should be told how the poster will be evaluated.

Students can use markers, pencil crayons and photos/phrases from old magazines on their posters. Students can decide how much information to put in text form and how much in picture form. Students will be given 60 minutes of class time to research their information and complete the poster. Encourage students to plan out how the group members will spend their time and to divide tasks where possible. Students will present their findings to the entire class.

Discuss the most recent occurrence of earth tremors in or nearest your community. What did people think, at first, that they were feeling? (a big truck going by, a distant explosion, etc.) Was there any structural damage? Were pictures on the wall crooked after the tremor, or did chandeliers jingle?

Ice Storm

Flood

Tornado

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TORNADO FACT SHEET

Tornadoes are relatively common in Canada, but only in specific regions: southern Alberta; Manitoba and Saskatchewan; southern Ontario; southern Quebec; the interior of British Columbia; and western New Brunswick. Tornado season extends from April to September with peak months in June and July, but they can occur at any time of year.

Tornado facts

- Canada gets more tornadoes than any other country with the exception of the United States.
- Tornadoes are rotating columns of high winds.
- Sometimes they move quickly (up to 70 km/hour) and leave a long, wide path of destruction. At other times the tornado is small, touching down here and there.
- Large or small, they can uproot trees, flip cars and demolish houses.
- Tornadoes usually hit in the afternoon and early evening, but they have been known to strike at night too.

Warning signs of a potential tornado include:

- Severe thunderstorms, with frequent thunder and lightning
- An extremely dark sky, sometimes highlighted by green or yellow clouds
- A rumbling sound or a whistling sound.
- A funnel cloud at the rear base of a thundercloud, often behind a curtain of heavy rain or hail.

Canada's tornado warning system

Environment Canada is responsible for warning the public when conditions exist that may produce tornadoes. It does this through radio, television, newspapers, its internet site, as well as through its weather phone lines. If you live in one of Canada's high-risk areas, you should listen to your radio during severe thunderstorms.

If you hear that a tornado warning has been issued for your area, find shelter and follow these instructions.

Canada's first recorded F5 tornado rages through Elie, Manitoba

What to do during a tornado

If you are in a house:

- Go to the basement or take shelter in a small interior ground floor room such as a bathroom, closet or hallway.
- If you have no basement, protect yourself by taking shelter under a heavy table or desk.
- In all cases, stay away from windows, outside walls and doors.

If you live on a farm:

- Livestock hear and sense impending tornadoes. If your family or home is at risk, the livestock will be a non-issue. If your personal safety is not an issue, you may only have time to open routes of escape for your livestock. Open the gate, if you must, and then exit the area in a tangent direction away from the expected path of the twister.

If you are in an office or apartment building:

- Take shelter in an inner hallway or room, ideally in the basement or on the ground floor.
- Do not use the elevator.
- Stay away from windows.

If you are in a gymnasium, church or auditorium:

- Large buildings with wide-span roofs may collapse if a tornado hits.
- If possible, find shelter in another building.
- If you are in one of these buildings and cannot leave, take cover under a sturdy structure such as a table or desk.

Avoid cars and mobile homes:

- More than half of all deaths from tornadoes happen in mobile homes.
- Find shelter elsewhere, preferably in a building with a strong foundation.
- If no shelter is available, lie down in a ditch away from the car or mobile home. Beware of flooding from downpours and be prepared to move.

If you are driving:

- If you spot a tornado in the distance go to the nearest solid shelter.
- If the tornado is close, get out of your car and take cover in a low-lying area, such as a ditch.

In all cases:

- Get as close to the ground as possible, protect your head and watch for flying debris.
- Do not chase tornadoes – they are unpredictable and can change course abruptly.
- A tornado is deceptive. It may appear to be standing still but is, in fact, moving toward you.

FLOOD FACT SHEET

Floods are the most frequent natural hazard in Canada. They can occur at any time of the year and are most often caused by heavy rainfall, rapid melting of a thick snow pack, ice jams, or more rarely, the failure of a natural or man-made dam.

Flood facts

A heavy rainfall can result in flooding, particularly when the ground is still frozen or already saturated from previous storms. Flash flooding – in which warning time is extremely limited – can be caused by hurricanes, violent storms or dams breaking.

All Canadian rivers experience flooding at one time or another. The potential for flood damage is high where there is development on low-lying, flood-prone lands.

Preparing for a flood

To reduce the likelihood of flood damage:

- Put weather protection sealant around basement windows and the base of ground-level doors.
- Install the drainage for downspouts a sufficient distance from your residence to ensure that water moves away from the building.
- Consider installing a sump pump and zero reverse flow valves in basement floor drains.
- Do not store your important documents in the basement. Keep them at a higher level, protected from flood damage.
- If you have a livestock farm, remember that livestock have a natural “move away instinct” to flash flood waters. They generally seek higher ground if possible. When purchasing or designing your livestock operation, it is important to allow livestock a way to reach high ground in each pasture. Without access, livestock will fight fences and be at a greater risk of drowning. Livestock will initially panic during flash floods. This complicates livestock handling.

If a flood is forecast:

- Turn off basement furnaces and the outside gas valve.
- Take special precautions to safeguard electrical, natural gas or propane heating equipment.
- If there is enough time, consult your electricity or fuel supplier for instructions on how to proceed.
- In floods, in a rural farm setting, sheltering livestock may be the wrong thing to do. Leaving animals unsheltered is preferable because flood waters that inundate a barn could trap animals inside, causing them to drown.
- If evacuation of the animals is being considered, then evacuation procedures, places, and routes should be planned. Animal evacuation routes must not interfere with human evacuation routes. Alternate routes should be found in case the planned route is not accessible. Places where animals are to be taken should be decided in advance and arrangements made with the owners of these places to accept the animals.

If flooding is imminent:

- Move furniture, electrical appliances and other belongings to floors above ground level.
- Remove toxic substances such as pesticides and insecticides from the flood area to prevent pollution.
- Remove toilet bowls and plug basement sewer drains and toilet connections with a wooden stopper.
- Disconnect eavestroughs if they are connected to the house sewer.
- In some cases, homes may be protected with sandbags or polyethylene barriers. This approach requires specific instructions from your local emergency officials.
- Do NOT attempt to shut off electricity if any water is present. Water and live electrical wires can be lethal. Leave your home immediately and do not return until authorities indicate it is safe to do so.

During a flood:

- Keep your radio on to find out what areas are affected, what roads are safe, where to go and what to do if the local emergency team asks you to leave your home.
- Keep your emergency kit close at hand,

If you need to evacuate:

- Vacate your home when you are advised to do so by local emergency authorities. Ignoring such a warning could jeopardize the safety of your family or those who might eventually have to come to your rescue.
- Take your emergency kit with you.
- Follow the routes specified by officials. Don’t take shortcuts. They could lead you to a blocked or dangerous area.
- Make arrangements for pets.
- Time permitting, leave a note informing others when you left and where you went. If you have a mailbox, leave the note there.
- Never cross a flooded area by foot or car. Fast water could sweep you and your car away.

ICE STORM FACT SHEET

Thunderstorms, hail, blizzards, ice storms, high winds and heavy rain can develop quickly and threaten life and property. Severe storms occur in all regions of Canada and in all seasons.

Listen to the local radio or television stations for severe weather warnings and advice. Keep a battery-powered or wind-up radio on hand as electricity frequently fails during severe storms.

Ice Storms

- Freezing rain is tough, clings to everything it touches and is more slippery than snow.
- A little freezing rain is dangerous, a lot can be catastrophic.

Preparing for severe storms

- Stock up on heating fuel and ready-to-eat food, as well as battery-powered or wind-up flashlights and radios – and extra batteries. For a complete list of emergency supplies, go to emergency kits. Also, learn what to have in your car emergency kit.

- When a severe storm is on the horizon, the Meteorological Service of Canada issues watches, warnings and advisories through radio and television stations, the WeatherOffice Website, automated telephone information lines and Environment Canada's Weatheradio.

What to do before and after:

- Ice from freezing rain accumulates on branches, power lines and buildings. If you must go outside when a significant amount of ice has accumulated, pay attention to branches or wires that could break due to the weight of the ice and fall on you. Ice sheets could also do the same.
- Never touch power lines. A hanging power line could be charged (live) and you would run the risk of electrocution. Remember also that ice, branches or power lines can continue to break and fall for several hours after the end of the precipitation.
- When freezing rain is forecast, avoid driving. Even a small amount of freezing rain can make roads extremely slippery. Wait several hours after freezing rain ends so that road maintenance crews have enough time to spread sand or salt on icy roads.
- Rapid onsets of freezing rain combined with the risks of blizzards increase the chances for extreme hypothermia. If you live on a farm, move livestock promptly to shelter where feed is available. Forage is often temporarily inaccessible during and immediately after ice storms. Animal reactions to ice storms are similar to that of blizzards.

The Effect of Earthquakes on Structures

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The Effect of Earthquakes on Structures

Objective: Students will be able to discuss how different magnitudes of earthquakes affect structures differently by simulating how buildings become damaged in an earthquake.

Materials:

- 8 1/2” x 11” sheets of paper or newspaper
- Roll of clear plastic tape
- Square pieces of cardboard for a base
- Box of metal paper clips
- Paper and pen to record observations
- Watch with a second hand or stopwatch

Earthquakes are a sudden motion that results from a release of built up energy within the Earth. Seismologists can record the energy (seismic waves) from earthquakes by using an instrument called a seismometer. The greater the amount of energy, the more the needle on the seismometer jumps to make “pulse-like” patterns. When we think of earthquakes, we often think of the damage that occurs as a result of the quake. With many earthquakes, damage to buildings and structures can be devastating.

In this investigation, students will learn how different magnitudes of earthquakes affect structures differently. Depending upon how a structure is built, the damage done to the structure can vary.

Investigation Question: How do earthquakes destroy buildings?

Procedure:

Introduce students to the destruction earthquakes cause by having them view the video “Forces Acting on Structures” and show them the pictures on page 31. Discuss how the damage to various structures happened. Be sure to accept as many explanations as you can. Some questions you might want to ask are:

- What happened in this picture? How do you know?
- What caused the damage to the buildings?

1. Have the students work in pairs. Instruct each pair of students to build structures. Participants will:
2. Roll 12 pieces of paper or newspaper into equal-size tubes and secure them with tape.
3. On the cardboard base, build a model of a four-story building by using the tubes as pillars and using the remaining paper as floors and the roof. Do not tape the tubes or paper together, but you should tape the floor of your structure to the cardboard base!
4. After all the participants have finished building their structures, instruct participants to shake the base gently for five seconds. Participants should record their observations. Then shake for 10 seconds, 15 seconds, and 20 seconds. Record what you observe after each interval of shaking. This shaking demonstrates a small-scale earthquake and its effect on structures that are not properly reinforced.

5. Instruct participants to rebuild the structure as before. Now, repeat your test and shake the base faster and harder than before. Participants should record their observations on their observation sheet. This demonstrates a much larger earthquake and the extensive damage to structures that are not properly reinforced. Discuss results. Be sure to accept as many explanations as you can. Some questions you might want to ask are:

   - Was your building more or less resistant than it was for the first shaking tests? Why was that?
   - How do you think you could make your structure stronger and more stable?

6. Rebuild the structure you tested, but this time, use the tape and paper clips to reinforce the structure so that it will not collapse easily. Once you have built your reinforced structure, repeat the tests as before, by first shaking the base gently and then harder and faster. If necessary, add more reinforcing material to make your structure as stable as you can and repeat the shaking tests. Participants should record their observations on the observation sheet.
7. Discuss the results of the simulation. Be sure to accept as many explanations as you can. Some questions you might want to ask are:

   - What did you have to do to your structure to keep it from falling down? What was the most important reinforcement you made and why?
   - What differences did you see in testing the reinforced structure compared to the non-reinforced structure?
   - How can your models resemble and demonstrate what happens to real buildings during an earthquake?
   - If you had to design a building to withstand an earthquake, what would you do to make sure it was strong enough, and why?

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Damage from Earthquake

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