

Feel the Forces of a Suspension Bridge

Lesson 3

3. Explore:

Understand forces, compression and tension in a suspension bridge.

"Compression" and "tension" are two forces that we can feel and see in the world around us. Where can you find examples of compression and tension? Using lots of math, civil engineers position the parts of a suspension bridge so compression and tension work together to hold up some of the world's longest spans. The main parts of a suspension bridge are its towers, cables, decking and anchorages. The long cables are the unique part of a suspension bridge. Anchored on land at each end, the cables are strung over the top of tall towers and gently slope back down to support the bridge deck (the road and/or walkway) from above.

Materials

- A partner (someone of similar size works best)
- Three straws: one to use as towers and two to use as bridge decks—one for each of the two bridges to be built
- Scissors
- Piece of string, four feet long, to use as a suspension cable
- Masking tape
- Large paper clip
- Load bucket (paper box takeout containers work well)
- Heavy nuts, bolts or anything else small but heavy to serve as weights
- Ruler

Preparation

- Move two chairs of equal height 18 cm apart.
- Carefully cut one straw in half to make two towers.
- Cut a small slit on the top end of each tower for the string to rest in.
- Cut one 122cm piece of string.
- Have the masking tape handy.

Procedure

- To learn about the forces that keep suspension bridges standing, you can experience them yourself. To start, face your partner.
- Join hands, and slowly, carefully lean backward. Don't let go! Do you feel a tug? What is the force associated with pulling? This is tension, which suspension bridge cables use.
- Facing your partner again, place your palms against your partner's. Now slowly, carefully lean toward each other. What kind of pressure do you feel now? This is compression, which is found in bridge towers.
- Now that we know what the forces of compression and tension feel like, we can

build two types of bridges and compare their strength. We'll start by building a model suspension bridge. Tape one half of the cut (tower) straw to the top of one of the chairs so that the slit is on the top, pointing to the other chair. Now tape the other half of the straw to the other chair in the same manner. The two slits should be in a line, and the straws should be 18 cm apart.

- Wrap the middle of the string twice around a whole straw. This will serve as the deck—where a road or walkway would go.
- Tape each end of this straw to a base of a tower straw so that it spans the distance between them.
- Thread each end of the string through the slit in each straw down the other side. To anchor the bridge, tape each side of the string to the chair. You've just built a suspension bridge!
- Loop a large paper clip around the deck straw and hang your empty load bucket from it. Begin to put your weights into the bucket, recording the number until the bridge breaks (by the straw bending or giving way).
- Now we'll build a beam bridge. Remove the string and carefully cut the two side-tower straws in half.
- Tape one straw "tower" to the edge of a chair. Tape the second tower to a second chair of the same height.
- Position these towers 18cm apart.
- Now tape each end of another straw to the bottoms of the two shorter side straws. This is your beam—where a road, path or railroad tracks would go. You've just built a beam bridge! Do you think this bridge will be able to hold more weight than the suspension bridge or less? Why?
- Hang the load bucket from the deck and run the test again by adding weights one at a time.

3. Explain:

Which bridge is stronger? Where did the bridges collapse? Where was each bridge weakest? Why do you think that is?

3. Extend:

Design and build a longer span. See if you can make a bridge twice as long that supports the same amount of weight. What parts of the bridge will you need to change?

3. Evaluate:

What makes a bridge strong?

[How do I get new ideas or build on other people's ideas?](#)

How do I use my observations, experiences and imagination to make judgements?

How did I contribute to my group and share responsibilities?

Did I communicate my ideas in different ways?

How did I take responsibility for my actions and accept feedback?

What personal connections did I make with this project?