Tension and Compression

In this activity, we're going to explore two different types of structures. We are surrounded by them both, all the time, that they seem obvious and natural: things that sit on the ground, and things that hang from the ceiling. But how do you know which one to use when you're building something new?

Materials:

- 2-4 paper towel rolls (cardboard tubes)
- String
- Piece of flat cardboard
- Tape
- A toy that is about the size and weight of a doll or action figure

Learning objectives:

- Compression and tension
- Prototyping
- Choosing a structural strategy

Time required: 20-45 minutes

Context:

When designers and engineers are creating something new, there are a million ways they could create the same object. There is often more than one type of structure that would be able to do what they needed it to (which is what we'll explore in this activity). How, then, do they decide which one to use?

Compression is usually when the object or building is standing on legs that sit on the ground. For example, standard tables and chairs have strong legs that sit on the ground and support us when we use them. Many buildings use columns, which act as strong legs that anchor into the ground and hold the building up. Compression is when a material is getting squeezed together. In many of these cases, gravity is pushing down on the legs, squeezing them against the floor.

Context:

Tension is the opposite of compression. Instead of the material being squeezed or crushed, it's being pulled apart and stretched. Things that use tension are usually hanging from the ceiling rather than standing on the floor. Gravity is still pulling down on the object, and in this case, it's pulling it away from the ceiling, where it's attached. Some examples of tensile structures are hanging lamps or circus tents.

Fun fact: There was a famous architect named Antoni Gaudi. He designed La Sagrada Familia, a famous cathedral in Barcelona, Spain. When he was designing the structure for the cathedral, he built a model of it upside down (in tension). When they built it in real life, they had to build it right-side-up and the tensile structures in the model became compression structures in real life.

Context:

In reality, most structures use both compression and tension. But we’re going to look at them separately here to really get a good sense of what they’re about. We’re going to design a platform for your toy, and support it with these two very different structures.

Activity:

1. Get a sturdy piece of cardboard. Cut it so that it is big enough for your toy to “stand” on it in the center, with about 2” of space around it to the edge of the cardboard. This is your platform, which we will use for both structures.

2. Let’s start with our compression structure. Cut your cardboard tubes down so you have (4) pieces that are the same height.

3. Tape these “legs” to the bottom of your platform. Place your toy on top of this platform: it should be stable enough to hold your toy up off of the ground. You can test how strong this structure is by pushing straight down on the top of the platform.

4. Great! Now we’re going to build the exact same thing - only using a tensile structure. It will use the same platform and function in the same way. Make a small hole in each corner of the platform. Cut (4) pieces of string to be the same length, about 12”-18”.

Activity:

5. Feed each piece of string through one of the holes, and tie a knot to secure it to the cardboard. You should have one piece of string tied to each corner of the cardboard.

6. Take the loose ends of the string and knot them together, above the platform. Find a place to securely hang the platform (or you can just hold it up if you need to).

7. Place your toy on top of the platform: it should be stable enough to hold your toy up off of the ground. You can test how strong this structure is by pushing straight down on the top of the platform.

Reflection:

Which structure did you think worked better? Which one would you choose to use for this project? Why?

Can you think of an instance where it would be better to use the other type of structure?

Ultimately, both the compression and tensile structures functioned in the same way: to hold your toy off of the ground. What difference does the structure make?

Happy Making!

-Team Hack