Tall and Strong Towers Made of Recyclable Materials: Grades 3 to 5

YOUR MISSION

In this activity you will be learning both civil and environmental engineering principles by designing and building tall and strong towers using only recycled materials. Your tower must be able to hold a tennis ball at the top and will undergo both wind and earthquake simulations to test its strength.

Click here to watch a quick introduction and tutorial for this activity. Watch this video (Reuse: Opportunities for better use of waste construction materials) to learn more about the future of recycling as we shift to an approach focused on re-using and re-purposing materials.

WHAT'S GOING ON

Engineers are problem solvers and they come up with solutions to problems to better the lives of everyone around them. They do this by coming up with designs, products, technologies, innovations, procedures and systems to make the world a better place.

Many different types of engineers often work together on a project or task. This activity is based around what an Environmental Engineer and a Civil Engineer would do. Environmental Engineers deal with many different things that can impact our environment and world in a variety of ways, such as improving air quality, water and land pollution, determining how long a product can last without harming the environment (product sustainability) and waste disposal and the recycling process. Civil engineers work hard to create strong and safe structures that we use every day, such as houses, schools, sewers, buildings, roads, bridges, and much more.

Every day more and more garbage is being added to our landfills. Many of the items that we are throwing away could actually be re-used. We must focus on the environmental impact of our designs on the future to prevent unnecessary waste. For example, how long will the product last? Can the product materials be recycled, or even re-used?

Re-using materials that would otherwise be considered trash to help build these structures is one way to reduce the amount of waste in our landfills. Civil and environmental engineers must work together to design and build structures using recycled materials that still meet the required safety and design criteria.

Figure 1: Examples of recycled materials used to build structures.

a) A treehouse in Brazil made from the remains of old houses.

(b) A house in Prince Edward Island made from recycled glass bottles.

Today, you will be designing and building a tall and strong structure out of recycled materials. Just like engineers, you will have to follow design criteria to make sure that your tower is tall and strong enough to survive testing. Before we get to that, here are some key terms that you need to know and will learn about while you are doing this activity.

KEY TERMS

- **Recycle/Recycling Process**: The process of converting waste into new material. In your homes, you sort the waste into recycling bins which are then collected and sent off to the recycling plant to begin the recycling process.

- **Re-use**: Using a material again, often for something different than what it was made for. For example, the glass bottles shown in Figure 1(a) were originally used for drinks, now they are being used as part of a house.

- **Structure**: Something that can be built and constructed, such as a building or bridge. Engineers create and arrange materials to form these structures. Another simple example is a cube, which is a structure containing a base (bottom), a top, and 4 sides.

- **Design Criteria**: Goals that a project must achieve to meet the necessary requirements for that engineering task. For example, your tower must be 1 metre tall and be able to hold a tennis ball.

Now that you are familiar with these terms, let's get started!

MATERIALS NEEDED

Before you design and build your own recycled tower, here are the materials you will need. You can ask a parent or teacher to help you gather these materials.

- 1 tennis ball (or similarly sized item if you don't have one)
- 1 stopwatch
- 1 fan
- 15 cm x 15 cm cardboard base
- 2 meters string
- 2 meters masking tape
- 1 pair of scissors
- Aluminum cans, plastic bottles, newspaper, toilet paper/ paper towel tubes, and any thing else you can find in your recycle bins that may be used as building materials!

WHAT YOU NEED TO DO

1. Before you get started, go through your recycle bin and collect any materials you might be able to use to build your tower! Aluminum cans, plastic bottles, newspaper, cardboard, and toilet paper tubes are normally a great place to start.

   Be sure to rinse off any bottles, cans and other materials that may be dirty thoroughly and let them dry before you start building.

2. Brainstorm ideas for your design and sketch out your plan on a piece of paper! Think of the materials you will use and how you will use them based on their strength and size.

Your tower must:

- fit on a 15 cm x 15 cm base (the bottom where your tower will be standing)
- be 1 metre tall
- be able to hold a tennis ball or similar sized item at the top (recommended to put a paper cup or something you have specifically designed out of the recyclable materials at the top of the tower to be able to hold the ball)

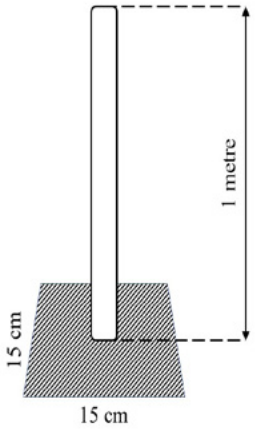


Figure 2: Schematic of the recycle tower with dimensions.

Please remember that the tower must be able to hold a tennis ball at the top.

3. Start building your tower! You have exactly 30 minutes to complete the construction of your tower.

4. Now begin testing:

   a) Use a metre stick to check the height. Is your tower 1 metre tall?

   b) Place a tennis ball on the top of your tower. Can your tower hold the tennis ball?

   c) Keep the tennis ball on the top of your tower. To simulate the wind test, place a fan 1 metre away from your tower. Turn the fan on high speed for 1 minute.
   Record your observations. Does your tower survive?

   d) Keep the tennis ball on the top of your tower. To simulate the earthquake test, lightly shake the cardboard base for 1 minute. Record your observations. Does your tower survive?

5. If you are doing this activity with friends or siblings, compare how your two towers performed under the different testing conditions. If you are doing this activity alone, try improving your design and repeat step 4 (testing).

6. When all of the testing is complete, take down your towers and make sure to sort the materials for recycling and place them back in the recycle bins.

FURTHER REFLECTIONS

1. Did your tower survive the wind and/or earthquake test? How do you think your design affected the performance of your tower?

2. Why do you think some designs performed better than others?

3. Did you use specific types of recycled materials for certain parts of the tower (for example, using aluminum cans for the base of the tower, and paper rolls for the top)? If so, why did you select those materials?

4. Do you think certain materials performed better than others?

5. What are some examples of other everyday materials that you can start re-using? Try to come up with at least 5 ideas.

All engineers use the Engineering Design Process to plan, build, test and reflect on their designs and when coming up with solutions to a problem. The steps for the Engineering Design Process are listed below. Use the Engineering Design Process to test and improve your design.

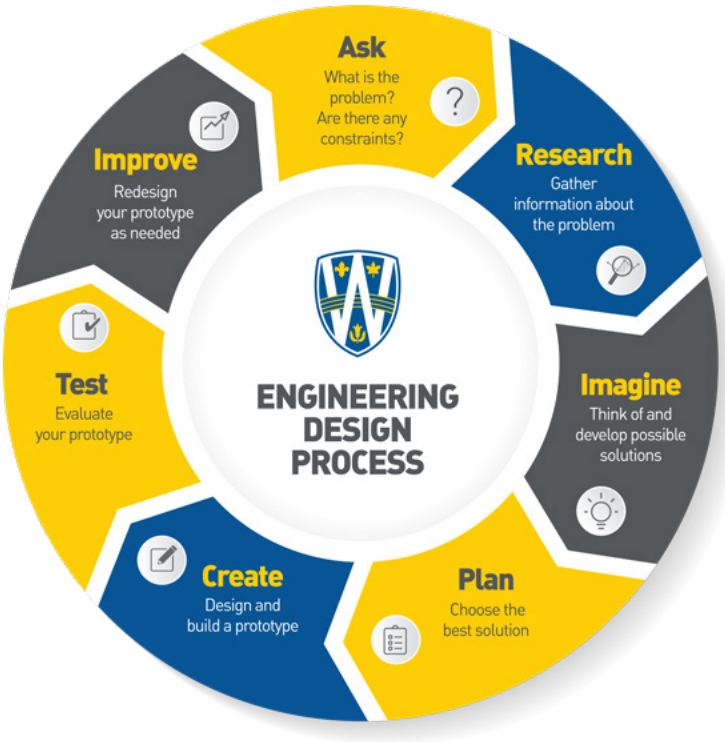
ENGINEERING DESIGN PROCESS

First, think of the problem.

How can you fix it? Think of as many ideas as you can that you think will solve this problem.

It might be helpful to first sketch out your ideas on a piece of paper. Make as many different designs as you can!

Test and compare all of your solutions. Which one solves the problem and works the best?



CURRICULUM UNIT CONNECTIONS

Grades 3 to 5 – Understanding Structures and Mechanisms – Strong and Stable Structures; Forces Causing Movement; Forces Acting On Structures and Mechanisms; Understanding Life Systems – Habitats and Communities; Understanding Earth and Space Systems – Conservation of Energy and Resources.

SHARE YOUR DESIGNS WITH US!

Tag us on our UWindsor Engineering Social Media Pages and show us your designs!

Twitter: @UWindsorENG
Facebook: @UWindsorEngineering
Hashtag: #UWindsorENG

REFERENCES

Teach Engineering.org STEM Curriculum For K-12. (2012). Hands-on Activity: Test & Improve: Making Tall & Strong Recycled Towers. https://www.teachengineering.org/activities/view/cub_environ_lesson05_activity3

Teach Engineering. (2017, July 3). Recycled Towers [Video]. Youtube. https://www.youtube.com/watch?v=291T-940WSA

Li, Yushi [Yushi Li]. (2015, August 8). Reuse: Opportunities for better use of waste construction materials [Video]. Youtube. https://www.youtube.com/watch?v=r0Ejq_4GXEA

Glink, I. (2017, January 23). 8 Homes Made From Recycled Materials. CBS News. https://www.cbsnews.com/media/8-homes-made-from-recycled-materials/

Jaime, Cabana Floripa. (n.d.). Cabana Floripa – Florianopolis, Brazil [Photograph]. Retrieved from https://www.cbsnews.com/media/8-homes-made-from-recycled-materials/

The Bottle Houses. (n.d.). The Bottle Houses – Cap-Egmont, Prince Edward Island [Photograph]. Retrieved from https://www.cbsnews.com/media/8-homes-made-from-recycled-materials/