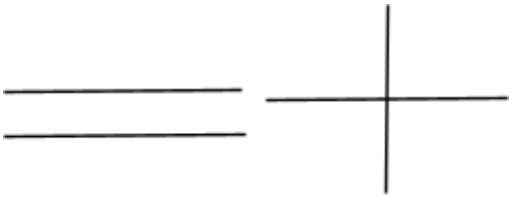
Cross Laminated Timber

LaCuKnoS Language Booster

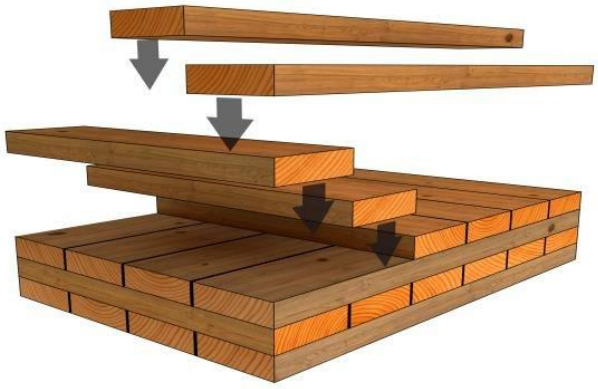
Most tall buildings today are built out of steel and concrete. These building materials are made from minerals that are dug from the earth. They are **non-renewable** resources that could run out in the future. Many homes and smaller buildings are made of wood. Wood is a **renewable** resource that can be used now and grown again for the future. So why don't we see large buildings made of wood?

Tall buildings need to be built with strong materials that can hold up the weight of many stories. Wood boards by themselves are not strong enough. However, wood boards can be glued together in a specific way to make larger and stronger pieces that can be used to build large structures. This new type of wood product is called **cross laminated timber** (CLT) and it can be as strong as concrete and steel. Here is a video about the world's largest wooden hotel, made with CLT.



Wood is strongest in one direction – **parallel** to the wood **grain.** It can break more easily **perpendicular** to the wood grain. When wood boards are glued together in layers, with the grain in one layer perpendicular to the grain in the next layer, the strength of the wood adds up. There is no longer a strong direction and a weak direction. Multiple wood boards can be put together in this way to build larger panels and parts. These parts can be put together like a big puzzle to build a tall structure.

One advantage of this technology for Oregon is that the CLT process can use smaller trees. Removing some of the smaller trees from Oregon forests can help reduce the risk of wildfires. Currently, removing smaller trees costs too much money and there is little use for the wood from these trees. CLT technology provides a new use for the wood from small trees, allowing Oregonians to make use of a renewable resource for construction and to reduce wildfire risk at the same time.



Cross laminated timber (CLT)

In this lesson, we will talk about **cross laminated timber** and how this new approach to building can increase the strength of wood boards for construction and change the economics of forestry in some parts of Oregon.

Talk with your partner about the following questions and then write your answers.

1. How could you test to see if it is true that wood is stronger perpendicular to the wood grain than parallel?
2. Take a walk around your school building. What building materials do you see? What is made of wood?

References:

- Comparative life cycle assessment of cross laminated timber building and concrete building with special focus on biogenic carbon https://www.sciencedirect.com/science/article/pii/S0378778821008884 (includes 8 additional references)
- CROSS-LAMINATED TIMBER VS. CONCRETE/STEEL: COST COMPARISON USING A CASE STUDY https://www.researchgate.net/publication/320739097_CROSS-LAMINATED_TIMBER_VS_CONCRETESTEEL_COST_COMPARISON_USING_A_CASE_STUDY

Videos:

- How It's made: Cross laminated Timber: (8 min) https://www.youtube.com/watch?v=rK49UjDivWM
- Largest CLT Project in the Pacific Northwest (6 min) https://www.youtube.com/watch?v=M-d5U5JUvqM
- Splitting firewood along the grain (5 min) https://www.youtube.com/watch?v=tUQdR2xUoes
- The World's Biggest Wooden Skyscraper (4 min) https://www.youtube.com/watch?v=GvHx_NS9wWw
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Images

Building: woodworks.org

CLT: Dietrich Buck, Luleå University of Technology

Cross Laminated Timber

Lesson Plan

Part 1--Exploration

- Have students gather in groups of four and provide each student with six sticks and glue.
- In a demonstration, hold up one stick and show students how bendy it is, encourage them to test this themselves without breaking the sticks. Then ask them the following question:
    - If you wanted to build something, these sticks seem very weak. How would you make them stronger?
- Encourage students to explore and come up with some arrangement of the six sticks, and glue that would make a stronger building piece.

Part 2—Knowledge building

- Provide students with the language booster. Have students read the language booster, explore the associated concept cards, and look at the background information about wood grain. This can be done as a whole class discussion, in pairs or small groups, or individually.
- Have students get into pairs and discuss the two questions at the end of the language booster.
- If possible, show students one or more of the short videos above.
- After students have had time to think about the language booster and associated materials, give students the activity instructions handout.

Part 3—Structured activity

- Have students follow the steps of the activity as shown on the activity instructions handout. They should build two panels and then let them dry.
- After they are dry, have students explore their two panels and test their strength along different directions. Specifically, ask students to:
    - bend the panels
    - twist the panels
- Discuss the following questions:
    - Which panel twists more than the other? Why do you think that is?
    - Would the wood grain orientation in the two panels make a difference? Why or why not?
    - Which panel would you want to build with? Why?
    - Which panel would you want to use for a load bearing part of a building?

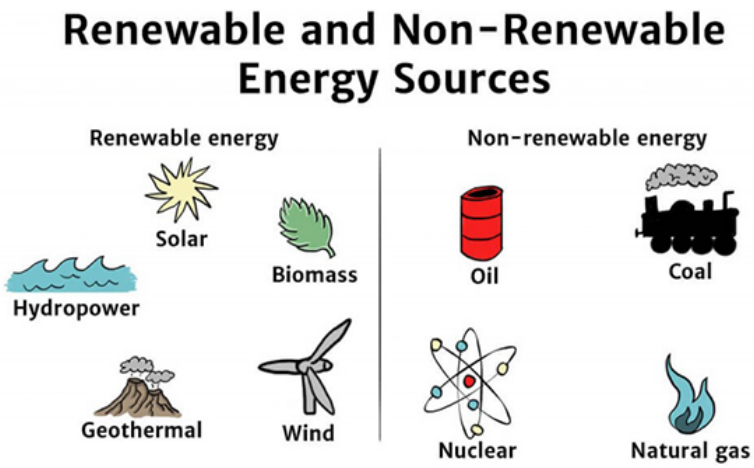
- Exit ticket: Complete the investigation summary sheet

Cross Laminated Timber
LaCuKnoS Concept Cards

Renewable/renovable

Is a natural resource which can be restored through a natural process faster than human consumption.

Es un recurso natural que se puede restaurar por procesos naturales a una velocidad superior a la del consumo por los seres humanos.



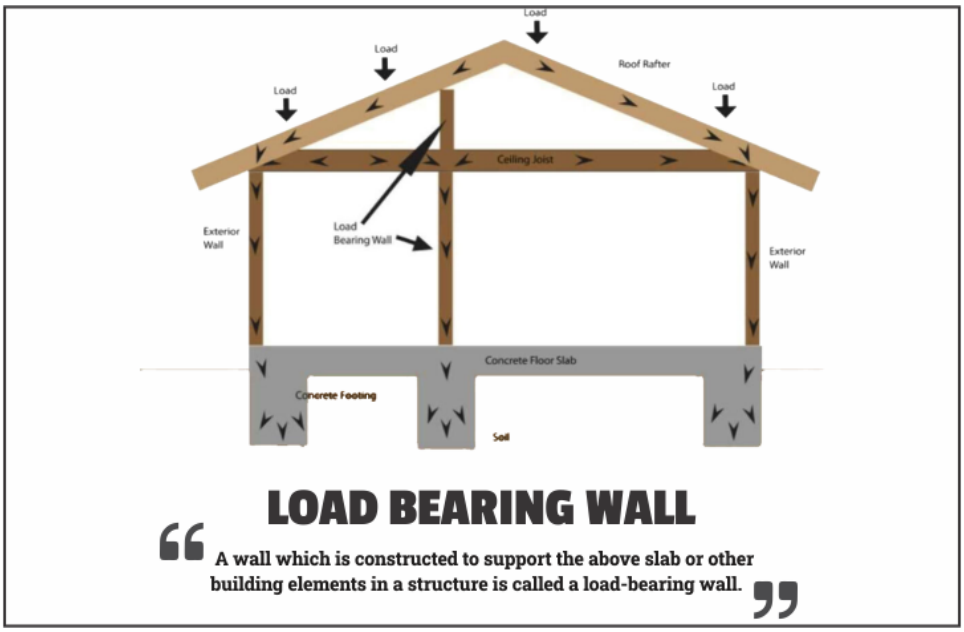
Energy source examples. Image: www.otsv.de

Concept Card

Load bearing capacity/capacidad de carga

Is the maximum ability of a structural member or material to take loading before failure occurs

Es la carga máxima que un miembro estructural o material puede soportar antes de romperse o fallar



Example of load bearing walls on a building. Image: https://constructionor.com/load-bearing-wall/

Concept Card

Cross laminated timber /panel contralaminado

A wood panel product made from gluing together layers of solid-sawn lumber. Each layer of boards is usually oriented perpendicular to adjacent layers and glued on the wide faces of each board, usually in a symmetric way so that the outer layers have the same orientation.

Un producto de madera construido pegando capas de tablas sólidas. Cada capa de tablas esta usualmente orientada en forma perpendicular a las capas adyancentes y pegadas en la superficie ancha de cada tabla, usualmente en forma simétrica de forma que las capas exteriores tienen la misma orientación.

A cross laminated timber panel. Image: https://www.naturallywood.com/products/cross-laminated-timber/

Concept Card

Wood grain /veta de la madera

It is the drawing (pattern of wood fibers) that marks the direction in which the fibers of the tree grow, also known as growth rings.

Es el dibujo (patrón de las fibras de madera) que marca la dirección en la que crecen las fibras del árbol, también conocidas como anillos de crecimiento.

Douglas-fir wood grain. Image: https://www.terramai.com/products/reclaimed-mixed-grain-doug-fir-flooring-paneling

Concept Card

Cross Laminated Timber
Background Information about Wood Grain

Wood grain is the arrangement of wood fibers and the pattern resulting from that arrangement. When you look at a board or any other object built of wood, you can usually see lines or streaks; those are what we call the wood grain. Wood has different strength depending on the direction that the wood is cut compared to the direction of the wood grain. The direction of a cut can be perpendicular, parallel, or tangential to the grain. In this lesson, we will focus on the first two. One example to better understand these differences is to think about splitting wood for a fire. If you had to chop firewood, is it easier to cut it parallel to the wood grain, or perpendicular to the grain? If you have ever tried, you know it's easier to chop parallel to the grain because the wood grain is weaker in that direction.

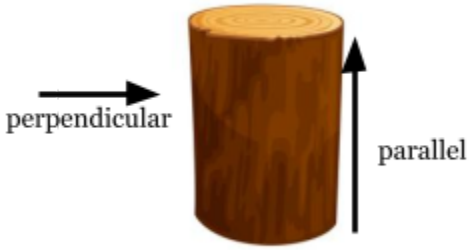


Figure: Log cross section and grain direction. Image credit: www.vectorstate.com

"Chopping firewood" by gerrypopplestone is licensed under CC BY-NC-ND 2.0.

Cross Laminated Timber
Building Activity Instructions

In this activity, you will build two panels, each using the same amount of sticks, but arranged in a different way.

1. Parallel arrangement

    a) Glue two sets of three sticks in parallel

    b) Glue the two stacks together

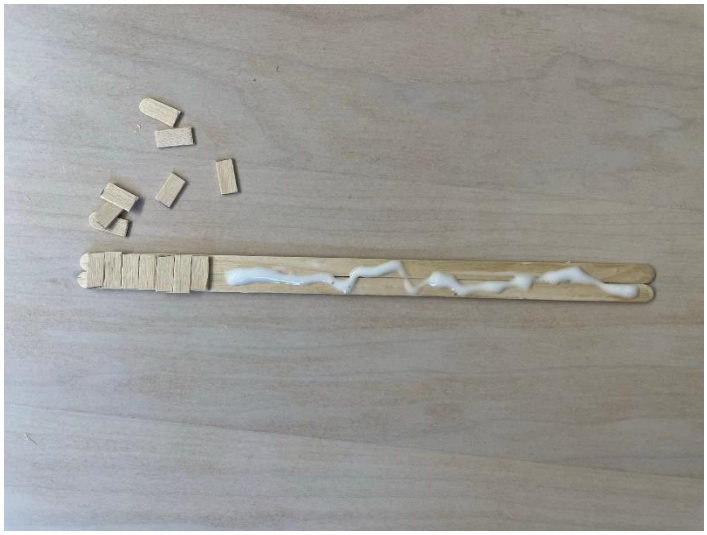
c) Put some weight on top, and let them dry

2. Perpendicular arrangement

a) Lay out two sticks together as a base

b) Cut two sticks in pieces that are the same width as the two sticks you have as a base. You can mark the width with a pencil or pen as shown in the picture.

c) Glue the cut pieces perpendicular to the base sticks



d) Then add glue to the perpendicular layer and add the two remaining sticks parallel to the base sticks

e) Put some weight on top, and let them dry

f) After the panels are dry, explore and test their strength along different directions. Try not to break them. Try bending the panels and twisting the panels. Start gently then gradually bend and twist harder.

g) With a partner, discuss the following questions:
   - Which panel twists more than the other? Why do you think that is?
   - Does the wood grain orientation in the two panels make a difference? Why or why not?
   - Which panel would you want to build with? Why?
   - Which panel would you want to use for a load bearing part of a building? Why?

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LaCuKnoS Investigation Summary

Shared anchoring events with community relevance (tool K1-1)

With a partner, look at the two wood panels you built. Then talk about and write your answers to the following questions.

If you want to convince your friends that the CLT arrangement of the sticks provides better strength in more than one direction, what would be the best way to convince them?

How would you explain to someone in your family what cross laminated timber is and why it can be good for Oregon?