

East Kootenay Branch Annual Popsicle Stick Structure Challenge

The goal of the contest is to construct a structure using standard white glue, and up to 200 popsicle sticks.

The structures are tested (broken using a load-tester) at the annual East Kootenay Regional Science Fair in 2024.

Entry Form

Name (please also write your name on your structure): _____

Age: _____

Grade: _____

Phone: _____

School: _____

Number of popsicle sticks used in tower: _____

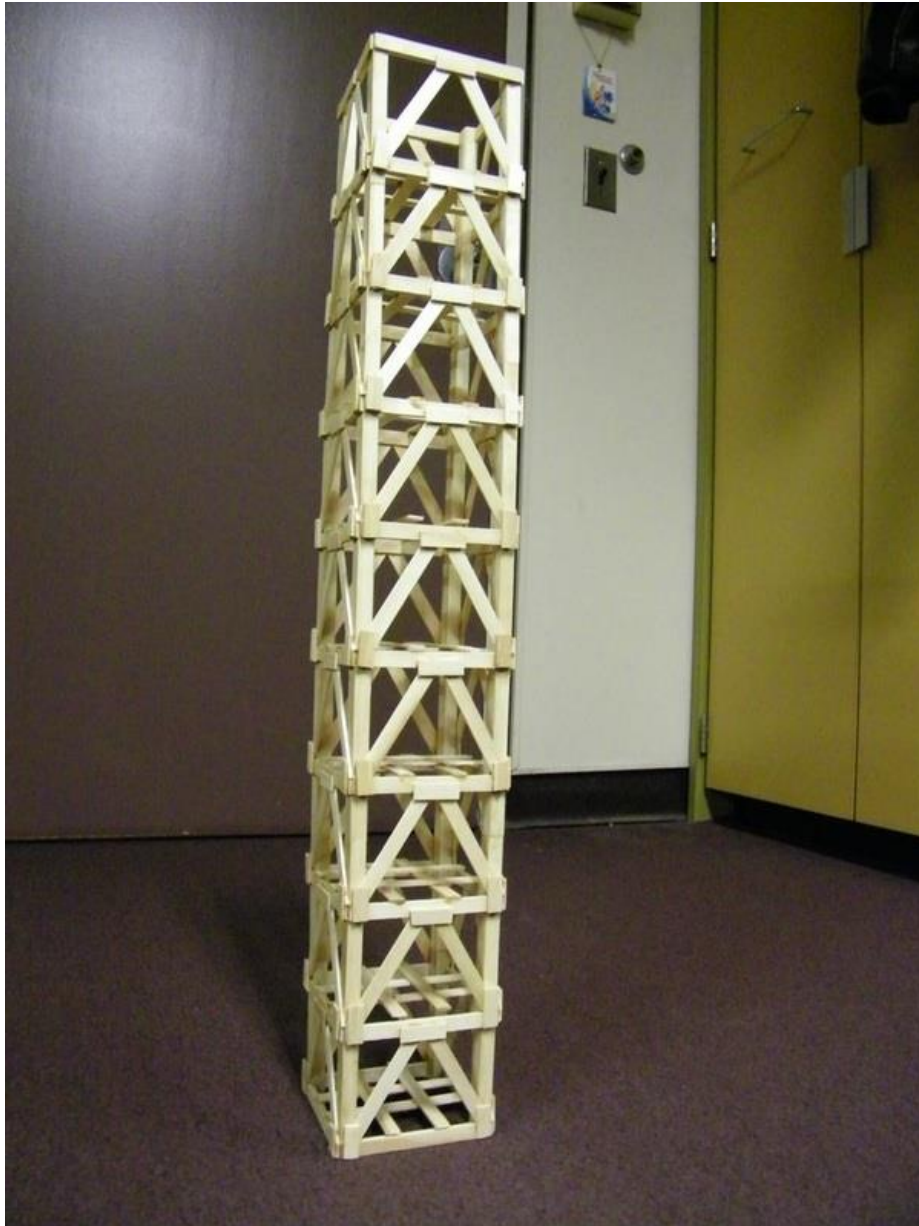
Please direct any questions regarding this contest to:

Allan Amundson, P.Eng – Engineers & Geoscientists British Columbia East Kootenay Chapter

Email: info@kootenay.winmar.ca cc: ek@egbc.ca

2024 Structure

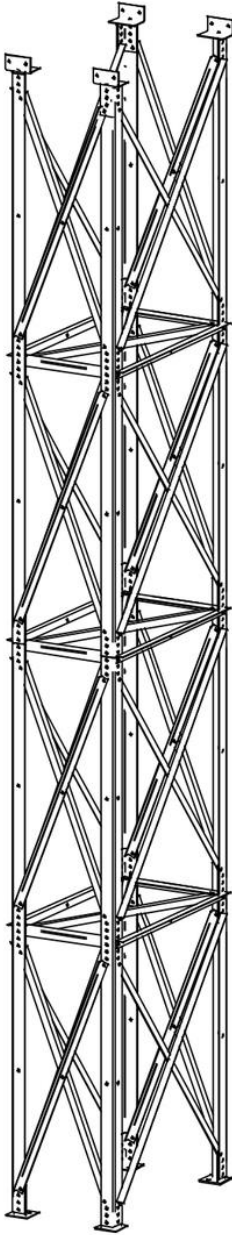
This year's contest will be constructing a 5-section freestanding (self-supporting) support tower



Example of a 9-section popsicle stick tower

Educational Background

- What is a section?
 - Towers are often constructed by assembling a section and then lifting it into place, and fastening it to the previous section either by bolting or welding. In the photo below (bottom left) you can count 4 sections total. We will be building a 5-section tower.



Example of a 4-section support tower (left) , and a tall radio tower (right)

- What is a freestanding tower?
 - Freestanding (self-supporting) towers stand on their own without the help of guy-wires/cables or adjacent structures.
 - The following two photos are examples of supported structures (non freestanding)

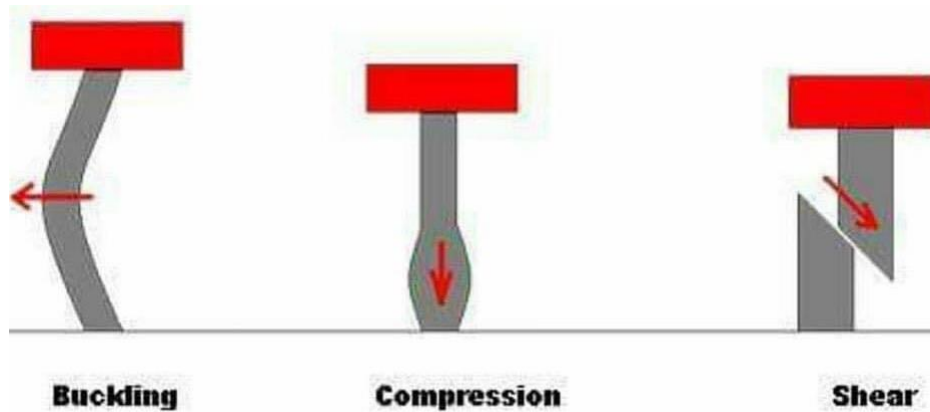


Tall tower with guy wires – This is not considered a self-supporting structure because the cables provide stability to the structure



Scaffolding tied to building – This is not an example of a self-supporting structure because the building adds stability to the scaffold.

- What are common failure methods of self supporting towers? Our self supporting tower is essentially a column. Columns are vertical/upright structures that are designed to support a larger structure above it. The following diagram outlines 3 common failure modes of columns, followed by two photos of real-life towers that have failed.



Wind failure of a power line support tower



Buckling of a wind turbine

Design Parameters

1. The footprint of the tower must be no greater than [1 popsicle stick x 1 popsicle stick]
2. The tower sections must be exactly 1 popsicle stick tall.
3. The sections must be the same size bottom to top of the assembled structure. i.e. no tapering of the structure. Your footprint needs to be the same size across all 5 sections.
4. Notice how we did not say the footprint has to be square. The footprint shape is up to you!

Rules

1. Popsicle sticks may be shortened by cutting or lengthened by splicing 2 or more together, but they may not be cut lengthwise in half.
2. No more than 200 sticks may be used.
3. White school glue only, no other adhesive allowed. White Gorilla glue is not allowed.
4. Paint is acceptable if you desire.
5. The inside of the tower sections can be reinforced / trussed with popsicle sticks if desired. (i.e. when looking down the middle of the tower there is no requirement to keep the middle hollow, unlike a bridge that needs to let a car pass through the structure)
6. Adults are welcome to enter the contest, but prizes are limited to those under 18 years of age
7. The top and bottom of the tower cannot have popsicle sticks protruding from it, as the top and bottom must be flat for the load tester.

Tips

1. The strength of your tower to withstand a vertical load will be primarily based on
 - a. The flatness of the base – construct your footprints/bases on a flat surface. Test your tower to ensure it can stand up on its own and not fall over.
 - b. The top surface and bottom surface of your tower should be “in plane”. If you place a flat object on the top and bottom of the tower, the flat surfaces should be parallel. Try placing a textbook on your tower and see if it stands on its own, or falls over.
 - c. The straightness of the tower – If there is a visible bend to your tower, it will be prone to continue to bend and ultimately fail (buckle) in that direction when a vertical load is applied.
 - d. The presence of triangles – More triangles, the better! If you see squares in your tower, look at how you can convert them into a triangle!
 - e. Popsicle stick structures often fail at the joints due to lack of gluing. There is no restriction on how much white glue you use! And we also don't recommend arriving with wet glue from the night before. Glue your structure several days before the event so it can completely dry.
 - f. Holding the popsicle sticks together during gluing significantly increases the bond strength. We recommend using paperclips, binder clips, or clamps if you have them.

Breaking / Testing

1. The tower will be placed on a wooden plywood base
2. Towers will be tested under vertical loading at the top. A 6"x6" piece of plywood will be placed on the top of your tower and the load applied evenly to the wood.
3. The load will continue to be applied until the tower fails (buckles, falls over, collapses)

Scoring

In structural engineering we want our structures to not only be strong, but also light. This helps us build taller structures, at a lower cost, in less time, and using less materials. As such, the structures will be graded on the following 2 criteria:

- Capacity – The maximum weight (pounds) the structure supported will be recorded.
- Efficiency – The maximum weight divided by the number of popsicle sticks used in your tower.
 - Note - If you cut 1 popsicle stick in half to create two smaller sticks, this counts as 1 stick.

Example:

- *Julie's tower has 71 popsicle sticks and held 100 pounds.*
 - *Capacity = 100 lb.*
 - *Efficiency = 100 lb. / 71 popsicle sticks = 1.41 lb. per popsicle stick*
- *Rapinder's tower has 100 popsicle sticks and held 130 pounds*
 - *Capacity = 130 lb.*
 - *Efficiency = 130 lb. / 100 popsicle sticks = 1.30 lb. per popsicle stick*

Rapinder's tower was stronger, but Julie's tower was more efficient!

Prizes

Capacity (1st, 2nd, 3rd)

Efficiency (1st, 2nd, 3rd)

Location

The breaking will occur at the East Kootenay Regional Science Fair on Friday, April 12. The event is held each spring in Cranbrook, BC at the College of the Rockies. Watch for dates on the fair's website in the coming months. Bring your structure with you to the event when it opens, the entry form, and a \$10 entry fee that goes 100% towards the prizes.

Teachers – While attendance to the science fair is preferred, if you cannot attend and if you have a full classroom (or multiple classrooms) that participate, we will also come to your school, explain the instructions, and then return at a later date to break the bridges in class!