

Pasta Towers

2019 NC Science Olympiad Coach's Institute

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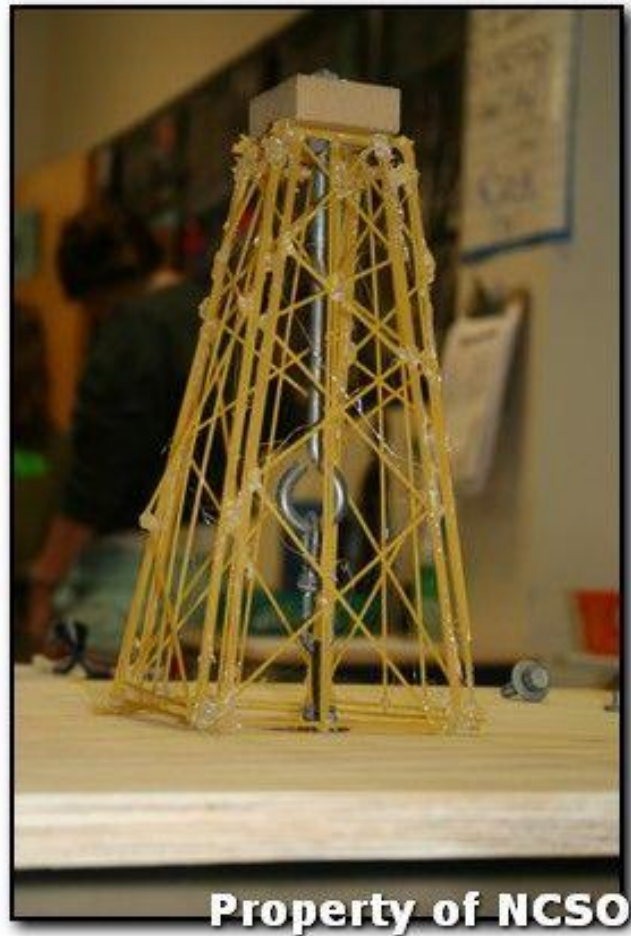
Raleigh, NC

Introduction

- 16th year involved with NCSO
 - 6 years competing
 - 10th year volunteering
- North Carolina State University Alumnus
 - Master's and Bachelor's of Science in Civil Engineering, Structures
- Work as a Structural Engineer
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What We Will Cover

- 2020 Rules
- Tower Basics
- Construction Tips
- Testing Essentials



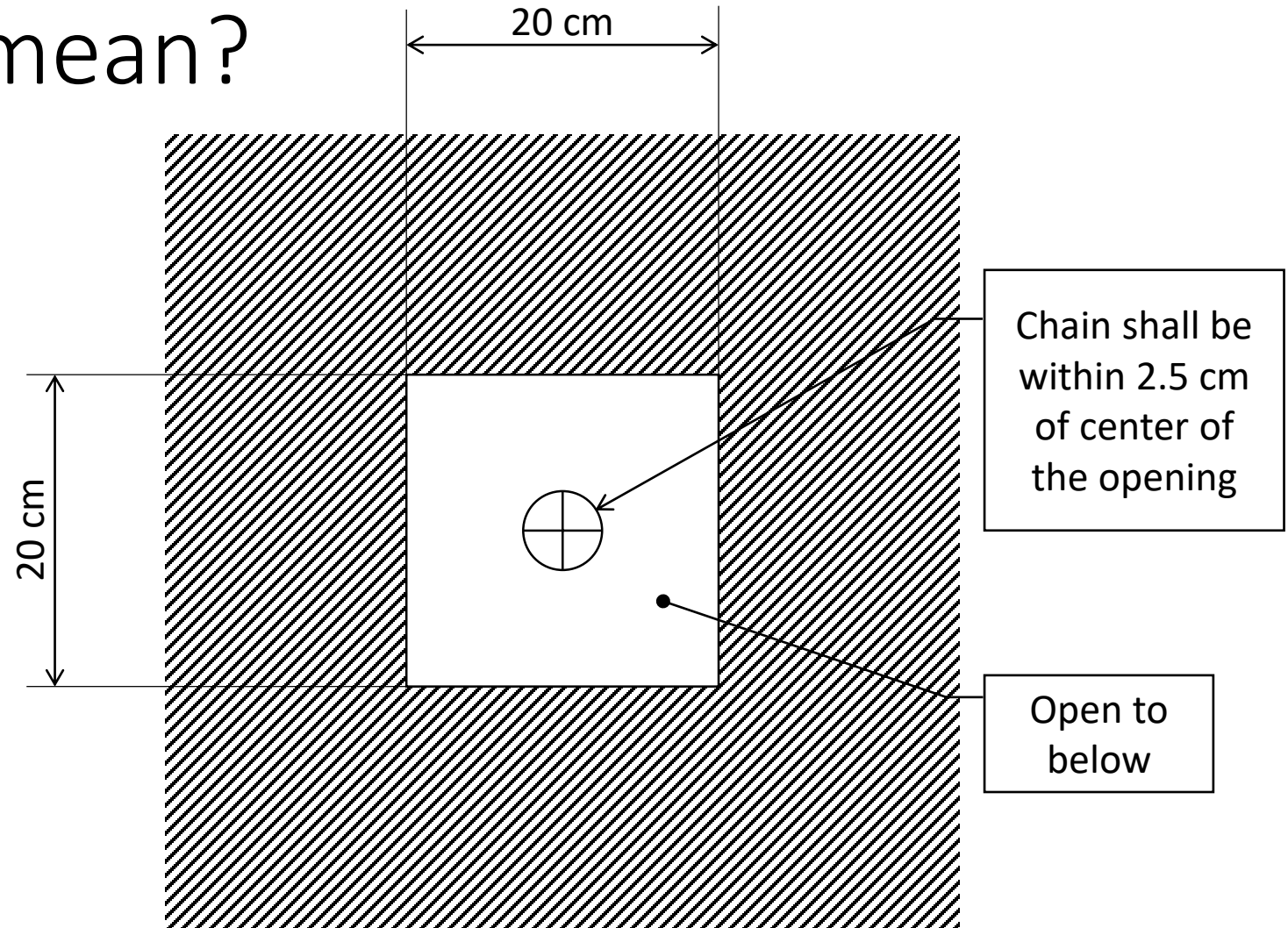
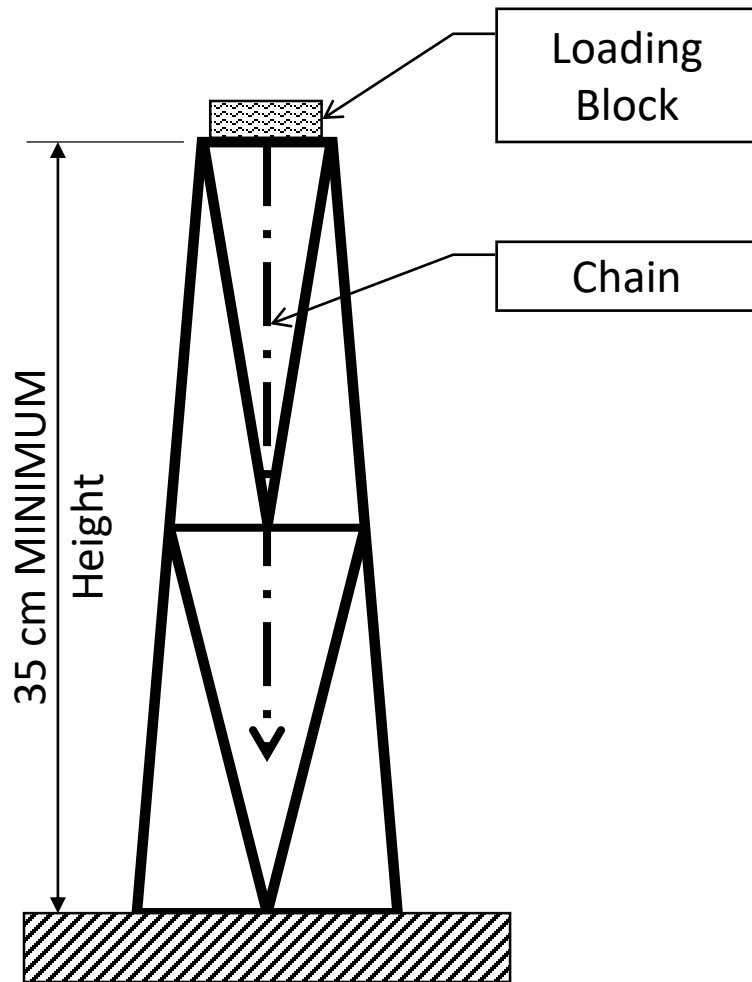
2020 Rules

- SAFETY is key!
 - Students must wear appropriate eye protection at all times.
 - Safety glasses are recommended over lab goggles; ensure they are ANSI impact rated
 - Recommended for construction and practice as well.
- Towers must be made of Pasta and Glue
 - Any type of pasta can be used
 - We recommend only multi-purpose or hot glue can be used
 - Students can use super glue (“cyanoacrylate”), but supervise carefully
 - You CAN make your own “pasta”

Dimensional Requirements

- Towers shall be at least a 35 cm tall
- Towers shall span a 20 cm by 20 cm square opening in the testing platform
 - Cannot extend below the testing platform surface in this opening
- Towers shall support at 5 cm wide by 5 cm deep by 2 cm tall loading block
 - A chain will be supported by the loading block which shall be threaded through the tower

What does this mean?



Scoring

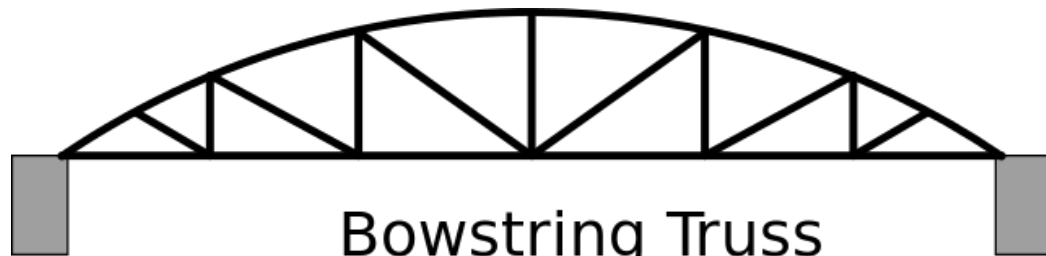
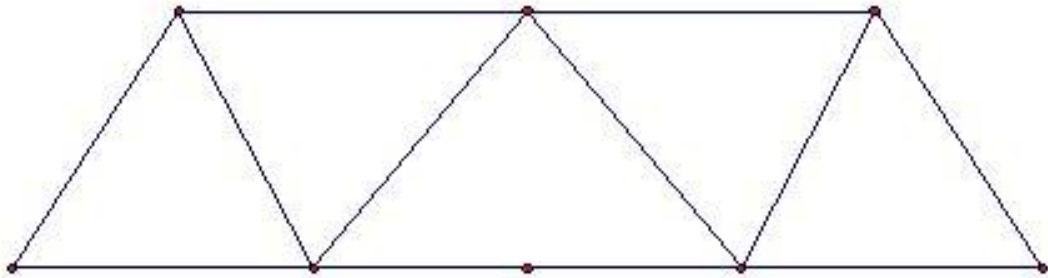
- Towers will be ranked upon EFFICIENCY
 - Efficiency is $\frac{\textit{Mass Held}}{\textit{Mass of Tower}}$
- Towers/Teams that meet all safety and dimensional requirements will be placed above all others that do not meet them
- The mass judged for a team will not exceed 10 kg (10,000 g)
 - A lighter tower holding maximum mass will place higher

Tower Basics

- The purpose of a tower is to carry a load above a given surface.
- The most basic type of towers are simple posts.
- More complicated trusses are trusses.
- Trusses are, generally, **MORE EFFICIENT** than post towers.



Trusses



Bowstring Truss

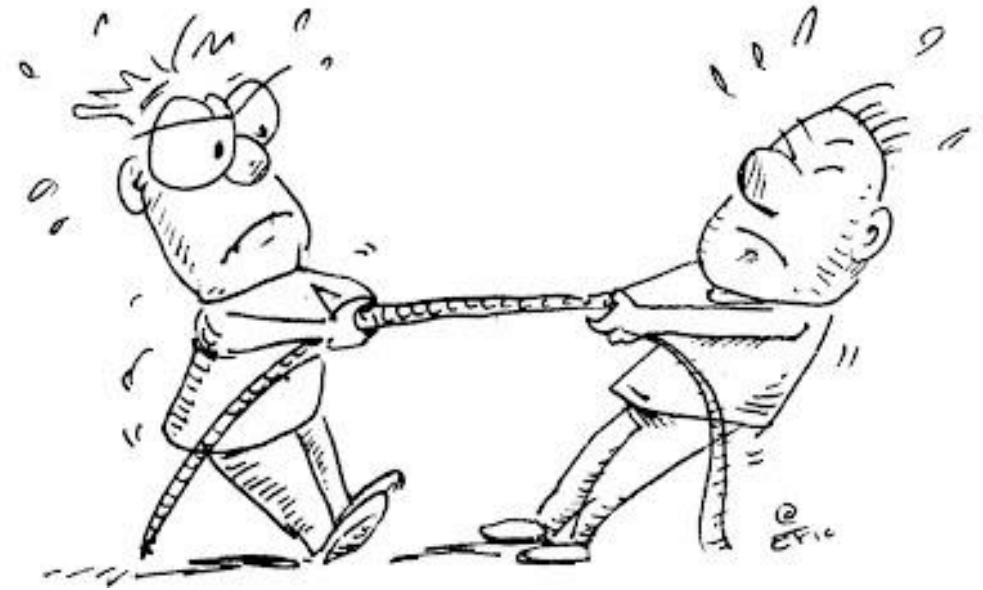
Top chord is a true arc. Members are often like a Pratt

NOTE: The above trusses are bridges, but the principles remain the same

- Trusses are made up of individual members in compression (pushing) or tension (pulling) and the joints between them.
- There are many types of trusses:
 - Pratt
 - Warren
 - King
- Each type of truss puts forces on their members differently.

Tension Members

- Strength of tension members depends on the material and cross-sectional area.
- If a tension member is not strong enough, try a larger member.
- If a tension member is too strong, a smaller member may be more efficient.

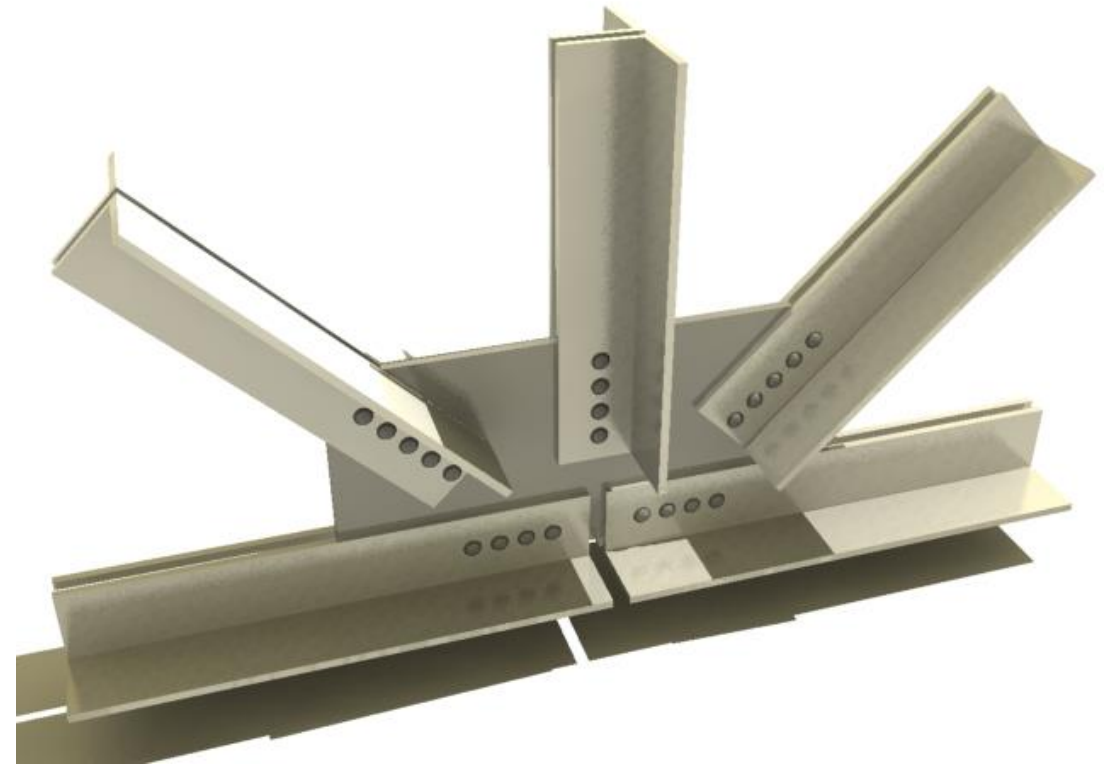


Compression Members

- Strength of compression members depends on more complicated factors.
- Buckling occurs when a compression member starts to bend.
 - To solve this, try different shapes of pasta and where they are braced along their length.
- Try the yardstick experiment with your students!

Joints

- Joints are the most important part of any structure!
- Like trusses, there are different kind of joints
 - Butt
 - Lap
 - Gusset plates
- TIP: Avoid using butt joints; instead use lap or gussets.



Construction Tips

- Have students draw out their designs at full scale before constructing.
 - Use straight edges and rulers to get accurate plans.
 - Tape the drawing down on a piece of foam board; you can then use push pins to hold pieces in place on the plans.
- Have your students start small and get larger with experience.
 - Lessons learned on the small scale can lead to success on the large scale!
- Always construct two of each design!

Testing Essentials

- Students must wear eye protection at all times!
- Students will use one of NCSO's "breakers" and testing equipment.
- Students will thread the chain through their bridge and hang the bucket underneath.
- The stick on the back controls the flow of the sand.
 - Faster is better for them!



Lessons Learned

- Keep compression members as short as possible.
 - If unable to do so, brace at regular intervals; it increases capacity.
- Make sure that your student's tower is **TALLER THAN 35 cm!**
- Have your students think about how the tower transfers the force.
 - From the bucket, to the chain, into the loading block, through the structure, and into the supporting surface.
- Leave room for the loading block.
 - It is 5 cm x 5cm in cross-section
 - Ensure your student's tower can receive a loading block and the chain.

Questions?

Feel free to reach out to me with any further questions at:

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