



STRUCTURAL ENGINEERING

2020 PROBLEM STATEMENT

BACKGROUND

Construction cranes, cell phone towers, water towers, fire lookouts, and power line towers are all examples of structures called truss towers. A truss tower is a freestanding framework tower. A truss is an assembly of beams that creates a rigid structure so that the assemblage as a whole behaves as a single object.

The tallest wooden truss tower ever constructed was built in Mühlacker, Germany, and topped out at a height of 190 meters. Currently, the tallest truss tower in the world is the Tokyo Skytree, with a height of 634 meters (2,080 ft).

CHALLENGE

Truss towers are often designed to hold a very heavy weight using only minimal materials. Water towers and lookout towers are examples of truss towers that carry a heavy load on top of the truss structure. The challenge this year is to research, design, and build a truss tower that uses minimal construction materials but holds the maximum weight possible.

The goal of this challenge is efficiency: holding the maximum weight using a minimum amount of material.

As an architect, designer, and engineer, be sure to consider the following when developing your design:

1. Aesthetics
2. Types of trusses (Function)
3. Size constraints
 - a. Height
 - b. Maximum diameter
 - c. Minimum interior diameter
4. Dead load of the structure
5. Live load of the structure
6. Materials durability and availability
7. Maintenance

DIMENSIONS, MATERIALS, SPECIFICATIONS

Actual dimensions

Scale dimensions for solution – 1' = 1/2"

Height of the Truss tower section:	24'	Structure height:	12"
Maximum structure exterior diameter:	6'	Maximum exterior diameter:	3"
Minimum structure inside diameter	2.63'	Minimum interior diameter:	1.315"

Building Materials

Balsa wood strips, 1/8" x 1/8" only. A MAXIMUM of 20 linear feet of balsa stick is allowed.

No other construction materials are allowed to be used in the construction of your truss tower.

Keep in mind that the weight of the structure affects its efficiency (weight is a factor in the efficiency formula). Unnecessary materials increase the structure weight without adding strength, and thus have a negative impact on the efficiency rating of the structure.

Measuring materials

12 inch long piece of **3 inch inside diameter schedule 40 PVC pipe** for measuring maximum diameter

- Your structure must fit inside of this pipe.

12 inch long piece of **1 inch inside diameter schedule 40 PVC pipe** for measuring minimum interior diameter.

- This pipe must fit inside of your structure from top to bottom, inclusive.

See attached images of the PVC pipe that is to be used for testing

Specifications

1. The truss tower needs to be constructed using only 1/8" by 1/8" balsa sticks.
2. A maximum of 20 linear feet of balsa stick can be used in the construction of your tower.
3. The structure needs to fit inside of a piece of 3 inch inside diameter schedule 40 PVC pipe.
4. A piece of 1 inch inside diameter PVC pipe needs to fit through the vertical center of your tower.
5. The test rod will run up through the center of your structure.
6. The test block will be a 3 1/2" by 3 1/2" square block that is 3/4" thick.
7. The test block will be placed on the top of your structure, at the 12" height
8. The height of the structure is 12 inches, maintained at multiple points to support the test block.
9. A tolerance of +/- 1/8" will be applied for the height measurement
10. Gussets are not allowed to be used in the construction of your tower
11. Lamination refers to the combining of two or more pieces of material with the grain running in the same direction. **Laminations of any kind are NOT allowed. Use of laminations will result in an automatic disqualification.**
12. Lap joints are allowed and involve the gluing of two pieces of balsa material with the grain pattern normally at right angles; however, lap joints less than 15° or greater than 165° would circumvent the lamination guidelines and would result in a disqualification.
13. Hot-melt glue is not allowed, all other types of glue may be used for construction.
14. The use of glue for coating structural components is not allowed. Excess glue on joints is considered a gusset and would result is a disqualification.

Automatic Disqualifications

1. Use of any material that is not 1/8" by 1/8" Balsa stick
2. Use of any laminations
3. Use of gussets or over-gluing that emulates a gusset.
4. The structure does not meet the inside, outside, and height requirements

REQUIREMENTS FOR CHECK-IN

1. Completed structure needs to be submitted in an appropriate sized box labeled with the team ID only.
2. The structure needs to have "up" and "down" clearly labeled so that the structure will be tested in the correct orientation.
3. Your portfolio, which is placed inside of the box, is to include all of the following complete materials:
 - Verification form
 - Analysis and assessment form
 - Full size single-side view of the submitted structure on paper no larger than 11"x17" (folded as needed to fit into submission box)
 - A parts list of all of the structure beam cut pieces used in construction (see below)

Drawing and Parts List

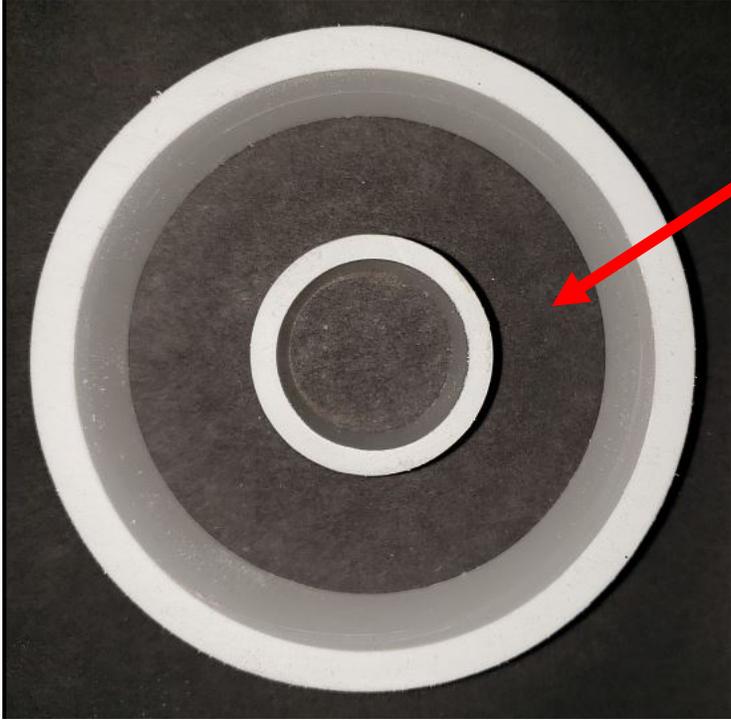
In construction, a builder uses a set of drawings along with a list of the actual cut parts needed for construction.

For this project, your drawing only needs to be a view of your structure from a single side. You do not need multiple side views or a top view for your drawing.

In addition, a parts list for this project is required. The parts list needs to be a list of the actual cut pieces used for the final construction. The list needs to include the length and quantity needed for construction.

Example Parts List: Cut from 1/8" Balsa Sticks

Part Name	Length	Quantity
Vertical Support	12"	8
Horizontal Connectors	3.25"	16
Diagonal Connectors	4.75"	12



**Your completed structure
MUST fit into the space
between the PVC pipes.**

**The completed
structure length
must be 12" tall,
with a tolerance
of 1/8".**

