



Structural Engineering

DESIGN BRIEF for 2022

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 create 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 Germany and topped out at a height of 190 meters. Currently, the tallest truss tower in the world is the Tokyo Skytree that has a height of 634 meters.

CHALLENGE

Truss towers are often designed to hold a very heavy weight using only minimal materials. Construction cranes are examples of modular truss towers, constructed from multiple, repeating sections. The goal of this challenge is efficiency; holding the maximum weight using the minimum amount of material.

The challenge this year is to research, design, and build a segmented truss tower that is composed of TWO SEPARATE truss sections that will be stacked one on top of the other. The two stacked truss sections measured together will form the total 10" height of your tower.

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

1. Aesthetics
2. Type 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

Dimensions of INDIVIDUAL tower sections

Regulation on Rubric

Maximum height of each truss tower: 5"

Maximum exterior diameter of each truss tower: 3"

Minimum interior void diameter of each truss tower: 1.66"

Outside Width of Structure

Inside Width of Structure

Dimensions of the COMBINED tower

Height of the completed FULL 2-segment tower: 10"

Maximum exterior diameter of the truss tower: 3"

Minimum interior void diameter of the truss tower: 1.66"

Outside Height of Structure

Outside Width of Structure

Inside Width of Structure

BUILDING MATERIALS

Balsa strips (1/8"x1/8") is the only building material permitted. A maximum of 16 linear feet of balsa is allowed to construct both sections of the tower.

The participants may choose a **glue** type; however, hot-melt glue is not allowed for the pre-built or on-site structures. Keep the time limit in mind when selecting the glue for semifinals.

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

SPECIFICATIONS

1. The truss tower must be constructed using only 1/8" by 1/8" balsa sticks.
2. A maximum of 16 linear feet of balsa sticks can be used in the construction of your tower (includes both tower section segment).
3. The two truss sections are to be submitted as separate pieces that will be stacked by the event coordinator when tested.
4. The structure needs to fit inside a piece of 3" inside diameter schedule 40-PVC pipe.
5. A piece of 1.25" diameter schedule-40 PVC pipe needs to fit through the vertical center of your tower.
6. The test rod will pass vertically through the center of your truss tower.
7. The test block will be a minimum 3.5" x 3.5" square block.
8. The test block will be placed on the top of your truss tower at the 10" height.
9. The height of the structure is 10" and must be maintained at multiple points to support the test block.

10. A tolerance of +/- 1/8" will be applied for the height measurement when both truss sections are combined by the event coordinator for the final truss tower of 10".
11. No tolerance is applied to the exterior and interior diameter dimensions.
12. Lamination refers to the combining of two or more pieces of material with the glue grain running in the same direction. **Laminations of any kind are NOT allowed in the construction of the INDIVIDUAL truss sections.**
13. 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.
14. Gussets are not allowed to be used in the construction of your truss tower.
15. Hot-melt glue is not allowed.
16. The use of glue for coating structural components is not allowed. Excess glue on joints is considered a gusset and will result in a disqualification.
17. The tower section segments should have "top" segment and "bottom" segment clearly labeled. Each segment also needs to be labeled for orientation "up" and "down." The labels will allow the structure will be tested in the correct orientation. Color coded marking on the structure segments may be used to indicate how the truss segments are to be aligned for testing.

AUTOMATIC DISQUALIFICATIONS

1. Use of any material that is not 1/8" x 1/8" balsa sticks
2. Use of any laminations in individual truss sections
3. Use of gussets or over-gluing that emulates a gusset
4. The truss system sections do not meet the inside, outside, or height requirements

DRAWING AND PARTS LIST

In construction, a builder uses a set of drawings along with a list of actual cut parts needed for construction. For this requirement, your drawing must be a full-size three view drawing that includes a left, top, and right-side view of ONE of your truss sections. The title block on the drawing must include only the team ID number. The paper size is no larger than 11"x17".

A parts list is required. The parts list needs to be a list of the actual cut pieces used for the final construction of the two sections. The list needs to include the length and quantity.

Example Parts List: All material is 1/8"x1/8" Balsa Sticks

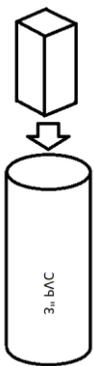
Part Name	Length	Quantity
Vertical Support	6"	16
Horizontal Connectors	2.75"	24
Diagonal Connectors	3.5"	16

REQUIREMENTS FOR CHECK-IN ON-SITE

1. Completed tower section segments separated and submitted together in a single plastic storage box (size limit for the storage box is a maximum of 12" tall, 16" wide, and 18" long). The segments are labeled with the team ID only. The plastic storage box should have the team ID on the outside.
2. The tower section segments should have "top" segment and "bottom" segment clearly labeled. Each segment also needs to be labeled for orientation "up" and "down." The labels will allow the structure will be tested in the correct orientation. Color coded marking on the structure segments may be used to indicate how the truss segments are to be aligned for testing. If not labeled, the event coordinator will randomly stack the tower segments.
3. The documentation portfolio, which is placed inside of the plastic storage box, must include the following materials:
 - Team Verification Form
 - Analysis and Assessment Form
 - Full size three view drawing of the one of the submitted structure tower segments on paper no larger than 11"x17" (folded as needed to fit into the documentation portfolio)
 - A parts list of all of the structure beam cut pieces used in construction

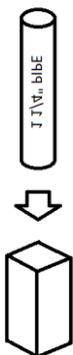
MEASURING MATERIALS

Schedule-40 PVC pipe is available from multiple sources or businesses. Using a 10" piece of the following two sizes of PVC pipe, check your solution for the height, inside diameter, and outside diameter. The PVP pipe as a measuring material will help you avoid a disqualification.



10" piece of **3" inside diameter schedule 40 PVP pipe** for measuring maximum diameter

Each segment of your truss system must fit inside of this pipe



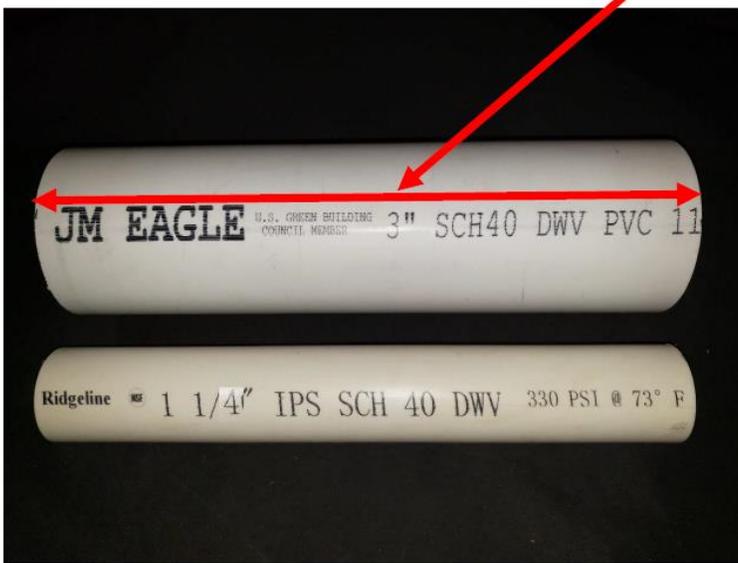
10" piece of **1 1/4" inside diameter schedule 40 PVC pipe** for measuring minimum interior diameter

This pipe must fit inside (pass through) each truss system segment from top to bottom, inclusive

Side View of Measuring Materials

Each PVC pipe should be exactly 10" in length.

When the two tower segments are stacked and placed inside the 3" schedule 40 PVC pipe, the height of the solution (two segments) has a tolerance of 1/8".



Top View of Measuring Materials

Each of the two truss tower segments **MUST** fit into the space between the PVC pipe sections in order to meet the specifications on inside and outside diameters on the rubric.

