Objective

Build a model bridge onsite with provided tools and materials within 1.5 hours and achieve the highest structural efficiency \( E = \text{maximum load/bridge weight} \). The goal is to build a bridge that will hold the most weight with the least amount of materials.

Rules

1. Teams will build a bridge within 2.5 hours at the competition site using a set of provided materials. Each team should build a bridge that is capable of supporting the greatest load per the bridge’s weight. Each team will independently perform both design and construction. No pre-constructed bridge components are allowed; however, written plans are permitted. Phones and tablets are not permitted to be used during the build time.

2. Each team will be provided a standard set of tools that will be turned in to the sponsors prior to leaving the build area for testing. Only tools provided by the sponsors may be used during the build. No tool, whole or in part, may be built into the bridge itself.

3. **Bridges must be designed to accommodate the loading apparatus.** The load will come from the top of the testing structure. The 6” plate, which must lay perpendicular to the bridge, must rest flat on the center of the bridge deck while the load is applied downward from above. Note that the plate is longer than the length of one large popsicle stick. Care should be taken in the deck design to reinforce the area where the loading plate rests and the ends where the bridge rests on the test stand. Note that since the structure comes down from the top, consider how the sides/top of your bridge could be impacted during testing.

4. The weight of the bridge will be recorded after inspection by the judges and prior to testing.

5. The load weight shall be increased until the bridge fails. The maximum load that breaks the bridge will be recorded.

6. The bridge will be judged based on the highest support efficiency rating \( E = \text{maximum load/bridge weight} \)

7. The bridge span cannot be greater than 24 inches or less than 20 inches.

8. The bridge height must fit within the testing mechanism. Bridges should be no more than one popsicle stick in height. See above pictures for scale.

9. The bridge width cannot be greater than 6 inches or less than 4 inches.

10. The bridge deck must be able to accommodate a toy car or truck. This is used to verify that the bridge acts as a bridge.
11. In the event of a support efficiency tie, the lightest bridge wins. It is up to the team to decide on the optimum balance between weight and strength.

12. The Judges are provided by the Institute for Transportation at Iowa State University; all decisions by the judges are final.

Modeling Tips

1. Remember, for a real bridge, the important part is the steel and/or concrete structure that supports the deck the cars drive on, not the deck itself…

2. A bridge needs to have a solid, stiff shape along its height, length and width. The structure should not bend or twist when weight is placed on it. For example, a Popsicle stick is easier to bend along its flat side than along its edge.

3. A bunch of sticks glued together flat, like a raft, has very little strength and will sag during testing under very little load (a force/weight placed on it).

4. String as a structural piece should always be in tension. In other words, it should always be stretched.

5. The strongest structural shape is the triangle. A bridge which is made of a series of triangles will be very strong. (See page 5)

6. A bridge that is symmetrical is less likely to twist when loaded with a weight and will probably carry more.

7. A bridge built too tall will have a high moment of inertia, increasing stiffness and strength (a good thing). However, it may become unstable and topple when under a load (a bad thing).

Idea Generating Guidelines

1. Read this document thoroughly, and watch this video: http://www.youtube.com/watch?v=gMgBjHBjcf0&feature=youtu.be

2. Explore the internet for bridge-building tips and other bridge-building competitions.
   - The Bridge Site – http://www.bridgesite.com/funand.htm
   - West Point Bridge Designer 2012 – http://bridgecontest.usma.edu/download.htm

3. See pages 4-5 for bridge-building basics provided by the American Society of Civil Engineers (ASCE).

4. Observe real bridges while traveling!
BRIDGE INSPECTION CHECKLIST

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Acceptable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge Length:</td>
<td>(24 inches max; 20 inches min)</td>
</tr>
<tr>
<td>Bridge Height:</td>
<td>(max 1 popsicle stick high)</td>
</tr>
<tr>
<td>Bridge Width:</td>
<td>(6 inches max; 4 inches min)</td>
</tr>
<tr>
<td>Bridge Span:</td>
<td>(≥ 18 inches)</td>
</tr>
<tr>
<td>Decking across the entire portion of the bridge span</td>
<td></td>
</tr>
<tr>
<td>Deck capable of supporting weighted toy truck</td>
<td></td>
</tr>
<tr>
<td>Assembly area clean / Tools and materials turned in</td>
<td></td>
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</tbody>
</table>

Tools List

1. 1/2” round file
2. Mini pliers with wire snaps
3. 6” utility calipers
4. Coping saw
5. 8” triangle carpenter square

Items not pictured:

6. Pencil and graph paper
7. Measuring tape
8. Nitrile (non-latex) gloves (2 pairs)
9. Pair of scissors
10. Clothespins (30 per team)
11. Cutting board
12. Hot glue gun

Materials List

1. Hot glue (3 sticks)
2. String (small ball) and floral wire
3. Masking tape
4. Bridge decking (poster board)
   a. 1 – 21” x 3 1/4”
5. Popsicle sticks (to be issued in manufacturer’s package)
   a. 120 – 5 7/8” x 3/4” x 1/16”
   b. 80 – 5 1/2” x 1/4” x 1/16”
6. Round wooden dowels
   a. 2 – 36” x 1/8”
7. Square wooden dowels
   a. 2 – 36” x 1/4”

*Please note, only materials may be used to construct the bridge. Tools (including clothespins) may not be incorporated into your bridge design.
Bridge Types

- Tied Arch
- Arch
- Basket Handle Arch

- Suspension
- Truss
- Cable Stay

Load Path

- Strengthen areas where loads are connected

Connections

- Reinforce joints, because bridges are only as strong as their connections
Stability

- Use triangular shapes to prevent rectangles from leaning/deforming
- Members in compression, such as the Top Chord, will try to buckle sideways during loading and can be prevented by using Top Lateral Bracing
- Some bridges will twist along their length during loading and can be prevented by using a "closed" shape, such as a box or triangle, as opposed to an "open" U-shape.

Truss Types