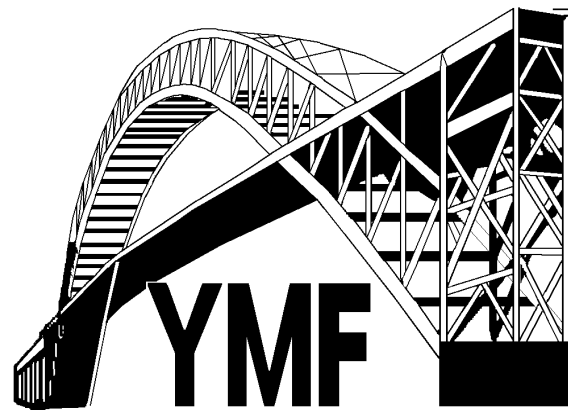




# THE 2010 POPSICLE STICK BRIDGE BUILDING CONTEST CODE

*Younger  
Member  
Forum*

seattle.asce.ymf@gmail.com  
<http://seattleasce.org/ymf/popsiclebridge.html>



# The 2010 Popsicle Stick Bridge Building Contest is:

## February 13, 2010

Located at:

# The Museum of Flight

<http://www.museumofflight.org>

9404 East Marginal Way South,  
Seattle, WA 98108-4097  
206.764.5720

Exit 158 from I-5, head west, turn right at East Marginal Way,  
the Museum of Flight is one-quarter mile on the right.

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## Chapter 1 2010 RULES

See the Contest Code, Chapter 4, for Official Rules and more information

1. Materials:
  - a. Students must use white birch Popsicle sticks provided by the contest organizers, the Seattle Younger Member Forum of the American Society of Civil Engineers. The dimensions of the sticks are roughly 4-1/2" x 3/8" x 3/32".
  - b. Sticks may be physically altered (i.e. cutting, notching, sanding, bending, etc.)
  - c. Sticks may NOT be painted, coated, or soaked in anything except water.
  - d. Only water soluble white Elmer's glue may be used as an adhesive.
2. Dimensions:
  - a. The height of bridge is limited to 12" above the support (see Figure 203.2).
  - b. No part of the bridge may extend below the end supports.
  - c. The width must be less than or equal to 5 inches.
  - d. The bridge length must be greater than or equal to 30 inches.
3. Weight:
  - a. The bridge must weigh 350 grams or less.
4. Roadway:
  - a. A 4-inch high by 4-inch wide vehicle must be able to pass through the entire length of the bridge with no obstructions.
  - b. The roadway must be continuous with no gaps (natural warping okay). The minimum dimensions of the roadway are the length of your bridge by 4-inches.
  - c. No part of the roadway can be more than 2.0-inches above the end supports.
5. Loading:
  - a. The load machine will apply a vertical load at the center of the bridge.
  - b. The load must be applied directly to the roadway.
  - c. The machine press is 3-inches by 3-inches. Make sure that there is a clear space above the center of the bridge for the machine press.
6. Supports:
  - a. Supports will be provided for the bridge to sit on.
  - b. The supports will be placed 29 inches apart.
  - c. The bridge may not exert any horizontal loads on the supports, other than friction.
7. Construction:
  - a. At least one entire side of the longest dimension (typically the edge or face) of each Popsicle stick used must be clearly visible for judging.
  - b. Only the end of a member needs to be seen for judging if it is being used as a dowel.
  - c. Voids or enclosed areas where sticks could be hidden from judging are not allowed.
8. Contest:
  - a. Each team may include up to four students.
  - b. Every student must be in 9<sup>th</sup>, 10<sup>th</sup>, 11<sup>th</sup>, or 12<sup>th</sup> grade.
  - c. At least one student from each team must be present at the competition.

## **Chapter 2**

### **INTRODUCTION**

#### **1. Background**

Bridges have fascinated people since the dawn of time when nature built many bridges in the form of trees fallen over rivers. As technology developed, people began to build artificial bridges where nature had not. Advances in bridge design, engineering, and construction have made possible many types of bridges using various types of materials.

Today, bridges can be of the span, arch, or suspension type. Materials used throughout history include wood, masonry, cast iron, wrought iron, concrete, steel, reinforced concrete, alloy and silicon steel, prestressed concrete, carbon fiber, and aluminum.

#### **2. The Contest**

One of the traditional competitions in the civil engineering community is the Popsicle Stick Bridge Contest. Individuals and teams from various schools build bridges using only Popsicle sticks and white glue as building materials. Bridges are loaded until collapse. In the past, bridges weighing between 200 and 400 grams have carried loads ranging from a hundred pounds to over a ton!

Chapters 1 & 4 of this packet define the rules to be used to construct bridges for the contest. These rules are needed to create a fair competition and to ensure the bridges can be loaded with the equipment ASCE provides. Chapter 5 explains how the results of the bridge loading will be used to award prizes. Although the goal of the contest is to expose students to engineering practice, prizes promote creativity, extra effort and make the contest more exciting for all involved.

#### **3. Why Popsicle sticks?**

Popsicle sticks are imperfect. Some may be bent, warped, or knotty; while others may be brittle, thin, or cracked. Visual inspection will weed out grossly deformed sticks, but students must deal with the slight imperfections present in all sticks. This is true in the real world where perfect materials are not available and careful thought must be given to the reliability of the construction materials. Engineers must attempt to quantify and account for deficiencies in both initial and post-construction material properties.

Popsicle sticks are limited to a standard size that falls short of the overall bridge dimensions. In order to span a distance of 30 inches, several sticks must somehow be connected together in a straight line. Again, this reflects real design problems where materials are finite in dimension and must be assembled in some manner to meet the engineer's needs.

By being limited to only two allowable materials - wood popsicle sticks and white glue - students will need to use creativity, ingenuity, and resourcefulness in order to maximize the strengths and minimize the inherent shortcomings of each material.

### Chapter 3 DEFINITIONS

**BRIDGE** is a structure that is self-supporting between supports and complies with this code.

**CLEAR SPAN** is the clear distance between the supports that the bridge must span over.

**DISQUALIFICATION** will prevent eligibility for prizes and you will not receive a score. This will only occur when the rules of Chapter 1 are not followed in their entirety.

**LAMINATED** is the actual portion of the face of a stick that is glued to another member.

**MEMBER** is a portion of the bridge, whether made of a single stick or multiple sticks that connects two parts of the bridge together. The sticks in a member are generally oriented lengthwise between connections and the member is much longer than it is wide. For example, a beam is a member, but the roadway is not a member.

**ROADWAY** is the portion of the bridge that wheeled traffic would drive over. Normally it is constructed by laying sticks flat and edge to edge to create a large surface. Only the sticks that would actually come in contact with wheeled traffic are considered part of the roadway.

**STACK** is multiple sticks glued face-to-face. Stacks are made of at least two sticks and have no maximum.

**STICK** is a single Popsicle stick. The broad side of a stick is called a **FACE**. There are two faces. The rest of the sides of the stick are narrow and are called **EDGES**.

**STUDENT** is described as any participant of a team that is currently enrolled in a high school-level math or science class.

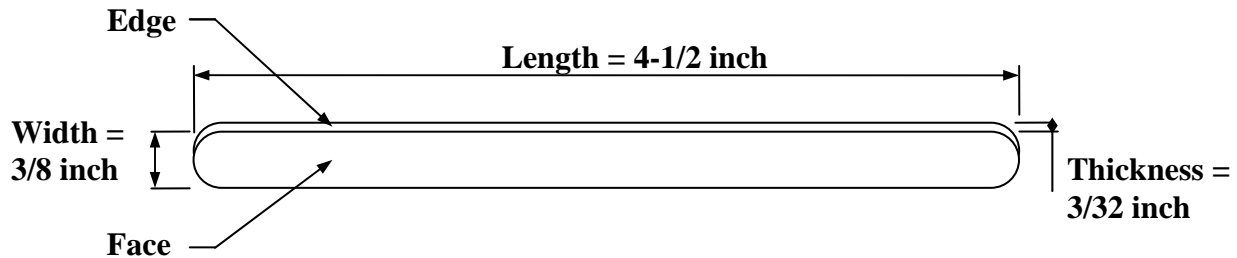
**SUPPORTS** are the end surfaces that will support the bridge. The supports will have the dimensions of  $\frac{3}{4}$  inches wide by 5 inches long.

**TEAM** is a group of up to four students (maximum) that compete in the competition. Three teams are allowed to compete per school. Each student must enter the competition on only one team, and at least one team member must be present at the contest.

**Chapter 4**  
**OFFICIAL CONTEST CODE**

**1. Materials**

- a. Use white Birch Popsicle sticks provided by the ASCE Younger Member Forum. Using other Popsicle sticks will result in disqualification. The sticks have the following dimensions:



*Figure 203.1*

- b. Sticks may be physically altered in any way, including:
- i. Cut / notched at any angle.
  - ii. Sanded to any width.
  - iii. Bent or curved (sticks may be soaked in water to curve).
- c. Sticks may **NOT** be altered in the following ways:
- i. Soaked in any material besides water.
  - ii. Painted or coated with any material.
- d. **ONLY** water soluble white Elmer's glue can be used as an adhesive.

**NOTE:** Yellow wood glue or glues containing resin additives or other cement binder are **NOT** allowed.

**2. Overall Dimensions**

- a. The height of the bridge must be less than 12" measured from the top support (see Figure 203.2). The bridge may **NOT** extend below the end supports.
- b. The total bridge width must be 5 inches or less.
- c. The bridge length must be greater than or equal to 30 inches.
- d. The clear span between the supports will be 29 inches.

**3. Weight:**

- a. The bridge must weigh 350 grams or less.

#### 4. Roadway

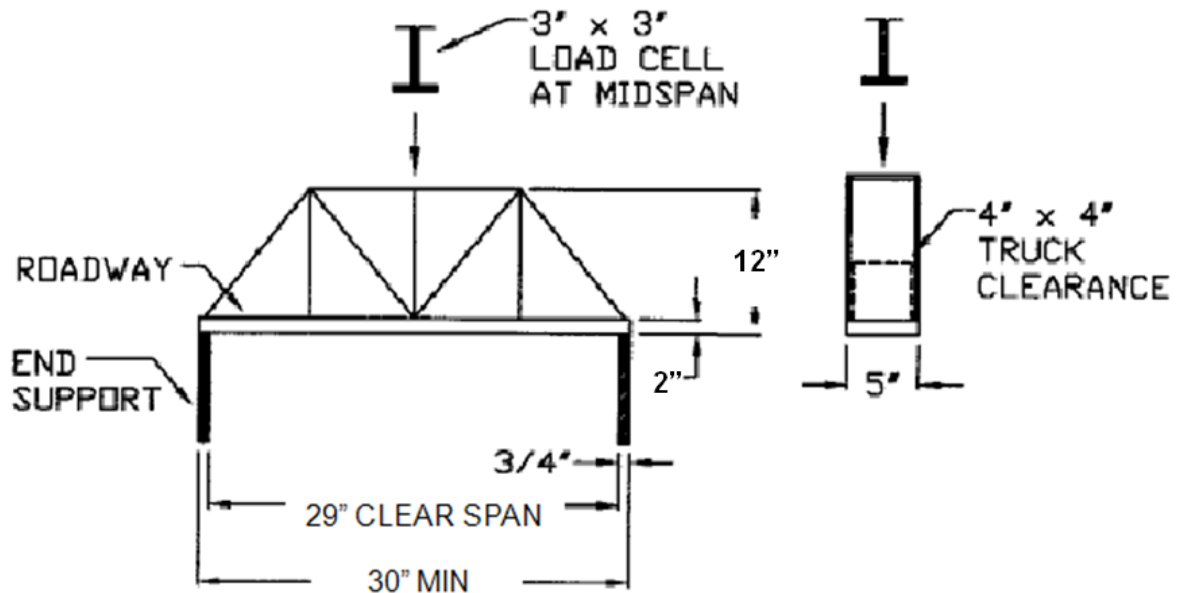
- A 4-inch high by 4-inch wide vehicle must be able to pass the entire length of the bridge.
- The roadway must be continuous with no gaps (natural warping okay). The minimum dimensions of the roadway are 30-inches by 4-inches.
- No part of the roadway can be more than 2.0-inches above the end supports.

**5. Loading:** The bridges will be loaded to ultimate capacity during the competition. Bridges will break.

- The machine will apply a vertical load at the center of the bridge.
- The load must be applied directly to the roadway.
- The machine press is 3-inches by 3-inches. Make sure that there is a clear space above the center of the bridge for the machine press.

#### 6. Supports

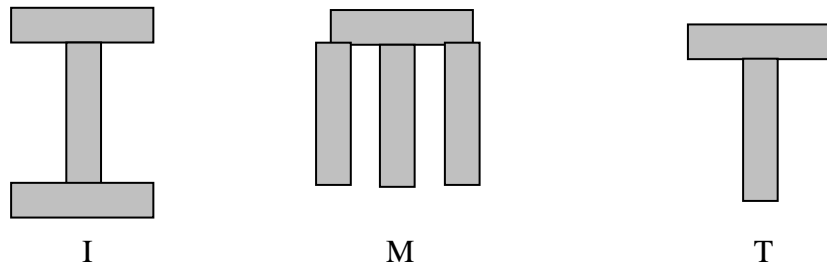
- Supports will be provided for the bridge to sit on.
- The supports will be placed 29 inches apart.
- The bridge may not exert any horizontal loads on the supports, other than friction.



*Figure 203.2*

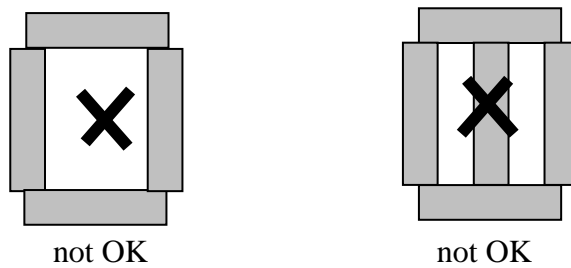
## 7. Construction

- a. At least one entire side of the longest dimension (typically the edge or face) of each Popsicle stick used must be visible for judging.
- b. Only the end of a member needs to be seen for judging if it is being used as a dowel.



*Figure 204.3a*

- c. Voids or enclosed areas where sticks could be hidden are not allowed.



*Figure 204.3b*

## **Chapter 5**

### **JUDGING and SCORING**

#### **1. First Judging**

A panel of technical judges will review the bridges for any rule violations. Any bridge with violations will be disqualified. However, if a rules violation can be corrected, the technical judges *may* allow the bridge to be modified, provided it can be re-qualified before the end of the contest registration.

After the technical judging, a panel of aesthetic judges will evaluate the bridges.

#### **2. Challenges**

Challenges may be made following the first judging period. Only students with bridges that have not been disqualified may challenge another bridge that is felt to be in violation of the rules.

Any bridge that has been disqualified during the first judging period may be appealed.

#### **3. Second Judging**

The panel of technical judges will review all challenged bridges. In addition, the panel will review the bridge of any team that challenges another bridge.

The technical judges will hear all appeals.

The decisions made by the technical judges after the second judging period are final. No challenges, appeals, or complaints will be heard after this time.

#### **4. Scoring**

Bridges will be evaluated in two categories: efficiency and aesthetics. These two categories are described below.

Your bridge will be scored on how well you have used your materials to support the load. We will call this efficiency and define it as the ratio of ultimate load capacity to bridge weight. In engineering, the best solution may not always be the biggest or strongest bridge. Typically our designs are driven by limitations such as money or availability of resources. These constraints often push us to find a solution that satisfies these limitations most efficiently.

Your bridge will also be scored on aesthetics. Professional designers will judge your bridges based on their detail to connections and members, the uniqueness of your design and its overall look. All bridges must meet aesthetic criteria because they must function well with their environment. Many bridges are paid for by the public, and if people don't like using it or looking at it, they will be unhappy paying for it! So before constructing your bridge take some time to think about how you want it to look in the end.

In this contest, your bridge will be loaded to its ultimate capacity. After this load is reached, the bridge will break to an extent that it will never be able to hold as much load. The ultimate load capacity of each bridge is needed to determine its efficiency. Most often your bridge will be

damaged beyond repair. Sometimes bridges will shatter into pieces or be broken in half. It makes the contest very fun to watch!

Each bridge will be scored against the others in each of the two categories for an overall score. Each category will have equal weight. To ensure equal weight, the highest score for efficiency and aesthetics will be given 100 points. The lowest score will receive 50 points. All other scores will be weighted accordingly. The scores for each category will be combined for the final score. The bridge with the highest overall score wins first prize. In the event of a tie for the overall rank, the bridge efficiency will be used as the tie-breaker, and the team with the highest efficiency score will be declared the winner. An example of overall ranking is illustrated in the table below.

Team	Bridge Weight	Actual Load	Efficiency	Efficiency Score	Aesthetic s Score	Total Score	<b>Overall Rank</b>
A	348	532	1.5	62	92	154	3
B	350	2168	6.2	100	74	174	2
C	349	827	2.5	70	81	151	4
D	332	245	0.7	56	70	146	5
E	341	1	0.0	50	95	145	6
F	345	367	1.1	59	65	124	8
G	347	278	0.8	57	76	133	7
<b>H</b>	<b>339</b>	<b>1256</b>	<b>3.7</b>	<b>80</b>	<b>95</b>	<b>175</b>	<b>1</b>
I	340	526	1.5	62	50	112	9

## 5. Prizes

Complete prize packages will be provided for the top three overall winners. Prizes in the past have included MP3 players, graphing calculators, back packs, Mariners tickets, gift cards, and much more. Smaller prizes are given to the top three teams in the aesthetics and strongest bridge categories.

Once again, this year we will be holding our POSTER COMPETITION. See the following section for the rules and prize information.

## **Chapter 6**

### **POSTER COMPETITION**

#### **1. General**

- a. Each team may submit one poster for the competition. The poster should describe the design process of your bridge. Each poster must include the following information: name of High School or group, names of bridge designers, a sketch of your bridge, and a description of your bridge. Additional information can include (but is not limited to): pictures of the construction process, pictures of similar real-life bridges that might have inspired your design, and examples of what makes your bridge unique. Feel free to be creative.

#### **2. Specifications**

- a. Maximum Dimensions of the poster are 3-feet by 4-feet, but the poster may be smaller if desired. The poster may be positioned in the horizontal or vertical direction. Folding the poster is allowed so that it stands on its own, or it can be left flat to hang on a wall. Again, feel free to be creative.

#### **3. Judging**

- a. Judging will be based on the following four categories: 1) description of the bridge, 2) bridge sketch, 3) creativity, and 4) overall quality of the poster. Each category will be weighted equally for a total of 100 points.

#### **4. Prizes**

- a. Prizes will be awarded to the overall winner of the competition.

## Chapter 7 FREQUENTLY ASKED QUESTIONS

Can we notch the members?

*Yes. See Rule 1.b*

Can we drill holes through the members or cut slots in them?

*Yes. See Rule 1.b*

Can we shave the members to make them thinner or narrower?

*Yes. See Rule 1.b*

Can we saturate the members in white glue?

*No., Rule 1.c restricts the soaking of the members in anything but water.*

Can we paint/color the bridges or add decorations to them?

*No. Rule 1.c restricts the bridge to only Popsicle sticks and white Elmer's glue.*

Can we glue the sticks together to form a corner or "L" section?

*Yes, just make sure each stick is visible for judging.*

Can we steam the sticks?

*Yes. Sticks may be steamed to form curved shapes allowed in Rule 1.b.*

Does the 3"x3" load area in Rule 5.c require clear access above it for the load application?

*Yes. The bridges are loaded from directly above the load area.*

If some paper was accidentally glued to a member, will that count against us?

*Not if it was truly accidental and wasn't for aesthetic purposes.*

Does the roadway have to meet the supports at grade?

*No. You may build a bridge with the roadway above the supports, but Rule 4.c states that no part of the roadway can be more than 2.0-inches above the supports.*

What if a student helps build more than one bridge? Is that okay?

*Yes. A student may help other teams and build other bridges, but they can only enter the competition on one team. This makes sure each student is responsible for only one bridge and that every student has an equal chance of winning a prize.*

How do I determine the numbers of stacked sticks if I have members glued to a joint at multiple angles?

*This year, there is no limit to the size of a stack.*

## Chapter 8

### TIPS FOR BRIDGE BUILDING

Remember, judges will be making sure you followed all of the rules according to this document. If you do not follow the rules, you won't be able to win prizes. Make sure you have read and understand the rules before building your bridge. If you still have questions, have your teacher e-mail our contest organizer or the classroom speaker.

Start with paper and pencil first. Sketch out your ideas. Draw your bridge in at least three views - looking at it from the side, looking at it from the end, and looking at it from the top so you get a good idea of what you're building.

Choose the design you are sure you can build. Think about how you will meet all the rules. Try using the West Point Bridge Designer at <http://bridgecontest.usma.edu/>

Think about how the load will transfer from the loading area, through beams or trusses and out to the supports at each end of the bridge. Not all parts of your bridge will have the same forces running through them. What bridge members do you think will take the greatest load? Make those members stronger.

Which members do you think will be in compression? Which ones will be in tension? A single Popsicle stick in tension can hold more weight than one in compression. Members in compression tend to buckle sideways. Make sure your compression members are strong and well braced.

Your bridge members are only as strong as your connections, so pay special attention to the connections! How can you construct strong connections? Make sure the gluing surfaces are large and flat. Use clamps to hold joints under pressure until the glue is dry.

If your bridge has similar patterns that are repeated throughout your design, construct modules so the pattern is accurately constructed each time. If your pattern is not dimensionally consistent or each side of your overall bridge is not symmetrical, some parts of your bridge will take more load than you originally planned.

If you use several rows of sticks to make up a structure, don't leave any sticks out or the structure probably will fail at that point.



Before you build your entire bridge you may want to test small parts of your bridge and compare one design to another to see which is stronger. You can even test your stick connections.

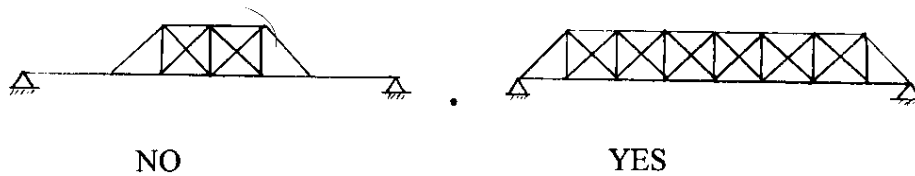
Your bridge is loaded on a 3-inch by 3-inch square on the roadway. Consider adding sticks that will stiffen the roadway from the underside, and be sure to make strong connections between the

roadway and the main members spanning the 29-inch gap. You don't want your roadway to fail before your main members are loaded up.

Lateral supports (members that are perpendicular to the direction of traffic on the bridge) are important to brace the tops of the trusses, but the majority of the strength is needed in the main members spanning the 29-inch gap (members that are parallel to the direction of bridge traffic).

Remember – your bridge will be picked up and inspected during judging and will probably be turned upside down. Make sure that all your pieces are glued together and that your bridge will not fall apart or lose its shape.

If you design a truss, be sure it extends all the way to the ends where it will be supported. Don't put a truss just in the center section.



How does your bridge look? If this were a real bridge, do you think the public would find it pleasing to the eye? Can you make your bridge attractive and strong at the same time?

Construct a bridge on a surface that glue will not stick to! Try to work in an area you don't mind getting messed up.

Are you at a loss for ideas? You can view photos and results from previous contests here: <http://www.flickr.com/groups/popsiclestickbridge> Keep in mind that the rules are different each year.

Plan ahead!!! Don't wait until the night before the contest to finish the bridge! (Wet or damp glue doesn't work very well.) You may have enough time at the contest to make adjustments if your bridge does not qualify. Bring some tools just in case.

Tools to help you with your bridge construction:

- pencil
- paper
- wire cutters for cutting sticks
- Exacto knife
- Hair dryer (to dry the glue quicker)
- clips, rubber bands, and weights to clamp pieces together when the glue is drying
- and finally, ..... PATIENCE !!! Good bridges take time to build.