SELMON EXPRESSWAY
BRIDGE DESIGN COMPETITION

January 13, 2014
BALSA WOOD BRIDGE DESIGN RULES

MATERIALS

Balsa wood and glue are the only materials to be used.

Balsa wood: The maximum permissible cross-section size is ¼" x ¼". Pieces of smaller cross-section may be used to economize on weight. Pieces of larger cross-section may be fabricated by gluing several ¼" x ¼" pieces together. For example, it is permissible to glue together three pieces of ¼" x ¼"cross section balsa wood to make one piece that is ¼" x $^3/_4$" in cross-section. It is important to make sure that the model shop gives you balsa wood since many shops also carry other woods which may look similar to balsa.

Glue: Bridges may be built using any type of glue. Consider the following when choosing glue:

1. *ZAP A GAP*, or similar glues which are known as cyanoacrylates, are very convenient. Cyanoacrylates "set up" or "dry" quickly, usually in less than 30 seconds. This allows you to move along quickly building your bridge. *ZAP A GAP* is usually more expensive than the other brands of cyanoacrylate. All brands of cyanoacrylate are expensive, so be careful when you use it. A little goes a long way.
2. When using *ZAP A GAP* or similar glues it is important to have a debonder readily available since the glues set so quickly that fingers are often stuck to the bridge or to each other. Debonder is usually available at the store where the glue is purchased.
3. Other types, like Elmer's White glue or Elmer's Carpenter's Glue, may be used. However the "set up" or "drying time" is usually 30 to 45 minutes and they do not achieve full strength for 24 hours or more. That means you will have to hold the pieces of your bridge together for a long time with your fingers or pins or clamps. If you are building your bridge in class the glue will not "set up" by the time you are ready to leave.
4. On the other hand, some bridge builders feel that carpenter's glue is stronger than cyanoacrylate glue. Also, using carpenter's or white glue avoids the problem of accidentally gluing ones fingers together, which is a definite advantage for younger bridge builders.

BUILDING TEAMWORK SKILLS

Engineers usually work in teams, but most classroom assignments are structured as individual activities. Essential teamwork skills do not always come naturally, but they can be cultivated. Bridge building affords a rare opportunity to learn and practice the engineering team approach to problem solving. Students that work in teams, as engineers do, usually produce better results. Experience has taught us that the ideal team size for this project is three team members. However, the number of students that want to participate is

often not evenly divisible by three. Also, special cases sometimes necessitate more than three members on a team. Therefore, the contest rules permit teams that have as few as two or as many as five team members. Each class, club chapter, or group can sponsor no more than two teams. For example, a school with an after school science club can send up to two teams to the contest. A science and technology magnet school that has three engineering classes can send up to six teams to the contest, two from each class.

DESIGN AND CONTEST RULES

1. The bridge shall be designed and constructed by a team of students. The preferred team size is three, but it is permissible to have as few as two or as many as five students on each team. Each class, club chapter, or group can sponsor no more than two teams.
2. The bridge contest will be scored on the following four areas of achievement:
    A. Load capacity - The bridge will be loaded to determine how much weight it can support.
    B. Design Drawings - Score will depend on:
        1. Resemblance - The accuracy of the drawings in relationship to the bridge. The drawings may be full size or to scale.
        2. Dimensioning - Proper indication of the height, width and length of various parts of the bridge.
        3. Completeness of title block - Must indicate: Name of project, school name, teacher name, team name, Team members, grade levels and date of completion.
        4. Appearance and neatness - Quality and cleanliness of the representation.
    C. Craftsmanship - The workmanship and care taken in constructing the bridge.
    D. Originality - Imaginative or innovative concepts used in design and construction of the bridge.
3. The bridge must be "free standing."
4. The bridge must be constructed so as to allow a 400 mm long by 20 mm high board to slide underneath it. This means the minimum "span" of the bridge is 400 mm.
5. The maximum height of the bridge is 300 mm.
6. The minimum height of the "roadway surface" is 100 mm above the surface supporting the bridge.
7. The bridge must provide a "roadway surface" that is approximately level across which a small metal car of Hot Wheels or Matchbox variety may roll, given a slight push of the hand. The roadway surface must have a minimum width of 46 mm. The roadway surface must extend the entire length of the completed bridge.
8. The maximum length of the bridge shall not exceed 550 mm and the width shall not exceed 100 mm.
9. Total mass of the bridge, including glue, may not exceed 110 grams.
10. No fastening method other than mechanical interlock of the balsa pieces or commercial glue is allowed.

11. The bridge design must allow the standard testing frame to be placed on the roadway surface with the testing rod(s) extending beyond the sides of the bridge. The standard testing frame is shown on the drawings attached to these instructions.
12. The bridge may not be painted or coated in any way including coating of members with glue.
13. The purpose in loading the bridge until it fails is to simulate the real life functioning of a highway bridge. Since any highway bridge which deflected (bent downward) seriously would immediately be taken out of service as being unsafe, any bridge in this competition which deflects more than 35 mm will be considered to have failed under load.
14. In order to prevent damage to the bridge during transportation to the contest, during handling and during the contest, each bridge should be in a protective container such as a cardboard box. The contest supervisors are not responsible for any damage to bridges that are not in a protective container.
15. All bridges, when presented for judging at the competition shall have, affixed to the bridge by tag or other means, identification which shall indicate the school name, teacher name, team name and team members and grade levels.

JUDGING

1. Bridges will be visually inspected, measured and weighed for compliance to the rules.
2. Bridge design drawings will be examined and compared with the completed bridge.
3. Points will be given for craftsmanship, originality and design drawings.
4. The bridge will be load tested after passing the weight, dimensional and materials examination. Bridges failing to pass these requirements will not be scored in the competition. The failed bridges may be load tested at the discretion of the judges, if the team requests the test.
5. The load capacity test will be conducted as follows:
   A. The bridge will be placed on the testing stand consisting of two flat, level surfaces which will be level with respect to each other and separated by approximately 350 mm.
   B. The testing frame will be placed on the roadway surface at the center of the span with 12.5 mm diameter rod(s) extending beyond the sides of the bridge. The load shall be applied to the bridge from either a single rod in the center slot of the test frame or two rods placed in slots in the test frame symmetrical about the center of the span. (Whether one or two rods are used will be determined by the design of the bridge. If either option would work, the tester will use one rod.)

C. A testing device will slowly apply pressure downward until one of the following occurs:
   1) Catastrophic destruction takes place.
   2) The vertical force applied drops to zero.
   3) The downward deflection of the bridge exceeds 35 mm. The load that the bridge sustained when the deflection reached 35 mm will be considered to be the failure load.

D. If there is more than one bridge which attains the same load capacity at failure, the position of an entry will be decided by comparing the efficiency of the bridges. The efficiency of each bridge will be determined by dividing the load at failure by the weight of the bridge.

$$\text{Efficiency} = \frac{\text{Failure Load}}{\text{Weight of Bridge}} \times 100$$

SCORING

	Points	Maximum Points
Craftsmanship	0 to 10	10
Originality	0 to 10	10
Design Drawing	0 to 10	10
Load Capacity	Highest	70
	2nd Highest	60
	3rd Highest	50
	All Others	30

ESTIMATING BRIDGE WEIGHT

Balsa wood is a natural material, so properties such as weight density and strength can vary. Bridge builders use several methods to ensure their bridges do not exceed the maximum allowable weight of 100 grams:

Method 1: Weigh out a 95 gram “kit’ of balsa wood pieces, which allows for 15 grams of glue. Limit yourself to the pieces that are in your kit. Your finished bridge cannot weigh more that the materials that go into it. Nevertheless, it is wise to weigh your finished bridge to confirm that it is not overweight.

Method 2: Calculate the weight. Determine the average linear density of each size of balsa that is used in bridge design. Put ten pieces of a given size balsa on an accurate balance of scale. Divide the weight in grams by the total length of the ten pieces. For example, ten 36-inch pieces of 1/4” x 1/4” balsa might weigh 55 grams. The total length is 360 inches. Therefore the linear density is: 55 grams/ 360 inches = 0.153 grams per inch.

The linear densities in the following table are typical. However, bear in mind that balsa wood is a natural material. Characteristics such as weight and strength can vary depending on the source, and the grade purchased. It is best to weigh your balsa and derive your own table.

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BRIDGE DESIGN COMPETITION

Typical Balsa Wood Weights

1/4” x 1/4”	Balsa – 36” long	5.5 Grams/36” stick	(0.153 Grams/inch)
1/4" x 1/8”	Balsa – 36” long	4.74 Grams/36” stick	(0.132 Grams/inch)
1/8” x 1/8”	Balsa – 36” long	2.00 Grams/36” stick	(0.056 Grams/inch)
1/4” x 1/16”	Balsa – 36” long	2.40 Grams/36” stick	(0.067 Grams/inch)

You can calculate how much your bridge will weigh using this guide and measuring the lengths of the various wood sizes you intend to use in your design. Remember the weight of the glue usually is 15% of the weight of the completed bridge. The weight of the wood then would be 85% of 110 Grams or about 93 Grams. Be careful! Wood can vary in weight in accordance with moisture content and the tree it is sawn from. The heartwood in the tree has greater density than the outer wood. It is well to weight your bridge as you go along to make sure you stay within the 110 Gram limit.

Bridge Weight Calculation Example

Member Main Supports	Size	Number	Length in Inches	Total Length in Inches (Number x Length)	Unit Weight G/inches	Total Weight in Grams (Length x Weight)
A Sides						
Columns	1/4 x 1/4	16	12 5/8 avg	202	0.153	30.90
Tension Bars	1/4 x 1/4	4	20 1/2	82	0.153	12.54
Tension Cross	1/4 x 1/8	1	3 1/2	3 1/2	0.132	0.46
Cross Braces	1/4 x 1/16	20	3	60	0.067	4.00
	1/4 x 1/16	8	4 3/4	38	0.067	2.54
	1/4 x 1/16	8	4	32	0.067	2.14
BEA Rings						
Vertical	1/4 x 1/4	64	1 1/4	80	0.153	12.24
Binders	1/4 x 1/8	8	3 1/2	28	0.132	3.69
	1/4 x 1/8	8	2	16	0.132	2.11
Crown	1/4 x 1/4	18	1 1/2	27	0.153	4.13
	1/4 x 1/8	2	3	6	0.056	0.33
End Bents	1/4 x 1/16	4	9 1/2	32	0.067	2.54
	1/4 x 1/16	6	3 5/8	21 3/4	0.067	1.45
	1/4 x 1/16	8	2	16	0.067	1.07
Roadway	1/4 x 1/16	14	10 1/4	143.5	0.067	9.61
	1/4 x 1/16	8	2	16	0.067	1.07
			Total Balsa Wood Weight			90.82 G
			Add 15% for Glue			13.62 G
			Estimated Bridge Weight			104.44 G
			Actual Weight on Scale			105.0 G

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BRIDGE DESIGN COMPETITION

ESTIMATING BRIDGE CAPACITY

Most balsa wood bridge builders do not calculate bridge capacity. However, free software, such as “West Point Bridge Designer” can be found online), or students that have a basic knowledge of vectors and statics may want to manually analyze their designs.

It is helpful to know the relative forces in each member, even if actual material properties are unknown. This is accomplished by simply by running programs based on assumed values and comparing the stresses that are calculated for each member.

In any case, a good basic design value for stresses in the balsa wood is about 1,000 pounds per square inch of area in both tension and compression.

SCORING THE CONTEST

Bridge Building Competition Scoring Chart						
Team Number and Name						
Load at Failure						
Weight Actual Weight in Grams Disqualified if more than 110 Grams						
Dimensions OK? Yes No						
Scoring Category		Judge 1	Judge 2	Judge 3	Judge 4	Average Score
Craftsmanship	0-10 points					
Originality	0-10 points					
Design Drawing	0-10 points					
Load Capacity						
Highest	70					
Second Highest	60					
Third Highest	50					
All Others	30					
Total Points						

If a tie occurs, highest load place will be decided by the team with the highest efficiency rating.

$$\text{Efficiency} = \frac{\text{Failure Load}}{\text{Weight of Bridge}} \times 100$$

TYPICAL BILL OF MATERIAL

Materials and Supplies Required to Construct One Bridge Drawing and One Bridge:

General Store Purchases
Roll of wax paper
Packet of straight pins (about 1 inch in length with round head)
Glue debonder (acetone – nail polish remover)
Gallon size Zip type plastic bags
Rubber band
Needle nose pliers

Hobby Shop or Craft Store or Home Store Purchases
Working board of cork or Styrofoam
One modeling saw with fine blade
One mitre box for modeling saw
Small bottle of cyanoacrylate glue (super glue)
Metric scale (or ruler)
Straight edges and triangles (for drawing)
Scale for weighing bridge (electronic or postal type)
Balsa wood in 36” lengths: 18 pieces of 1/4” by 1/4”
6 pieces of 1/4” by 1/8”
10 pieces of 1/4” by 1/16”

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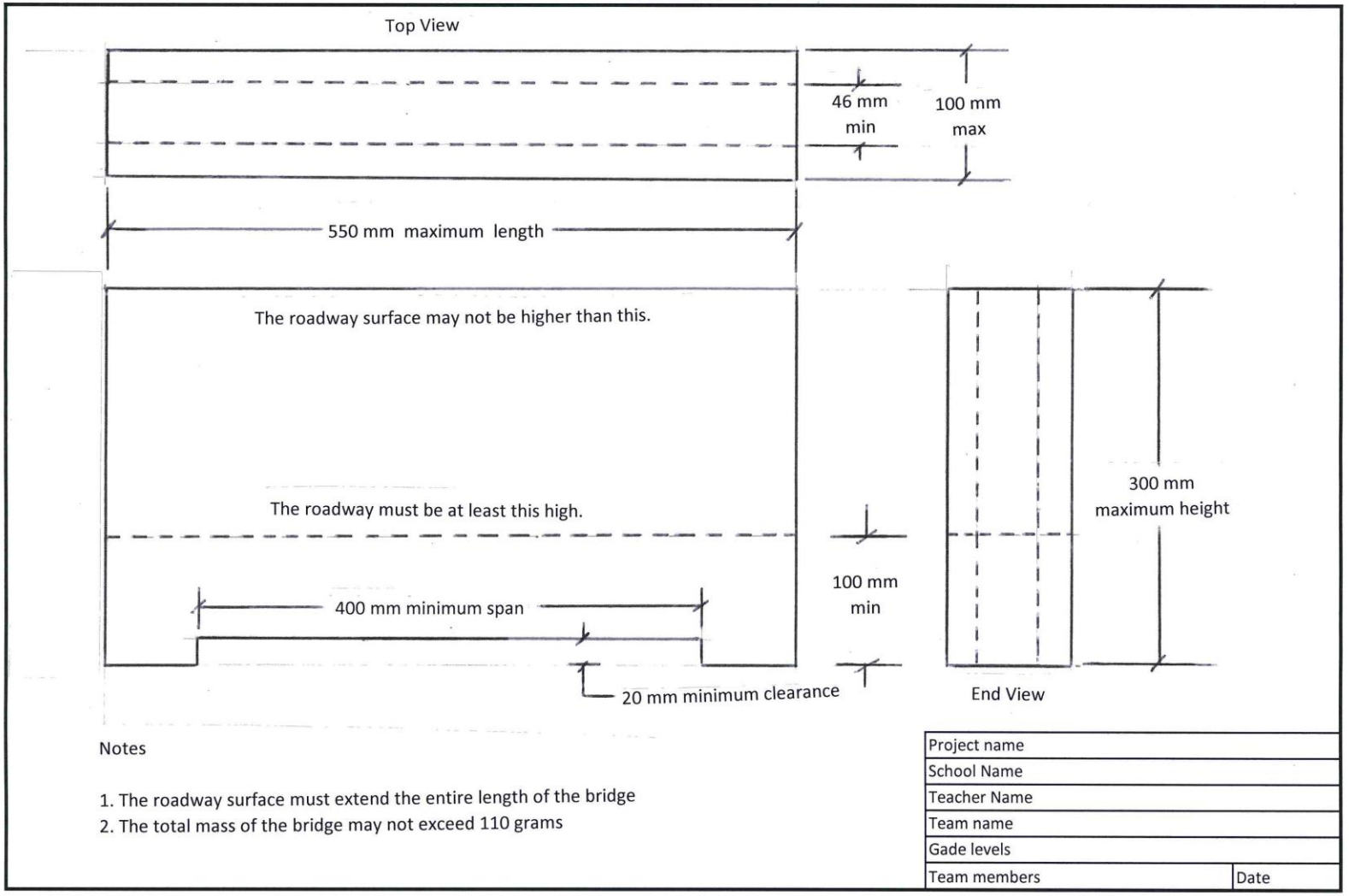

Notes

1. The roadway surface must extend the entire length of the bridge
2. The total mass of the bridge may not exceed 110 grams

Project name	
School Name	
Teacher Name	
Team name	
Gade levels	
Team members	Date

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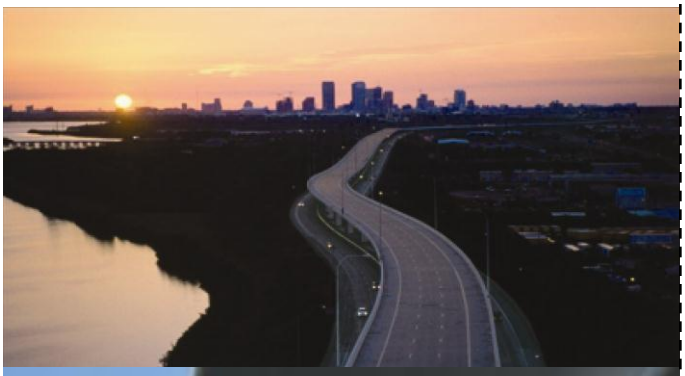

HOW DO THEY DO IT?

PBS.ORG-Building Big

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Type in: ***Building Big***

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West Point Bridge Design
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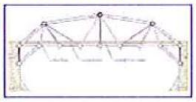
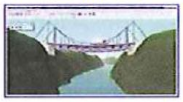
Images for West Point Bridge Design - Report images


[PDF] **ST. LOUIS WEST POINT BRIDGE DESIGN CONTEST**
File Format: PDF/Adobe Acrobat - Quick View
2010 **West Point Bridge Design** Contestants: RULES UPDATE AND ASSISTANCE ... Download and install the **West Point Bridge Designer** 2010 software (free software, ...
www.slapt.org/events/2010**West_Point**_Contest.pdf

Videos for West Point Bridge Design


West Point Bridge Design 2003 Glitch
19 sec - Jun 17, 2007
Uploaded by EagleBoy13524
www.youtube.com


Cheap West Point Bridge Design free!!!
1 min - Dec 3, 2008
Uploaded by Rocklobstaa
www.youtube.com

BridgeBuilder-Game.com - The ultimate bridge building game page
As long as our own contest hasn't started yet, we recommend taking part in the 2005 **West Point Bridge Design** Contest, that will begin on January 6, 2005. ...
www.**bridge**builder-game.com/ - Cached - Similar

[PDF] **Opening Westpoint Bridge Designer :**
File Format: PDF/Adobe Acrobat - Quick View
Opening **Westpoint Bridge Designer**: 1. Click on the Start Menu. 2. Using your mouse, left-click on CAE Applications. 3. Move your mouse to Engineering and ...
www.engr.wisc.edu/outreach/tutorials_files/**BridgeDesigner**.pdf - Similar

West Point Bridge Design Contest - Chief Delphi
Jan 4, 2010 ... **West Point Bridge Design** Contest General Forum. ... We had to design in West Point, then actually build it out of basswood. ...
www.chiefdelphi.com › Chief Delphi › FIRST › General Forum - Cached

Can someone help me with my West Point Bridge Design? - Yahoo! Answers
Feb 7, 2010 ... I have mine down to, like, 200000. Does anyone ever use it and if so ... haha yeah i had to do that from one of my grade 9 computer classes... ...
answers.yahoo.com/question/index?qid... - Cached - Similar

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the contest website - Bridge Building Contest Home Page. ... - bridgecontest.phys.iit.edu
Bridge-Builders - Our first Spotlight Video profiles United 2 ... - bridge-builders.ning.com