

Civil Structures

LEVEL:	Grades 11-12
TYPE OF CONTEST:	Team
COMPOSITION OF TEAMS:	1 - 2 students per team
NUMBER OF TEAMS:	3 teams per Center (Strength to weight winners only advance)
SPONSOR:	Larry Lim, USC
OVERVIEW:	Students will design and construct a model balsawood bridge from their own plans that will carry a maximum load while using as little wood as possible, stressing neatness, craftsmanship, and creativity.
MATERIALS:	$\frac{1}{4}$ " x $\frac{1}{4}$ " square balsawood (ten 3 ft. lengths usually sufficient) and <u>water soluble Elmer's white glue</u> .

RULES FOR SIZE: Bridge Dimensions (See attached Testing Apparatus Figures in Attachment B):

1. Maximum length: 40 cm
2. Maximum width: 10 cm
3. Maximum height: 21 cm
4. Minimum clearance: 10 cm
5. Minimum span: 25 cm
6. Maximum Bridge weight: 95 grams

RULES FOR CONSTRUCTION:

MESA DAY CONTEST RULES 2009– 2009
Master Set

©University of California Regents

These rules are for the internal use of MESA staff and teachers only and should not be forwarded or used outside of MESA

1. Civil Structure should be labeled with team member's names, school and MESA Center. There will be a 10% penalty in the strength to weight score for failing to properly label.
2. No kits are allowed.
3. **Joints must be at or within ¼" of the end of at least one of the sticks (members).** No part of a stick may be glued to another stick except at the joints of the sticks. (i.e. gluing is very limited) See Appendix C, "Clarification of Gluing"
4. No glue may extend beyond 3 mm of any joint.
5. Members joined at an angle must be at an angle of 30 degrees or more.
6. Members may be carved, notched, or cut anywhere along their length.
7. Pins and/or gussets are not allowed.
8. No materials (e.g. paint, varnish, hairspray, etc.) may be applied to the bridge. Ink or pencil to identify bridge builders, school and center is ok.
9. **Maximum allowable weight of completed structure is 95 grams.**
10. Top of bridge must support a 10 cm x 10 cm plate which will bear the load for testing.
11. Bridge must have supports at least 25 cm apart, and must measure at least 10 cm above a flat surface (an imaginary "river") at at least one point (may be more than one point) between the supports.

JUDGING:

1. Prior to load testing, the bridge receives a specifications check to determine whether it conforms to the weight, dimension, and construction rules.
2. The bridge is weighed and its weight recorded.
3. Bridges are judged for neatness, craftsmanship, and creativity by a team selected by the Host Center prior to testing.
4. Bridge will be tested for load bearing capacity using the set-up shown in Attachment #2. The maximum load recorded by the load testing machine will be used as the load capacity of the bridge, regardless of when failure begins.
5. Disqualified bridges may be tested in private, time permitting.

AWARDS:

Awards are given in two categories*:

1. Strength to Weight Ratio: Determined by dividing the maximum load by the weight of the bridge. The bridge with the greatest load bearing capacity compared to its weight wins.

MESA DAY CONTEST RULES 2009– 2009

Master Set

©University of California Regents

These rules are for the internal use of MESA staff and teachers only and should not be forwarded or used outside of MESA

Example: Maximum load = 120.0 lbs
 Bridge weight = 20.0 g
 Strength to weight Ratio = $[(120 \text{ lbs} \times (454 \text{ g/lb})) / 20 \text{ g}] = 2724.0$ *

* subtract 10% if structure is improperly labeled:

e.g. $2724.0 - (2724.0 \times 0.10) = 2724.0 - 272.4 = 2451.6$

2. Creativity: Finest workmanship, including neatness and innovation of design.

* Medals will be given in the Strength to Weight category. Ribbons will be given in the creativity category.

Although awards will be presented in two categories, bridges that qualify for MESA Day finals will be determined by Strength to Weight Ratio only.

SAFETY: Appropriate safety measures will be used in testing.

ATTACHMENTS:

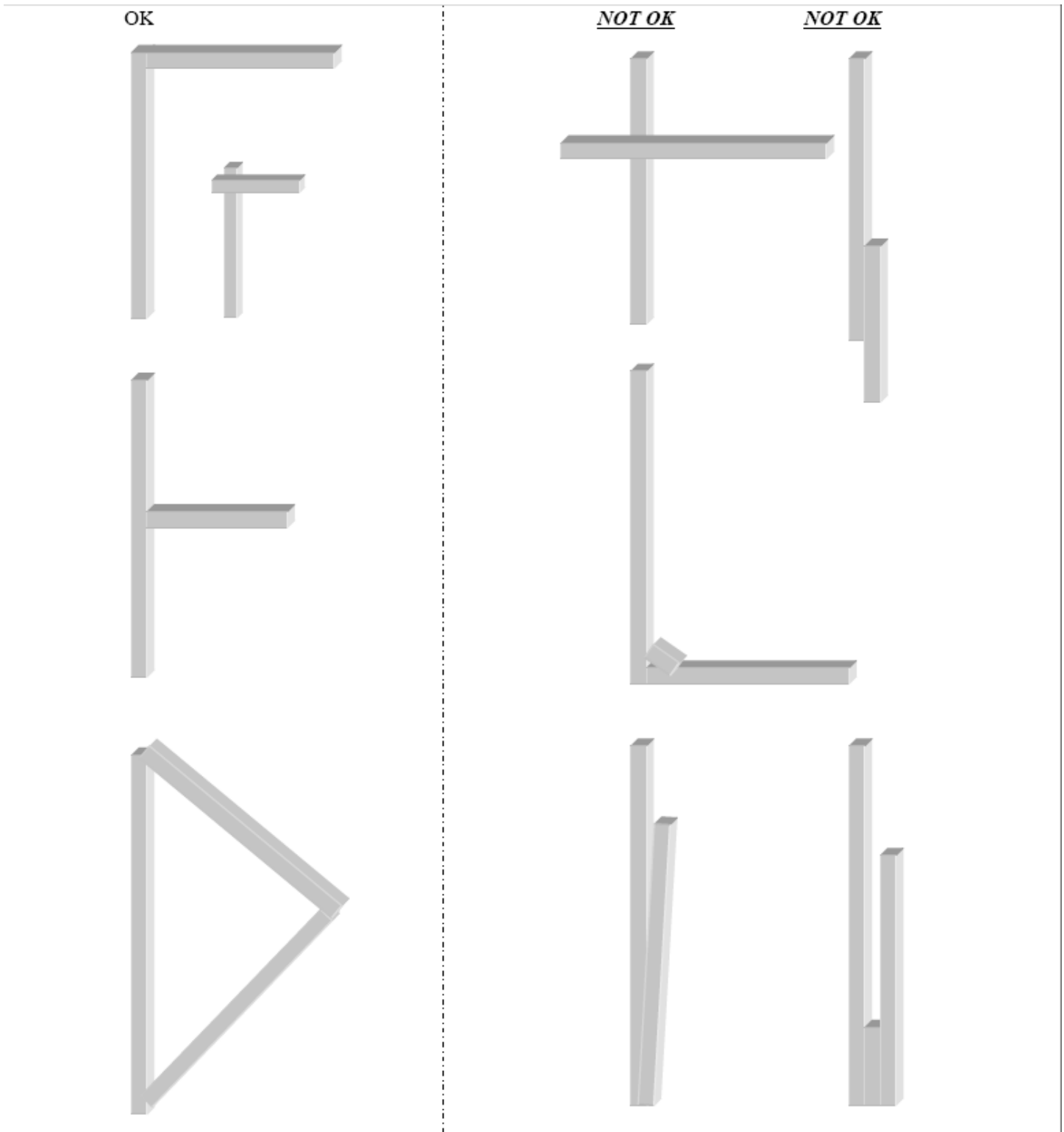
A – Sample Joints

B – Testing Apparatus

C – Clarification of Gluing

D – Balsa Bridge Specification Checklist

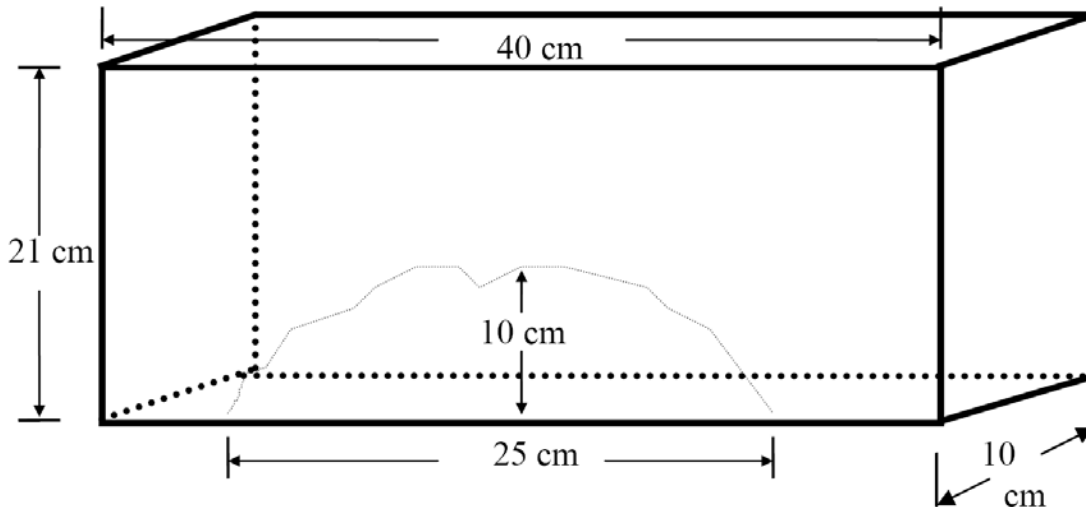
Attachment A – Sample Joints



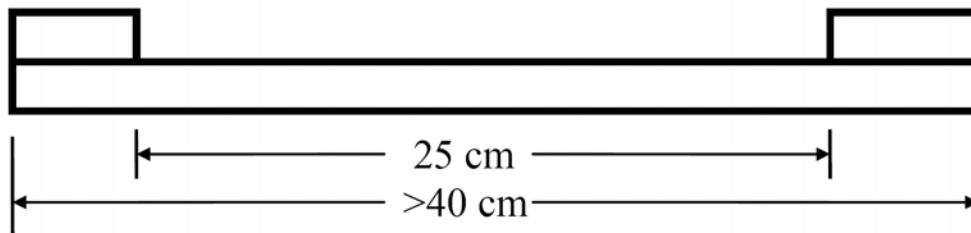
**Balsawood Bridge Contest
Senior High School**

Attachment B – Testing Apparatus

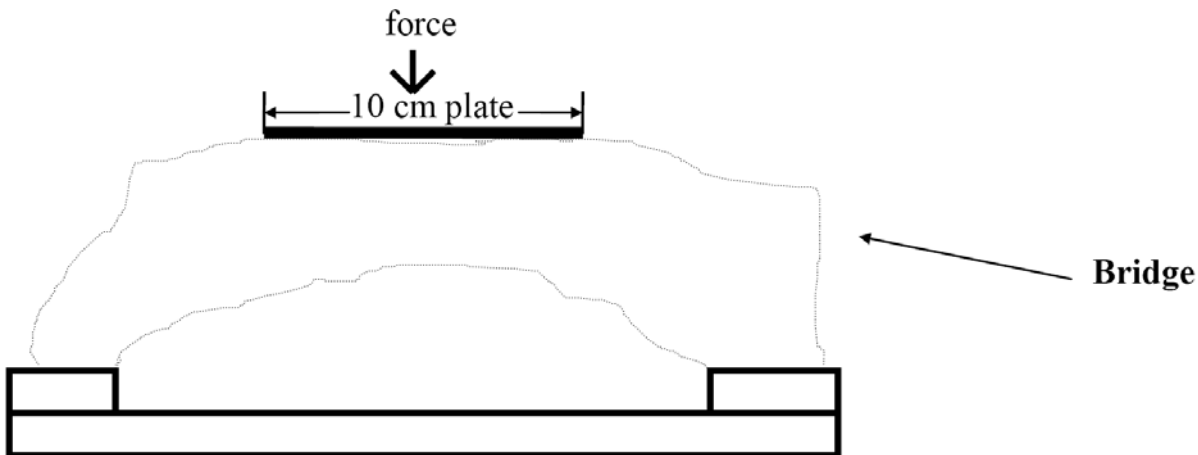
1. Figure 1a: Overall Dimension Test: The bridge must fit inside a box with the following dimensions to be considered legal; bridge must also pass the 10 cm clearance test.



2. Figure 1b: The bridge will be supported on both of the blocks as shown:



3. Figure 2: The bridge is tested for strength by applying weight (force) to a 10 cm square plate placed on top of the bridge. The bridge is tested for strength while sitting on the blocks.



Attachment C – Clarification of Gluing

The spirit of the gluing rule is to allow bridges made of balsa **ONE LAYER** thick. Since the balsa may need to be overlapped at the joints, the bridge may need to be more than one layer thick at the joints.

Rule for Construction #1 states: **“Joints must be at or within ¼” of the end of at least one of the sticks (members).** No part of a stick may be glued to another stick except at the joints of the stick. i.e. gluing is very limited.”

Since dry glue is nearly invisible and it is impossible to tell what part of overlapping members is glued and what part is not, judges must assume that the entire length of overlapping members is glued. Therefore, no two members anywhere on the bridge may overlap by more than ¼”.

¼” long pieces of balsa may be used as “spacers.” A spacer is defined as a piece whose sole role is to separate structural members (such as at the corners of the bridge).

Wholly glued pieces which appear to strengthen, reinforce, serve a purpose other than separating, or are placed too closely together will be considered lamination, not spacers.

Determination of what is a spacer and what is excessive gluing will be left solely to the judges. Since this may be a “gray area,” with disqualification as a possible result, students are encouraged to avoid the use of spacers.

Please remember that the purpose of this contest is to use creativity to build the best structure within the framework of the rules. The purpose is not to break the rules and see if you can get away with it.

Attachment D – Balsa Bridge Specification Checklist

This check list is provided for you to “pre-inspect” your bridge to ensure that it meets the rules specification. Please check-off each item after you have compared your bridge’s dimensions with the rules.

- 2008-2009 rules were followed
- Bridge is properly labeled with team members names, school and MESA Center
- Material is ¼” x ¼” balsa wood
- Glue is water soluble Elmer’s white glue
- Maximum length \leq 40 cm
- Maximum width \leq 10 cm
- Maximum height \leq 21 cm
- Minimum clearance above “river” \geq 10 cm
- Minimum span \geq 25 cm
- Maximum Bridge weight \leq 95 grams
- All joints are at or within ¼” of end of one member
- No glue beyond 3 mm from any joint
- No excessive gluing (i.e. members are glued only at the joints)
- All members joint at an angle \geq 30 degrees
- No pins or gussets used
- Balsa wood is not painted or treated
- Top center of Bridge has 10 cm x 10 cm area for placement of the test plate
- Bridge has supports suitable for placement on testing fixture