

## Stick Together

<b>LEVEL:</b>	Grades 6 - 8
<b>TYPE OF CONTEST:</b>	Team
<b>COMPOSITION OF TEAM:</b>	2 - 3 students per team per level
<b>NUMBER OF STUDENTS:</b>	Preliminary – As determined by your local MESA Center Regional – 3 for 6 <sup>th</sup> Grade; 3 for 7 <sup>th</sup> /8 <sup>th</sup> Grade per Center
<b>SPONSOR:</b>	Luis Topete, SDSU & Jeanette Espino, Imperial Valley

**OVERVIEW:** Students will use math and science to implement engineering concepts in the design and construction of a model bridge from your own plans that will carry a maximum load while using as few craftsticks as possible; stressing neatness, craftsmanship, and creativity. **Participation logistics, limits, and competition facilities may vary by host site. Advisors and students are responsible for verifying this information with their center director.**

An engineering notebook is a required component of this competition. The purpose of the Engineering Notebook is for students to more closely follow the practices of an engineer in the completion of their MESA Day project. The Engineering Notebook will encourage students to take a purposeful and sustained approach to building their devices. MESA projects are not designed to be completed in a single class period or day, but to be the result of thoughtful research, planning, analysis and evaluation. The notebook should provide a written record of the thought and insight that a student put into their project, from initial ideas to the final completed project.

### **MATERIALS:**

- Only solid untreated (no manufactured notches or holes), natural wood craftsticks (e.g. popsicle sticks) with the following approximate dimensions may be used:
  - Length= 4 ½ inches (11.4cm)
  - Width = 3/8 inches (0.95cm)
  - Thickness = 1/16 inches (0.2cm)
- Maximum number of sticks allowed, including partial sticks, is 200. Each piece of stick, regardless of size, will be counted as one structural member.
- Only water soluble Elmer's-type white glue must be used.
- For the Engineering Notebook, any standard notebook, including but not limited to spiral and subject notebooks and composition books may be used. Notebook page size must be equivalent or greater than that of a composition book page (approx. 9.75" length x 7.5" width). Pocket sized notebooks, post it

notes, flashcards, etc. cannot be used. Computer generated notebooks and/or pages are allowed.

### GENERAL RULES:

- 1) Stick Together structures should be labeled with team members' names, school, and MESA Center. There will be a 10% penalty in the strength to weight score for improper labeling.
- 2) No kits are allowed
- 3) A maximum of 50% of a craftstick's total wide/flat surface may be glued. Both sides of each stick can be considered in the 50% calculation. e.g. 100% of side 1 and 0% of side 2; 75% of side 1 and 25% of side 2.
- 4) Glue (water soluble Elmer's type white glue) must only be used at joints, and must not be used on the surface of the roadway.
- 5) No coatings of any kind, including glue, paint, cement, epoxy; etc. may be applied to any surface of the bridge. The Bridge will be disqualified if it is coated with any substance.
- 6) The bridge MUST meet the following dimension restrictions:
  - a. Maximum horizontal length = **17 inches (43.2 cm)**
  - b. Maximum width = **5 inches (12.7 cm)**
  - c. Maximum height above the top of the roadway = **7 inches (17.78 cm)**
  - d. Maximum depth below the top of the roadway = **3.5 inches (8.89 cm)**
  - e. Minimum horizontal length = **15 inches (38.1 cm)**
  - f. Minimum width **at every point** = **4 inches (10.16 cm)**
  - g. Minimum width of open roadway across entire bridge length = **3.5 inches (8.89 cm)**
- 7) The bridge must be open at the top to allow insertion of testing apparatus.
- 8) The bridge must have a clear and unobstructed roadway at least 3 ½ inches wide, running the full length of the bridge, as if automobile traffic were going to cross it. The roadway shall be considered a roadway if a toy model car or truck freely rolls from one end to the other. The toy car/truck can be provided by the entrant. If a car is not provided by the entrant, a standard "Hot Wheels" or "Matchbox" car will be used.
- 9) The bridge may not have a roof, covering or any other object that will interfere with the 3½ x 3½ inch test plate that is placed directly on roadway at mid span to apply the force for load bearing capacity.
- 10) I-beams are illegal.
- 11) T-sections and longitudinal lamination may be used on the roadway only.
- 12) The bridge must rest on the tester support blocks in a stable manner, i.e. bridge substructure may NOT interfere with testing apparatus.
- 13) Project must be the original work of student(s). Judges may ask questions to confirm provenance.
- 14) 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.
- 15) The engineering notebook must contain the following sections with each section tabbed/labeled:
  - a. Proper Labeling
    - i. Proper labeling is required of each notebook. Students must have group member names, grades, school and MESA center on the inside cover of their MESA Engineering Notebooks.
  - b. Project Introduction
    - i. A one page introduction for the project. Students can write about why they chose the project that they are worked on and what challenges they expect to run into with

this project. They may also briefly describe the project criteria and constraints. This introduction should be honest and genuine.

c. Daily Entries

- i. At least ten daily entries will be required. Each entry must have the date of entry and be at least half a page long. They should answer the following questions:
- What did you work on/discuss today?
  - What was the result of your work?
  - What do you need to do during your next meeting?

d. Project Sketches

- i. Notebooks must contain at least two distinct project sketches that should be placed towards the back or end of the completed notebook pages. The sketches should indicate a progression in the thinking and design of the device, and be detailed. Sketches must be larger than half a page, and can either be drawn on the notebook page directly or attached.

e. Applied Mathematics

- i. Notebooks must contain evidence of two (2) applied mathematics principles as it pertains to the project. This section **MUST** include following principles:
- Calculate the surface area of the entire bridge. Must include sketches and proper labeling identifying each surface.
  - Calculate the mass (Newtons) of the bridge.

16) A deduction of 20% of the total team score will be assessed for a missing or incomplete engineering notebook.

## JUDGING:

- 1) The bridge is examined and measured by the judges to check whether it conforms to contest rules and specifications.
- 2) Any bridge that does not meet the requirements will be disqualified.
- 3) The bridge is weighed and its weight recorded.
- 4) The bridges are judged for neatness, craftsmanship, and creativity by a team selected by the Host Center prior to testing.
- 5) The bridge will be supported by two wide blocks (each >1 inch) 14 inches apart (see Testing Setup & Apparatus)
- 6) A 3½ x 3½ inch test plate is lowered onto the bridge at mid span so that it rests on the roadway.
- 7) The test plate is loaded until a point of maximum load is reached as determined by judges. The maximum load recorded by the load testing machine will be used as the load capacity of the bridge, regardless of when failure begins.
- 8) Individuals' bridges are not limited in the number of categories they may win.
- 9) Disqualified bridges are not eligible for awards in any category; however, they may be tested, time permitting.
- 10) Strength-to-Weight Ratio: Determined by dividing maximum load at failure by weight of bridge. Bridge with greatest load bearing capacity compared to its weight wins.

Example:                      Maximum load = 220.0 pounds  
    Bridge weight = 50.0 grams  
    Ratio =  $1997.8 * [(220 \text{ pounds} \times 454\text{g/pound}) / 50\text{g}]$

- 11) Creativity & Engineering Design: Finest workmanship, including neatness and innovation of design.

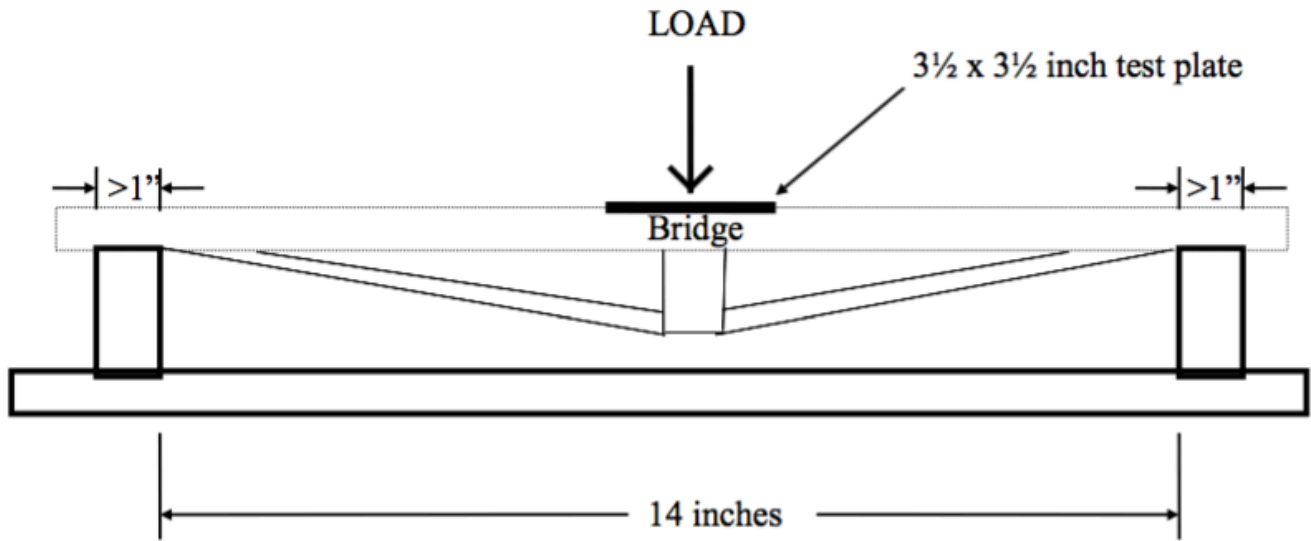
**AWARDS:**

- Awards will be given per grade level: 6<sup>th</sup> grade and 7<sup>th</sup>/8<sup>th</sup> grade.
- Medals will be awarded for 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> place based on the best Strength-to-Weight Ratio
- Ribbons will be awarded for Creativity and Engineering Design.
- Only teams placing in the Strength-to-Weight category will advance to Regional MESA Day.

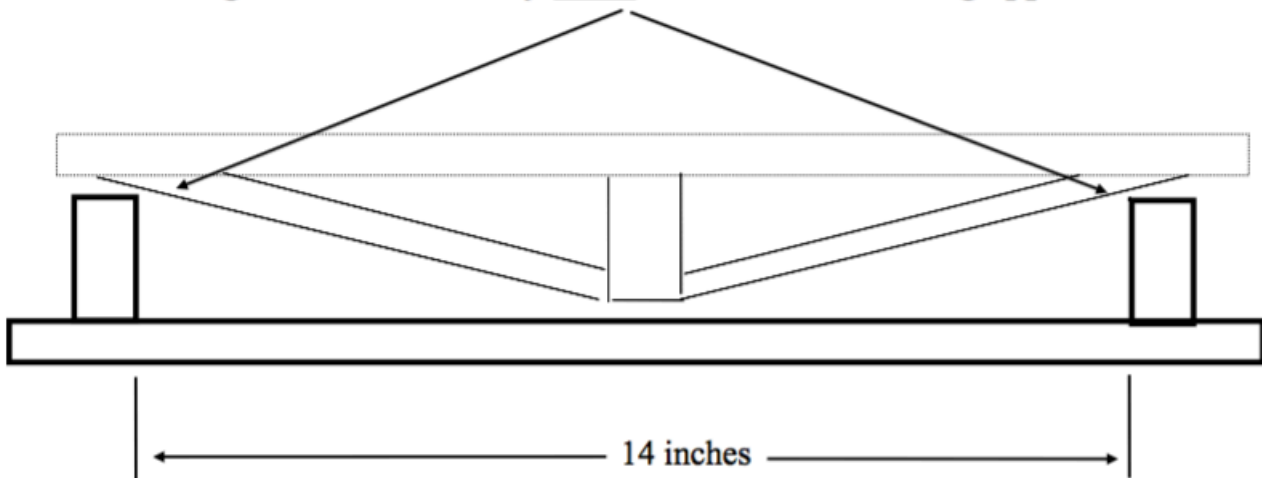
**ATTACHMENTS/APPENDIX:**

- Testing Setup & Apparatus
- I-beam & T-Section Samples
- Specification Checklist

## TESTING SETUP & APPARATUS



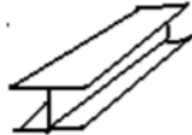
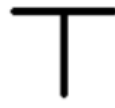
Bridge **MUST** rest on tester support blocks;  
Bridge substructure may **NOT** interfere with testing apparatus



I-Beam & T-Section Samples

I-beam

T-section

Specification Checklist

*\*Note: As the name above implies, this list is intended simply as a guide for meeting the required competition specs. It should not be treated as an official judging document.*

- Bridge is properly labeled with team members names, school, and MESA Center
- Material is solid, natural wood craftsticks (popsicle sticks)
- Glue is water soluble Elmer's-type white glue
- Maximum length  $\leq 17$  inches (43.2 cm)
- Maximum width  $\leq 5$  inches (12.7 cm)
- Maximum height above top of roadway  $\leq 7$  inches (17.78 cm)
- Maximum depth below top of roadway  $\leq 3.5$  inches (8.89 cm)
- Minimum length  $\geq 15$  inches (38.1 cm)
- Minimum width  $\geq 4$  inches (10.16 cm)
- Minimum width of roadway  $\geq 3.5$  inches (8.89 cm)
- Roadway runs entire length of bridge
- Maximum number of members (sticks and/or partial sticks)  $\leq 200$
- Glue only at the joints
- Each stick glued  $\leq 50\%$
- No I-beams
- T-sections on roadway only
- Sticks are not painted or treated
- Bridge open at the top (no roof or covering)
- Bridge has open  $3\frac{1}{2}$  inch area for placement of the test plate on roadway
- Bridge has supports suitable for placement on testing fixture
- Bridge substructure does not interfere with testing fixture

# MESA DAY 2017-2018

## *Notebook Requirement Rubric*

Please use this rubric to assess notebook entries. An incomplete or missing notebook will lead to a 20% deduction from the total project score

<b>Criteria</b>		<b>YES</b>	<b>NO</b>
1	Is the notebook properly labeled? <i>(Names, Grades, School, MESA Center)</i>		
2	Does the notebook contain a one page introduction to the project? <i>(On the first page of the notebook)</i>		
3	Are there at least 10 dated entries in the notebook?		
4	Is each entry at least half a page long?		
5	Are there at least two distinct project sketches included?		
6	Is there evidence of the 2 applied mathematics principles as outlined in General Rule #15?		
<b>TOTAL</b>			

Does the notebook meet the requirement? (circle one)    **YES**    **NO**  
*Notebooks must meet all criteria to fulfill this requirement*