

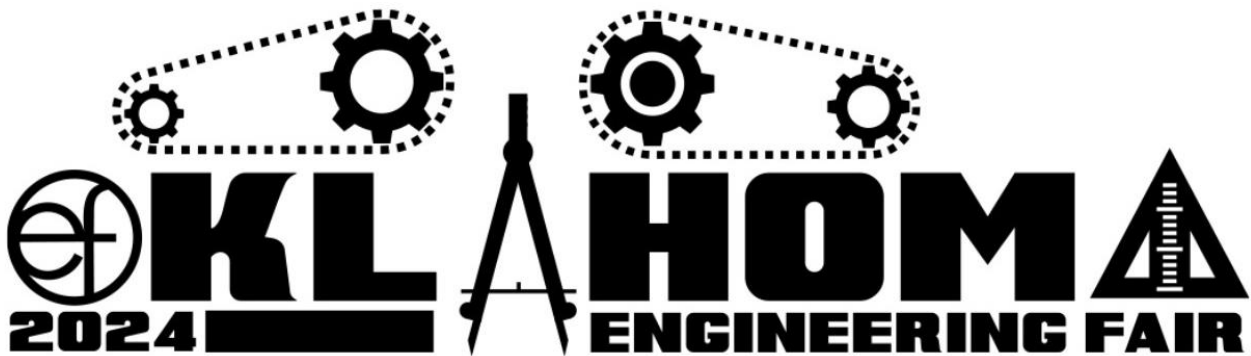


OKLAHOMA ENGINEERING FOUNDATION  
*Engineering Makes Life Better*



# 2024 BRIDGE BUILDING RULES

SPONSORED BY Oklahoma Structural Engineer's Association and the American Society of Civil Engineers



## Foreword

Each school **MUST** preregister one week (5 business days) prior to the date of the Engineering Fair. Visit [oef.org](http://oef.org) for registration information. Upon check-in the day of the event, you will receive the contest entry forms, which your students will fill out and turn in to the contest directly. Prizes will be awarded to winning entries from registered schools (entries from unregistered schools will **NOT** be eligible for prizes).

## Design

**Prior to the Fair** a STUDENT bridge builder must design and build his/her own bridge. All design and building techniques should fall within the specifications that follow. Tolerances are given in the specifications. Should any bridge fall outside the tolerances, that bridge will be disqualified or the builder may attempt on-the-spot modifications to bring the bridge within specifications. Each bridge must be free standing.

**Note:** While adults may aid the student with suggestions, etc., the bridge **MUST** be built **ONLY** by the student — **NO ADULT CONSTRUCTION ASSISTANCE IS PERMITTED.**



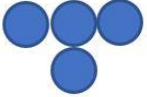

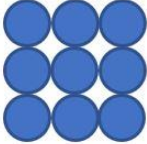

## Materials

1. Square or round **wood** toothpicks (Standard restaurant size – 2.75 inch, tapered ends) (unlimited quantity) **No skewer or 'pick' type toothpick cut to size, No Bamboo or plastic toothpicks, no "Craft" toothpicks. STRUCTURES BUILT FROM OTHER TOOTHPICKS WILL BE DISQUALIFIED.**
2. Elmer's Carpenters wood glue or Elmer's School Glue. **(NO COLORED GLUES OR EPOXY BASED GLUES. STRUCTURES BUILT FROM OTHER GLUES WILL BE DISQUALIFIED.)**
3. **Kite String.** Students may use up to four (4) lengths of common, white, cotton kite string (no yarn, fishing line, nylon, or other plastic string). Each of the four lengths should not exceed seven (7) inches when measured in their final in-place location on the bridge.
4. One (1) metal eye bolt with 1/4" diameter shaft, washers and nut.
5. Loading Block: Block of wood with dimensions not to exceed **3 1/2" x 4 1/2" x 1/2"**. The block is used to attach the eye bolt to the bridge. A minimum dimension of 2 1/2" x 2 1/2" is recommended.
6. Materials list of brand and type of glue and toothpicks used. Students are encouraged to bring the bottles/boxes (or their labels and a sample of an unmodified toothpick) with them in the event that any questions arise as to construction materials.

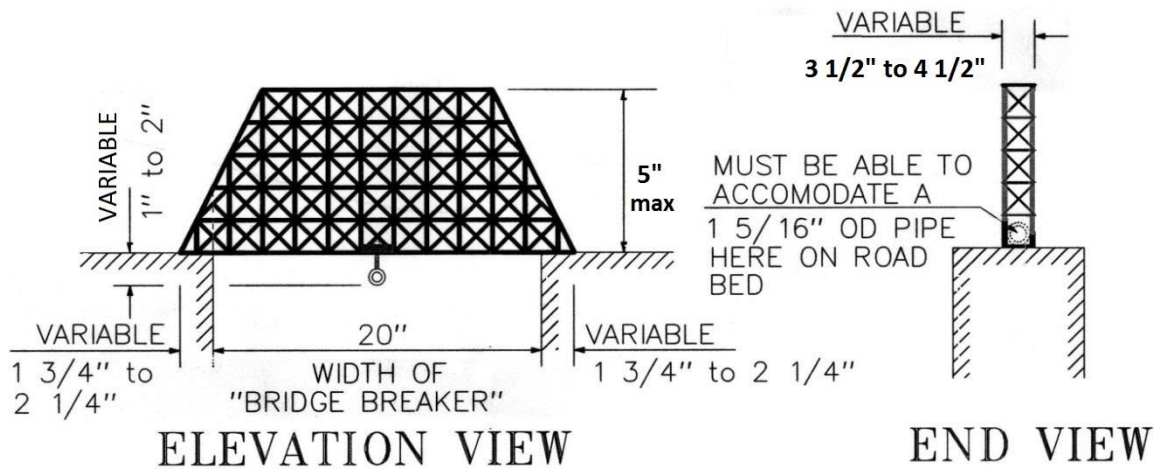
## Geometry

- Length: **23 1/2" to 24 1/2"**
- Width: **3 1/2" to 4 1/2"**
- Height: **Maximum 5"** (excluding eye bolt). See the Structural Efficiency criteria below for more height considerations.
- Weight: **Maximum 11 oz.** (excluding eye bolt). See the Structural Efficiency criteria below for more weight considerations. **Eye bolt should be removable.**
- Roadbed: Bridge must have a flat roadbed. The area above the roadbed must accommodate a 1-5/16" O.D. (outside diameter) pipe.
- Toothpicks may be cut and glued.
- **Bundles of no more than (4) toothpicks are allowed. Exception: road bed may have toothpicks side-by-side if the designer so chooses.**
- **NOTE:** Weight is heavily penalized in the Structural Efficiency Score so think carefully about bundling members (see scoring details).



Table 1: Toothpick Bundling	
	Allowed
	Allowed
	Allowed
	Allowed only for road bed (toothpicks > 4)
	<b>NOTE ALLOWED</b> (toothpicks > 4)
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GEOMETRY EXAMPLE. . .



**Additional Geometry Notes**

1. The eye bolt must be located in the center of the bridge and be large enough to pass a  $\frac{1}{4}$ " diameter "S" hook through its eye. The "S" hook is part of the testing apparatus ("Bridge Breaker") and is provided by the judges.
2. The eye bolt is attached to the Loading Block; the block should sit on the top of the roadbed (see above) and be supported by the roadbed, but should not be attached (e.g. glued) to the bridge. The Loading Block and shaft of eye bolt may protrude ABOVE the roadbed. Bottom of eye bolt MUST protrude a minimum of 1" but not more than 2" BELOW the end supports of the bridge.
3. The Loading block is used to transfer the load from the "Bridge Breaker" to the bridge. The larger the block of wood, the better it will transfer the load. Students should consider using the largest Loading Block that can fit inside the roadbed without exceeding the maximum sizes listed above ( $3\frac{1}{2}$ " to  $4\frac{1}{2}$ " square).

**Optimal:** 3"x4"

**Minimum:**  $2\frac{1}{2}$ " x  $2\frac{1}{2}$ "

**Additional Rules & Remarks**

The over-use of the approved glues typically does not result in satisfactory load capacities; i.e. "soaking," "dipping," or otherwise coating random configurations of toothpicks in glue will not be looked upon favorably by Aesthetics and Construction Quality judging and has historically resulted in substantially lower bridge load capacities.

**ATTN!!!** Label your bridge: A tag tied to the bridge or a single piece of masking tape looped around a member with the student(s) name(s) to ease in tracking the bridge through registration and judging is appreciated.

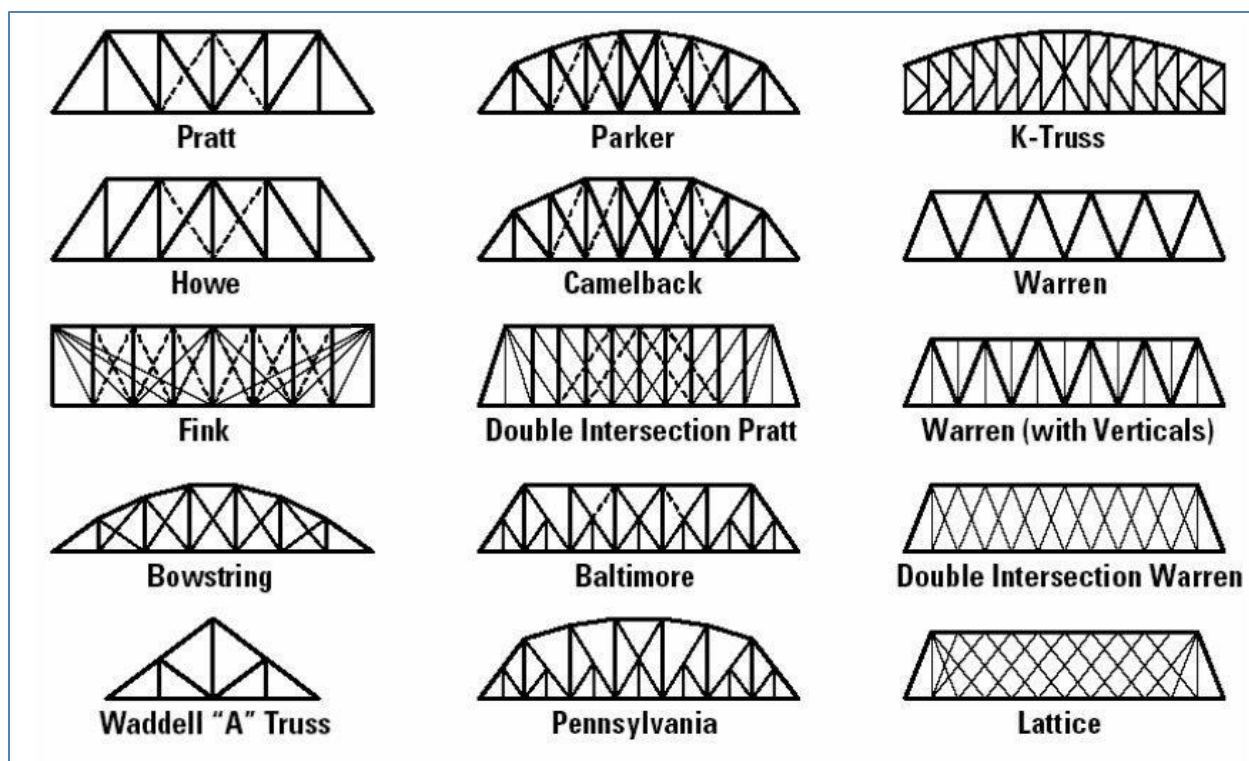


Figure 1: Examples of typical bridge designs (but not limited to these)

Students and instructors are encouraged to research various bridge design types, specifically trusses, when designing their bridges. Look for efficiencies such as least number of members and shallow depths. Pay attention to tension and compression member locations and the path the load will follow through the loading block into the truss and then to the supports.

During Load Capacity testing, the students and spectators **MUST** stand outside the designated “Debris Zone” to avoid being hit by any bridge piece(s) that may be ejected when/if the bridge fails. Students and spectators are encouraged to take photos/video of the testing, especially “before” and “after” photos. Students will be able to dispose of their bridges at the competition room or are free to take their engineering creations with them at the conclusion of all testing and judging.

## Judging

1. **Decision of judges, during all phases of the competition, ARE FINAL.** Any bridge that fails to meet geometry criteria, weight criteria, or material restrictions and has been disqualified from the competition may still be load tested at the judge’s discretion assuming adequate time remains after all qualified entries have been tested and judged.
2. Students must fill out the *Bridge Building Entry Form* before OEF pickup of bridge. **Students must attach this form to the bridge in order for the bridge to be entered into the contest.** Upon receiving the bridge, judges will then inspect the bridge for compliance with the rules and assign an entry number indicating student’s turn in sequence of competing. Judges may alter the testing sequence as they see fit. Competition will run until all registered entries have competed. Further information will be provided regarding virtual testing day and how students and teachers can watch the contest.

3. Judges will weigh, measure, and register each bridge prior to Load Capacity testing. If a bridge does not meet the geometry or weight specifications. **Because bridges will be pickup before the contest, participants must insure that their bridge meets the material and geometry specifications in order to be entered into the contest.** The 1-5/16" pipe, scales and rulers will be supplied by the judges.
4. The bridges will be competing in three categories Structural Efficiency, Load Capacity, and Aesthetics and Construction Quality. Top three bridges (which comply with all rules) in each category will receive prizes. The judging criteria for each category is as follows:

**A. Structural Efficiency category:** Entries will be weighed and measured and these results, along with the results from the Load Capacity category will be entered into a formula to generate a Structural Efficiency Score for the bridge. **Lower scores represent more efficient designs compared to higher scores.** Students wishing to excel in this category should strive for maximizing the load capacity (up to a maximum value of 200 lbs) while trying to maintain low weight in ounces and utilizing the shallowest bridge depth (height in inches). The 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> lowest scoring bridges will be awarded prizes in this category. The formula for the Structural Efficiency Score is as follows:

$$SE = \frac{1,000 \times \sqrt{Height \times Weight^{1.5}}}{Load}$$

**B. Load Capacity category:** Entries shall be load tested by means of a custom "Bridge Breaker". Judges will position the bridge with each end of the bridge resting on the tester. The "S" hook will be attached to the eye bolt and pressure will be applied in a downward vertical direction. A load indicator will display pressure applied until the bridge fails. Failure is determined when (a) the bridge collapses, (b) a deflection of the base of the bridge exceeds one inch, or (c) the wood block causes a failure of the bridge roadbed. No repairs or modifications are allowed once testing has begun. However, if the eye bolt fails before the bridge fails, judges may choose to allow a new eye bolt to be placed on the bridge. 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> prizes will be awarded in this category.

**C. Aesthetics and Construction Quality category:** Entries will be judged on the overall design of the bridge and its consideration of engineering principles, design, and mechanics. Consideration will be given to bridges that are constructed with care and precision as well as entries that show ingenuity and creativity in appearance and form. Decorating the bridges is not required, but is encouraged. The judges will award a 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> prize in this category.

## Prizes & Distribution

Contest winners will be announced on the Engineer Fair web page at <http://http://oef.org/programs/engineering-fair>. Those entries winning prizes will be notified through their teacher of record by email.

1. First, Second and Third Place entries in the Structural Efficiency category will receive a cash award. In the event of a tie, cash prizes will be equally distributed between winning entries.
2. First, Second and Third place winners in other categories will receive medals.

3. Predict and Win: On each entry form on the day of the Fair, the student(s) responsible for the bridge design and construction shall give their estimate of the bridge's load capacity, in pounds, on the entry form. The bridge designer(s) who guesses the closest to the failure load will win a special prize from one of our sponsors!
4. People Choice Award: The judges will select between 5 or more bridges to be nominated for People Choice Awards. Teachers will receive an email with the link for online voting which will open to the public for 5 days. The selected team will receive an prize from one of our sponsors.

### **Questions**

Contact Isabella Horton (OSEA Central Chapter President 2024) at [oebridgebuilding@gmail.com](mailto:oebridgebuilding@gmail.com)