



7th Annual RooBuilders Competition

For Middle and High School Students

2019-2020

INTRODUCTION

The following information has been developed for the 2019-2020 University of Missouri-Kansas City Balsa Bridge Building Competition for middle and high school students in the greater Kansas City Metropolitan area. The competition will be held on **Saturday February 2, 2020**.

Bridges are fundamental pieces of our built infrastructure, carrying vehicles, trains, and utilities across rivers, ravines, and gorges. Bridges are designed to carry various combinations of moving traffic loads along with distributed loads from wind and the weight of the bridge itself. Real-world bridges are designed to carrying the required loads using the smallest amount of materials possible to save money. Your model bridges are intended to be simplified versions of real-world bridges.

The object of the competition is to see who can design, construct, and test the most efficient bridge. The final results will be based on the ability to follow specifications, maximum load before failure, bridge efficiency, aesthetics, and a video diary describing your design and construction process. Efficiency (E) is calculated as ***E= load supported (lbs)/weight of bridge (lbs)***.

Each team will design a bridge to meet the competition specifications. The team will bring a drawing of your design, with pertinent dimensions, to University of Missouri-Kansas City, Flarsheim Hall on Saturday, **November 2, 2019**. Teams will be partnered with current Civil Engineering students and faculty to create a computer model of your bridge. Flarsheim Hall is located at 5110 Rockhill Rd., Kansas City, MO 64110. Teams will be advised of your scheduled time prior to the computer analysis.

Students from the UMKC Chapter of American Society of Civil Engineers will work with each team to create a computer model of the bridge and to perform an analysis of the design. The team will take the results of the analysis and determine if any modifications of the design are necessary prior to construction of your bridge.

The materials to use in the construction of the bridge will be provided to the teams at the end of the computer modeling session. The teams then have until the date of the competition to construct the bridge. Participating teams will present their completed bridges for evaluation and testing on **February 2, 2020**. The competition will begin at 10:00 a.m with check-in starting at 9:30 a.m.

Awards will be given to the top three teams. The winning teams will be determined based on the total points earned during the evaluation process. Please refer to the section on Evaluation found in this document.

REGISTRATION

- A maximum of 30 (10 from middle schools and 20 from high schools) teams may participate in the RooBuilders 7^h Annual Competition on a first-registered-first-accepted basis.
- A maximum of 5 teams per school may participate (maximum of 4 students per team, grades 9-12, and maximum of 5 students per team grades 6-8).
- [Registration](#) may be made online until 5:00 p.m. on October 31, 2019.
- Registration fee is \$10.00 per team, with the fee used to cover the cost of the bridge construction materials.
- Checks, paid to "University of Missouri-Kansas City", must be received by the above registration deadline. Checks may be mailed to Dr. Megan Hart, 352 Flarsheim Hall, 5110 Rockhill Rd. University of Missouri-Kansas City, MO 64110.

MATERIALS AND CONSTRUCTION

UMKC will provide the bridge construction materials which consist of 36 balsa wood sticks (1/8 inch x 1/8 inch x 36 inches in size), glue, and a card sheet. Only the materials provided may be used for the construction of the bridge.

The design dimensions of the bridge are illustrated in Figure 1(a) and shall be as follows:

- The bridge span (support-to-support) will be 28 inches.
- The total bridge length may not exceed 36 inches.
- The bridge height shall be between 5 and 10 inches.
- The bridge width shall be between 3 and 6 inches.
- Completed bridges may not weigh more than 40 grams (about 1.5 ounces) above the weight of the 36 sticks of balsa wood provided to each team.
- The bridge may not be painted, coated, treated, or decorated. Reinforcing the balsa pieces with glue is not allowed.
- Bridge members (balsa wood sticks) should be individual and shall not be laminated or bundled together. Bridge members (balsa wood sticks) may be overlapped with a maximum of 1/2 inch overlapping length as show in Figure 2.
- Bridge members may be joined together at their ends by gluing gusset plates over the joints using the provided card sheet. Gusset plates may be of any shape; however, the maximum dimension of the gusset plates shall not exceed 3/4 inch, as shown in Figure 3.
- No supports below the bearing plates are allowed (under trusses).
- The bridge will be load tested during the competition to failure. Two 2 inch x 2 inch metal plates with loading rod will be placed on the road deck of the bridge, centered at 10 inches from each of the support bearing seats. The loading rods hang below the lowest chord of the bridge. To enable the bridge to be load tested, the bridge must be constructed to accept the metal plates and loading rods at the locations shown in Figure 1(b).

The judges will assess the workmanship, creativity and aesthetics/visual appeal of your bridge design. Your bridge will be given a score for each of the following:

- Workmanship
 - Joints with good contact between members
 - Neat glue joints
 - Neat finish
 - Robust feel
 - Splice details and location
- Creativity
 - Structural form
 - Member sizes correspond to force flow path
- Aesthetics/visual appeal
 - Proportion
 - Form
 - Appeal

HIGH SCHOOL COMPETITION SPECIFICATIONS

Deliverables:

- Each team shall submit a video report documenting the design and construction process of your bridge. You may include things like diagrams, pictures, graphs and other reference needed to completely present your bridge. Each video should summarize the design and construction of the bridge along with what the team learned during the computer modeling.
- **Hey, this is fun, be creative!** Your video counts towards the overall score **(15 points)** and is a way for you to distinguish your team personality from everyone else.
- The length of the video shall not be more than five minutes including references and acknowledgements.
- The video is due by **5:00 PM February 1, 2020**. Videos will be uploaded to Vimeo and shared with [Dr. Megan Hart](#) so that judges can review the videos prior to the competition. Late videos will have points deducted from the team's scores.

Competition Testing:

- Each bridge will be evaluated by the judges prior to testing for aesthetics **(15 points)** and compliance with the construction specifications **(20 points)**. Bridges that fail to meet the construction specifications will be disqualified. Bridges disqualified prior to the start of the competition may be tested as exhibition bridges at the discretion of the team and competition directors.
- Each team's constructed bridge will be weighed prior to the load-testing phase of the competition. The final weight will be used in the efficiency calculations of the bridge. **(20 points)**
- Each team will be given five minutes to prepare their bridge for evaluation. Preparation includes placing the bridge on the support bearing seats and installing the metal plates with loading rods on the bridge.
- The two support bearing seats will be placed on a flat, level surface 28 inches apart. The facing planes of the support bearing seats will be parallel and exactly 28 inches apart. The bridge will be placed on the support bearing seats.
- The bridge may only rest on the support bearing seats. The bridge may not bear on the inner sides of the support bearing seats and no additional support from the floor, ceiling, walls or any other object is allowed.
- The bottom chord of the bridge, as shown in Figure 1, shall not be lower than the top of the support bearing seats.
- The bridge will be subjected to two-point loads at 10 inches from each support. The loads will be applied at the bottom chord of the bridge.
- The bridges will be load-tested to the point of failure. Each team has a maximum of 20 minutes to completely load their bridge to failure. Additional time will result in point deductions for every 5 minute increment. **(30 points)**
- Failure of the bridge is determined as:
 - Complete collapse of the bridge (Defined as when the bridge is no longer able to carry any additional loads) or
 - Excessive deflection (sagging) where the bridge is no longer able to bear load or otherwise no longer functional.

MIDDLE SCHOOL COMPETITION SPECIFICATIONS

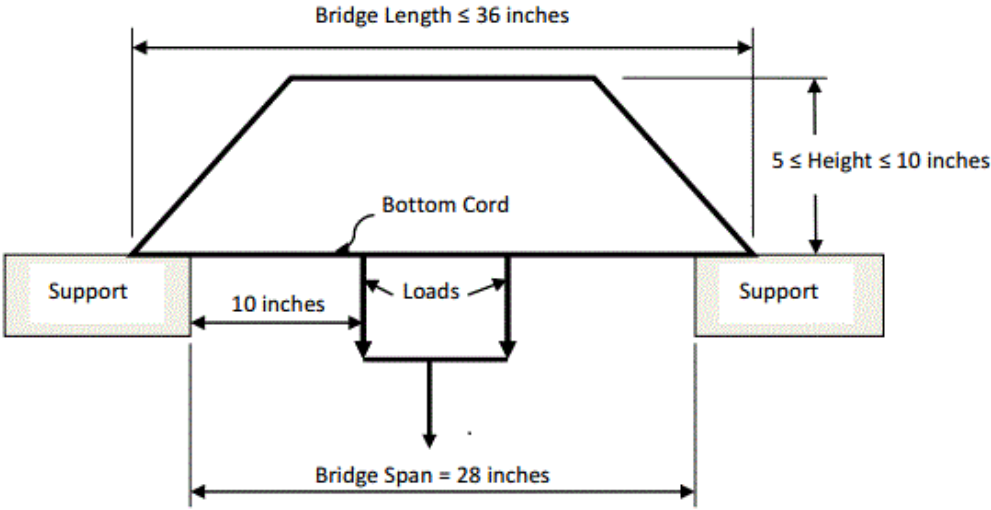
Deliverables:

- Each team shall submit a video report documenting the design and construction process of your bridge. You may include things like diagrams, pictures, graphs and other reference needed to completely present your bridge. Each video should summarize the design and construction of the bridge along with what the team learned during the computer modeling.
- **Hey, this is fun, be creative!** Your video counts towards the overall score **(15 points)** and is a way for you to distinguish your team personality from everyone else.
- The length of the video shall not be more than five minutes including references and acknowledgements.
- The video is due by **5:00 PM February 1, 2020**. Videos will be uploaded to Vimeo and shared with [Dr. Megan Hart](#) so that judges can review the videos prior to the competition. Late videos will have points deducted from the team's scores.

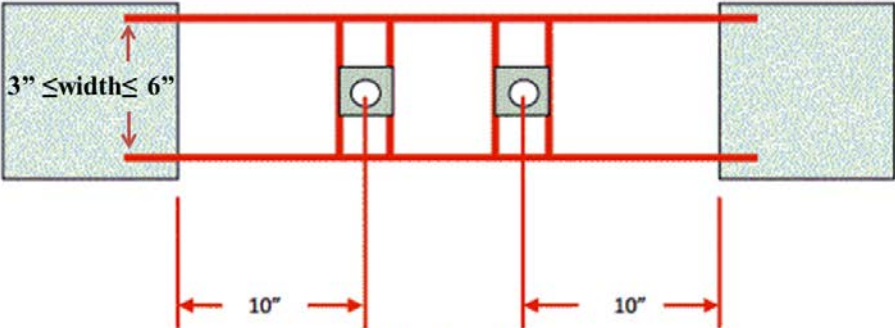
Competition Testing:

- Each bridge will be checked by the judges prior to testing for aesthetics **(15 points)** and construction specifications **(20 points)**. Bridges that fail to meet the construction specifications will be disqualified. Bridges disqualified prior to the start of the competition may be tested as exhibition bridges at the discretion of the team and competition directors.
- Each team's constructed bridge will be weighed prior to the load-testing phase of the competition. The final weight will be used in the efficiency calculations of the bridge. **(20 points)**
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Bridge Construction Requirements



(a) Bridge Dimensions



(b) Loading Points

Figure 1: Dimensions and Loading

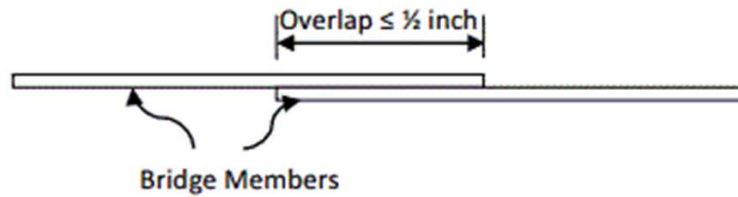


Figure 2: Members Overlapping

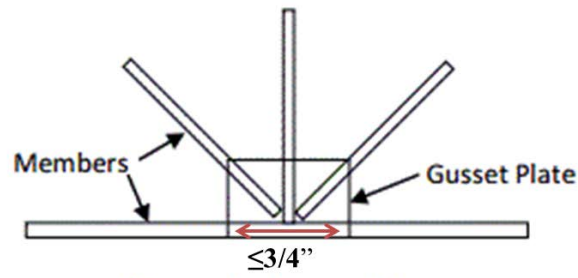


Figure 3: Gusset Plate



Figure 3a: Gusset plates on a model and actual bridge

IMPORTANT DATES TO REMEMBER

Saturday, November 2, 2019

Location: Flarsheim Hall 557, 5110 Rockhill Rd., UMKC, Kansas City, Missouri

Material pickup and computer modeling (analysis and design). Each team will be notified of their time slot for the November 2nd event once registration has closed. Each team should bring a drawing of the bridge with dimensions.

Friday, February 1, 2020

Location: Your Home/Office/School

Upload video to Vimeo by 5 pm.

Saturday February 2, 2020

Location: TBD – UMKC Volker Campus

Competition begins at 10:00 a.m. At least one member of the each team must be present when the bridges are tested.

EVALUATION

Summarized below are the categories and maximum points available for each category to be used in the evaluation of the bridges.

20 Points: Bridge Meets Specifications

30 Points: Load Carrying Capacity Prior to Failure

20 Points: Load/Weight Efficiency Ratio Prior to Failure

15 Point: Video of Design and Construction

15 Points: Aesthetics

Total Points 100

AWARDS

Awards will be given for first, second and third place teams in each division. Additionally, a Rising Star award will be given at the discretion of the judges for each division based upon merit and attempt. The 1st place winner of the high school competition team may receive a scholarship for those choosing to attend UMKC and plan to major in engineering or computer science. The winners will be determined based on the total points collected as per the above criteria. **Judges' decisions are final. In the event of a tie, consideration will be given to the bridge with the greater bridge efficiency.**

If you have questions regarding the bridge design, construction and /or rules you may contact Dr. Megan L. Hart, Director of RooBuilders, at hartme@umkc.edu or by calling (816) 235-1270.

Many thanks to Dr. Riyadh Hindi, Director of Billiken BEAMS, Saint Louis University, for assisting in the development and adaptation of the rules used in this competition.