

# West Virginia Bridge Design & Build Statewide Contest 2018



## Important Dates

WV Statewide Qualifying Round Begins: October 2, 2017

Deadline for Teachers to Request Classroom Visit

WV Statewide Qualifying Round Ends: – March 30, 2018 11:59 p.m.

Statewide Finalist Notification Deadline: April 4, 2018

Statewide Finals: May 12, 2018

## Contest Sponsors



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# **1 What's New? Important Information for this Year's Contest**

## **1.1 Team Registration**

The 2017 WV Statewide contest will be run separate from the National Engineering Encounters Bridge Design Contest (EEBDC), which typically starts in January of the contest year. Therefore, registration for the WV Statewide contest must be completed at the contest website:

[www.wvbridgedesignandbuildcontest.com](http://www.wvbridgedesignandbuildcontest.com). The outcome of the WV Statewide Finals does not have any impact on the selection of teams for the National Contest Finals.

## **1.2 Bridge Design Software and File Submission**

The 2018 WV Statewide contest will utilize the Bridge Designer 2016 software (same software as the 2016 WV Statewide contest with some modifications for 2018). The software can be downloaded from [www.wvbridgedesignandbuildcontest.com](http://www.wvbridgedesignandbuildcontest.com). Software design files must be uploaded to the WV Statewide contest website for evaluation using the team's login information.

## **1.3 Balsa Bridge Required for Statewide Finalists and Separate Ranking**

Balsa bridge building and testing was incorporated into the WV Statewide contest for the first time in 2016. Due to the overwhelming positive response from the participants, the balsa bridge building will be included again this year. In the 2016 contest, the balsa bridge was optional and teams with bridges that held the minimum required load were able to double their bridge design prize. For the 2018 contest, finalists are required to construct a balsa bridge and the balsa aspect of the contest will have its own rankings based on judges scores and strength-to-weight ratio. Therefore, prizes will be awarded independently for the design and the build aspects of the contest.

## 2 WV Statewide Contest Information

### 2.1 Overview

West Virginia Bridge Design and Build Contest is a statewide contest intended to conduct outreach to middle school and high school students in the area of engineering, specifically civil engineering. The contest primarily covers bridge design, but teams invited to the Final Round will also have the opportunity to compete in a bridge building contest.

The WV Statewide Contest runs from October 2, 2017 until March 30, 2018 at 11:59 p.m. In order to be entered into this contest, teams must register for the WV Statewide Contest at [www.wvbridgedesignandbuildcontest.com](http://www.wvbridgedesignandbuildcontest.com). This will ensure that the correct contact information is available to contact the finalists. All bridge design files will be uploaded to this website.

The top ranked teams entered in the WV Statewide Contest will be invited to participate in the Statewide Finals to take place on May 12, 2018 at Marshall University in Huntington, WV. It is anticipated that approximately 25 teams total will be invited from high school and middle school entries. The teams will be notified by March 31, 2018.

The teams that accept the invitation to the WV Statewide Finals will receive a balsa wood kit to construct a bridge and bring to the finals.

### 2.2 Oversight and Coordination

The 2018 West Virginia Bridge Design and Build Contest is being conducted by the Appalachian Transportation Institute at Marshall University and the West Virginia Department of Transportation – Division of Highways. The contest steering committee members for 2018 are listed in the table below:

<b>Name</b>	<b>Organization</b>
Brie Salmons	Appalachian Transportation Institute
Jennifer Dooley	West Virginia DOT-DOH
Alex Wriston	St. Albans High School
Ryland Musick	West Virginia DOT-DOH
Greg Michaelson	Marshall Universit

The coordinator of the 2018 contest is Brie Salmons. She can be contacted directly with any questions using the contact information below:

Brie Salmons

[salmonsb@njrati.org](mailto:salmonsb@njrati.org)

### 2.3 Rules & Eligibility

1. Students may participate in the state finals contest from grades 6-12. Students must be attending a West Virginia school or must be home-schooled at a West Virginia address.
2. Students may compete individually or in teams of two.
3. All eligible students will be placed into one of two Contest Categories—Middle School or High School—based solely on their grade level. Eligible students in grades 6-8 will be registered in the Middle School Competition. Eligible students in grades 9-12 will be registered in the High School Competition.
4. Teams composed of one high school student and one middle school student will be considered as a high school team for competition purposes.
5. Any contestant who is not eligible may register and compete in the Open Competition.
6. Students must register the West Virginia Statewide contest website ([www.wvbridgedesignandbuildcontest.com](http://www.wvbridgedesignandbuildcontest.com)).
7. Students participating in the WV Statewide contest must create their designs using the Bridge Designer 2018 software that can be downloaded from the contest website. All designs must be uploaded to the contest website for evaluation.
8. Students are expected to perform their own work during the Qualifying Round and Final Round. Students that are caught cheating or exhibiting behavior that is not representative of the contest values of teamwork and honesty may be disqualified at the discretion of the contest advisory board.

### 2.4 Contest Schedule

The schedule for the WV Statewide Contest are shown in the table below. Registration can be completed at [www.wvbridgedesignandbuildcontest.com](http://www.wvbridgedesignandbuildcontest.com). The Qualifying Round will end on March 30, 2018 at 11:59 p.m. EST. The top teams at the end of the Qualifying Round will be invited to participate in the West Virginia Bridge Design & Build Contest on May 12, 2018 in Huntington, WV.

<b>Event</b>	<b>Dates</b>
Registration	October 2, 2017 – March 30, 2018
Qualifying Round	October 2, 2017 – March 30, 2018
Notification of Finalists	April 4, 2018 – April 10, 2018
Balsa Bridge Construction	April 10, 2018 -May 11, 2018
Final Round	May 12, 2018

### **3 Bridge Design Contest**

#### **3.1 Bridge Designer Software**

The Bridge Designer 2018 software can be downloaded from [www.wvbridgedesignandbuildcontest.com](http://www.wvbridgedesignandbuildcontest.com). The bullets below provide an overview of the software use. Additional tutorials are provided on the [bridgecontest.org](http://bridgecontest.org) website.

- Students will be presented with a requirement to design a bridge to carry a given load from a roadway across a river.
- Students may choose from a wide variety of different site configurations for their bridge. Each will carry the load in a different way, and each will have a different site cost.
- Students will develop a design for their bridge by drawing a picture of it on the computer.
- Once the design is complete, the 2018 Bridge Designer will test the bridge to see if it is strong enough to carry the specified highway loads. This test includes a full-color animation showing a truck crossing the designed bridge. If the design is strong enough, the truck will be able to cross the bridge successfully. If not, the structure will collapse.
- If the bridge design collapses, it can be strengthened by changing the types of steel and the sizes of the structural components that make up the bridge, or by changing the configuration of the bridge itself.
- Once the bridge can successfully carry the highway load without collapsing, the student can then refine the design with the objective of minimizing its cost while still ensuring it is strong enough to carry the specified loads.

### 3.2 Requesting Classroom Visits

Teachers may submit requests prior to March 1, 2018 for an engineering professional to conduct a free classroom visit to explain to students how to use the Bridge Designer 2018 software and teach some aspects of bridge design. The visits may be conducted by an undergraduate engineering student chapter member (e.g., Bluefield State University, Fairmont State University, Marshall University, West Virginia University, or WVU Institute of Technology), a West Virginia Department of Transportation employee, or another professional engineer volunteer.

These assignments will be based on the location of the school and day/time of the requested visit. Requests must be submitted via the contest website under the Teacher Portal.

### 3.3 Team Registration

The 2018 WV Statewide contest will be run separate from the National Engineering Encounters Bridge Design Contest (EEBDC), which typically starts in January of the contest year. Therefore, registration for the WV Statewide contest must be completed at the contest website: [www.wvbridgedesignandbuildcontest.com](http://www.wvbridgedesignandbuildcontest.com). The outcome of the WV Statewide Finals does not have any impact on the selection of teams for the National Contest Finals.

### 3.4 Bridge Design Software and File Submission

The 2018 WV Statewide contest will utilize the Bridge Designer 2016 software (same software as the 2016 WV Statewide contest with modifications for 2018). The software can be downloaded from [www.wvbridgedesignandbuildcontest.com](http://www.wvbridgedesignandbuildcontest.com). Software design files must be uploaded to the WV Statewide contest website for evaluation using the team's login information.

### 3.5 Finalist Selection

The top ranked teams entered in the WV Statewide Contest will be invited to participate in the Statewide Finals to take place on May 12, 2018 at Marshall University in Huntington, WV. It is anticipated that approximately 25 teams total will be invited from high school and middle school entries. The teams will be notified by March 31, 2018.

### 3.6 Final Round

Teams will compete in their respective Middle School and High School divisions. The 2018 Bridge Designer software will be utilized to design the lowest cost bridge for two different scenarios to be identified by the judges (e.g., deck material, deck elevation, abutments, etc.). These scenarios will be different than the Qualifying Round, which did not specify the bridge type or other parameters. Awards will be based on the lowest bridge costs from the two scenarios.

### 3.6.1 Team Composition

The Bridge Design team competing in the Contest Finals must be the same individuals that competed in the qualifying round. If one of the individuals on a team of two is unable to compete in the Contest Finals, the remaining team member can compete as an individual. Under no circumstances can a team member be substituted.

### 3.6.2 Competition

The Bridge Design Finals will consist of two rounds of design with a brief intermission between the rounds. Each round will utilize a specific design scenario that is selected by the judges. The following rules will be enforced during the competition.

1. All teams in the same division (High School and Middle School) will be in the same computer lab. Each team will be seated in front of a primary computer and a backup computer that are both capable of running the Bridge Designer Software. Only one computer can be utilized for the competition. If the primary computer encounters a problem during the competition, notify a judge immediately. Do not start using the backup computer without a judge's permission.
2. The bridge design scenario will be pre-configured on the computers. Teams are not permitted to change the design scenario during the competition. If the program shuts down and has to be restarted, notify a judge so that they can confirm the scenario is correct after restarting the program.
3. Computer problems are always possible. Therefore, save your design file on the computer desktop when you start designing. Make sure you save the file frequently so that you do not lose your work in the event of a computer malfunction. If a design is lost and unable to be judged, no additional time or other allowances are permitted.
4. Teams will be given a sheet of paper to record their bridge costs and iteration number. This is for both the team and the judges to keep track of their lowest bridge cost. Judges will periodically record all of the bridge costs and display the live rankings for all participants to see.
5. The bridge design (iteration) that is shown on the screen when the round ends is the design that will be judged. It is the responsibility of the team members to ensure that their lowest cost design is shown and that it passes the load test. If the final design does not pass the load test, a cost of \$9,999,999 will be recorded.
6. It is not feasible to hide the computer monitors from the view of other teams. Therefore, all individuals must keep their eyes on their own screens. Anyone caught looking at another team's screens will result in the disqualification of that team for the entire competition.
7. Cell phones and other personal communication devices are not permitted in the computer lab during the competition. Anyone caught with a device in the room during the competition will be disqualified from the entire competition.
8. Individuals whose behavior is deemed to be inappropriate or unsportsmanlike will be dismissed from the competition and may forfeit any prizes their team is eligible to receive.
9. Parents, chaperones, teachers, siblings or other persons are not permitted in the



computer lab or the hallway outside of the computer lab during the Bridge Design competition.

### 3.6.3 Judging

The judges will determine the two design scenarios for the high school division and the two design scenarios for the middle school division prior to the competition.

At the conclusion of each design round, judges will record the cost of the bridge design shown on the computer screen. If that bridge design does not pass the load test or if it is determined that the design scenario was not followed, the judges will record a cost of \$9,999,999. Judges' decisions are final.

The bridge costs from the two design rounds for each team will be utilized to rank the teams.

## 4 Balsa Bridge Build Contest

### 4.1 Overview

The teams invited to the Statewide Finals will be mailed a kit to construct a balsa wood bridge. Teams are to construct a single balsa bridge, which will be tested and judged on the day of the Statewide Finals. Bridges will be judged on both aesthetics and the amount of weight it will hold before failure.

### 4.2 Balsa Bridge Kits

The balsa bridge kits will be mailed no later than April 10, 2018 to the home address provided for the team captain. The kit will consist of Balsa Wood and Wood Glue that is to be used to construct the bridge. Only the materials included in the kit can be used in the construction of the bridge. Please contact the Brie Salmons ([salmonsb@njrati.org](mailto:salmonsb@njrati.org)) if there is a problem with your supplies.

### 4.3 Team Composition

Only one bridge can be submitted per team. The Balsa Bridge Build team and the Bridge Design team must be the same individuals. The Bridge Design team is the same team that is registered on the contest website.

### 4.4 The Problem

The goal of this competition is to develop a Truss Bridge that will carry the maximum load while weighing as little as possible (strength-to-weight ratio). It is recommended that each team research the bridge type and design, then conduct experiments to test for the highest strength-to-weight ratio, and then design and construct a competition bridge based on those experiments.

Each bridge will be checked for compliance with the Truss Bridge Specifications in Section 4.6. The bridges will be weighed and load tested during the competition to calculate strength-to-weight ratio.

### 4.5 The Challenge

An engineer's job is to not only design a safe bridge to carry required loads, but also to make sure that it is cost effective (least amount of materials used to support the desired load). The objective is to obtain a high strength-to-weight ratio (example calculation shown below).

Example: Maximum Load Held = 40.0 lbs

Bridge Weight = 20.0 grams

$$\text{Strength-to-Weight Ratio} = \frac{40 \text{ lbs}}{20.0 \text{ grams}} \times \frac{454 \text{ grams}}{\text{lb}} = 908.0 \frac{\text{lbs loading}}{\text{lbs weight}}$$

#### 4.6 Truss Bridge Specifications

The bridge must be designed and constructed following these specifications. Violation of these specifications will result in the judges recording zero for the load supported.

1. The materials provided in the kit are the **ONLY** materials to be used when building the bridge structure. No modifications to the structural properties of the balsa wood are allowed. Different glue is not allowed.
2. The device used for testing is the Pitsco Structures Testing Device shown in Figure 1.
3. The required dimensions of the bridge are shown in Figure 2. Note that the portion of the bridge that is above the testing apparatus supports is referred to as the superstructure and the portion below the testing apparatus supports is referred to as the substructure. Bridges are not required to have a substructure.
  - a) The total length of the bridge shall be 12 inches  $\pm$  0.5 inches.
  - b) The total width of the bridge shall be 5 inches  $\pm$  0.5 inches (not shown in Figure 2).
  - c) The maximum length of the bridge substructure, if utilized, is 9.5 inches.
  - d) The maximum depth of the bridge substructure, if utilized, is 1.0 inch.
4. The bridge shall only touch the top of the supports as shown in Figures 1 and 2.
5. A block of wood that is 3.25 inches long by 2.0 inches wide by 0.75 inch high must be able to be pushed across the bridge deck. The block of wood is necessary for load testing the bridge.
6. The bridge deck must incorporate an opening at mid-span to allow a 3/4-inch diameter testing rod to pass through and attach to the wood block (see item 5 above). The rod must be able to pass through the full height of the bridge.
7. Lamination (gluing two pieces of wood along their longitudinal length to increase strength) is not permitted (shown in Figure 3). However, joints may be thicker to accommodate joining wood pieces.



Figure 1. Bridge Testing Apparatus

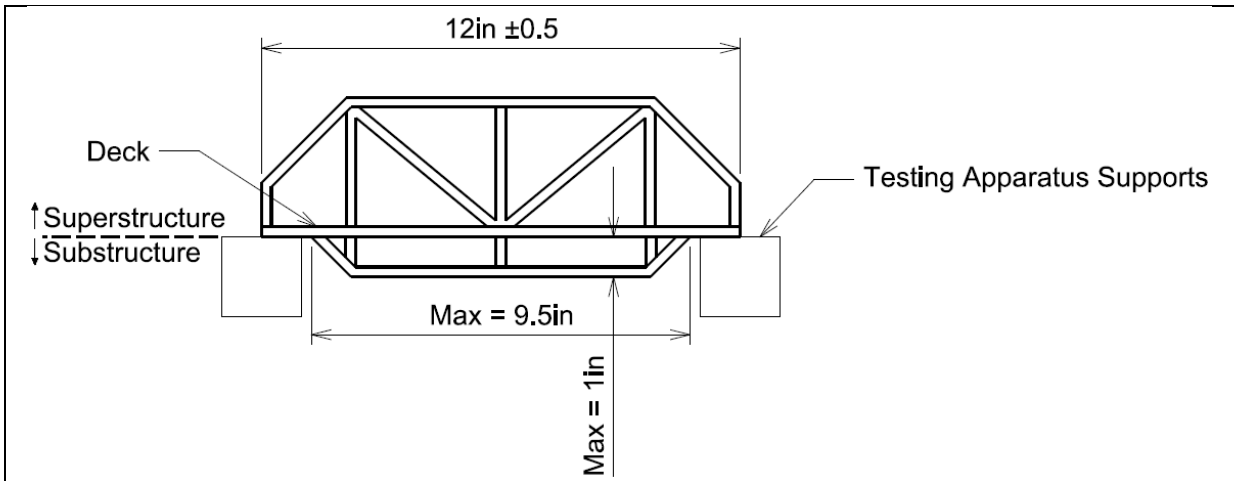


Figure 2. Bridge Dimensions

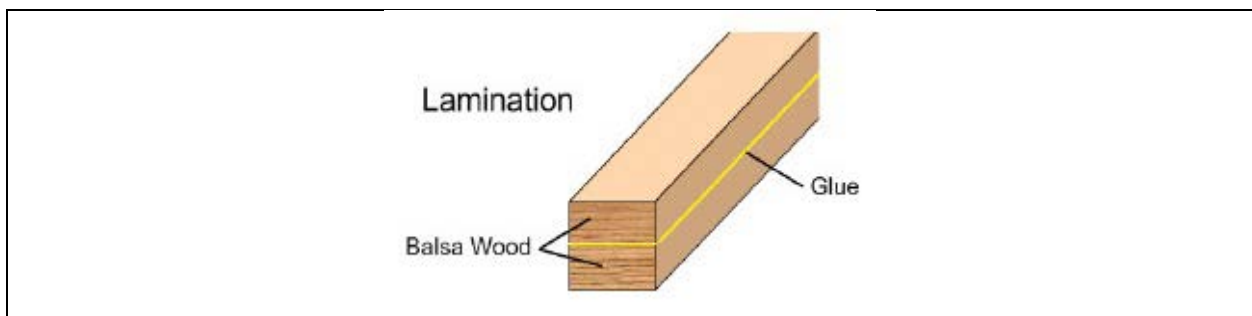


Figure 3. Lamination of Balsa Wood Members is Not Permitted

#### 4.7 Final Round

On the day of the Statewide Finals, teams will bring their Balsa Bridges and set them up in their designated display area. The bridge will remain in that designated area until load testing. The following criteria will be used in judging the bridges.

**AESTHETICS:** Judges will evaluate the bridges for quality of construction (e.g., no excess glue, neat cuts, symmetry, etc.) and the resemblance to a truss bridge. The most aesthetic bridge in the High School division and Middle School division will win a non-cash prize.

**PERFORMANCE:** Bridges will be weighed and then load tested on the Pitsco Tester. Results will be used to calculate strength-to-weight ratio. Any bridge not meeting the Truss Bridge Specifications will result in judges recording zero for the load supported.

#### 4.8 Notes to Team Mentors

Work on all phases of the Balsa Bridge project shall be done by the students. Mentor assistance is to be limited to:

- Mentoring
- Basic guidance of the students
- Teaching engineering, mathematical and scientific principles applicable to the project
- Guiding students in research
- Assisting in the production of the report and preparation of the drawings
- Overseeing the manufacturing stages of the project

Guidance should be in the form of asking questions, (leading questions if necessary) to promote creative thinking by the students to identify the scientific and engineering principles involved. Encourage students to consult credible websites and other resources to help with the project. Encourage students to test and improve their designs. A good way to begin is for each student to design and/or construct a rough prototype, test it and make improvements.

### 5 Disclaimer

The contest organizers have made every effort to adequately explain the contest format and corresponding rules within this document. However, they reserve the right to change the rules without notice right up to the Final Round. Any changes will be communicated to the contest participants at the Final Round.