

# SAMPE 2023

## Student Bridge Contest

### Rules and Guidelines



The Governing Committee can be reached at:  
[studentbridge@sampe.org](mailto:studentbridge@sampe.org)

## Table of Contents

1. Contest Intentions
  - 1.1. Teams
  - 1.2. Design
  - 1.3. Expectations
2. Categories and Design loads
3. Geometric Constraints
  - 3.1. All Categories
  - 3.2. I-Beam
  - 3.3. Square Beam
  - 3.4. Open Design
  - 3.5. Sandwich Beam
4. Materials and Manufacturing
  - 4.1. Approved Raw Materials
  - 4.2. Natural Fibers
  - 4.3. Core Materials
  - 4.4. Manufacturing
5. Testing
  - 5.1. Setup
  - 5.2. Parameters
  - 5.3. Equipment
6. Registration
  - 6.1. Proposal
  - 6.2. Posters
  - 6.3. Material Kits
7. Evaluation Criteria
  - 7.1. Bridge Evaluation
  - 7.2. Poster Evaluation
  - 7.3. Overall Contest Winner
8. Contest Details

Appendix A – Proposal Cover Page Template

Appendix B – Poster Template

1. Contest Intentions. The contest is an opportunity for students to learn and develop skills in composite design and manufacturing. To participate, students must be enrolled in an accredited university, college, community college or high school. Students must be 16 years of age or older, in accordance with SAMPE conference regulations. Students under the age of 16 may participate as a team member but cannot attend the conference. The rules and guidelines in this document are to be considered an outline and are subject to interpretation by the Governing Committee. Students are encouraged to contact the Governing Committee for clarification of the rules and regulations. Any team that is not compliant with the spirit of the rules and guidelines will be subject to disqualification.
  - 1.1. Teams. An individual team shall have no more than 5 members, consisting of one team leader and up to four additional members. Team members must be enrolled at the school they are representing unless the team meets the requirement of a complex team per section 1.1.1.1.
    - 1.1.1.1. Unique Team. A registered team must consist of a unique set of team members for each category. A team consisting of the same team members may compete in multiple categories but cannot register multiple bridges in the same category.
      - 1.1.1.1.1. Complex Teams. A team consisting of students from multiple schools can participate in the contest. The schools are required to be located geographically close to form a complex team and approval of the team is subject to the Governing Committee prior to registration.
      - 1.1.1.1.2. Failure to Comply. Teams that do not meet the unique team requirement the day of the contest will not be disqualified. Each bridge submitted by the team will be tested but the only the lowest scoring bridge will be eligible for rewards.
    - 1.1.1.2. Failure to Comply. Teams that do not meet the unique team requirement the day of the contest will not be disqualified. Each bridge submitted by the team will be tested but the only the lowest scoring bridge will be eligible for rewards.
  - 1.2. Design. Teams must submit unique designs for their registered categories. For schools submitting multiple bridges in a single category, the teams must show each design is unique. Uniqueness is subject to determination by the Governing Committee.
    - 1.2.1.1. Submitting Similar Designs. Teams may submit similar designs for comparison evaluation by the Governing Committee. Similar bridge identification numbers must be listed in the preliminary design proposal. It is recommended that this be done prior to registering for the contest.
    - 1.2.1.2. Failure to Comply. Teams that do not meet the unique design requirement the day of the contest, will be asked by the Governing Committee to select a single bridge to be tested and the remaining bridges will be disqualified. If a team cannot or will not select a single bridge, each bridge will be tested but only the lowest scoring bridge will be eligible for prizes. Bridges will not be permitted to switch categories.

- 1.3. Expectations. Students are encouraged to seek advice from school faculty, peers and industry professionals throughout the project. However, all manufacturing shall be done by student team members only without assistance from school faculty and/or industry professionals. Students are encouraged to focus on manufacturability and design optimization.
2. Categories. There are 8 independent bridge categories comprised of different materials architectures and load requirements.
  - a. Category A: Carbon and/or Aramid Fiber I-Beam
    - i. Design Load: 7,200 lbf
    - ii. Minimum Required Load: 1,500 lbf
  - b. Category B: Carbon and/or Aramid Fiber Square Beam
    - i. Design Load: 7,200 lbf
    - ii. Minimum Required Load: 1,500 lbf
    - iii. No prepreg permitted
  - c. Category C: Boron I-Beam or Square Beam
    - i. Design Load: 7,200 lbf
    - ii. Minimum Required Load: 1,500 lbf
    - iii. Only SAMPE provided material permitted
  - d. Category D: Glass Fiber I-Beam
    - i. Design Load: 5,600 lbf
    - ii. Minimum Required Load: 1,000 lbf
  - e. Category E: Glass Fiber Square Beam
    - i. Design Load: 5,600 lbf
    - ii. Minimum Required Load: 1,500 lbf
    - iii. No prepreg permitted
  - f. Category F: Natural Fiber I-Beam or Square Beam
    - i. Design Load: 2,400 lbf
    - ii. Minimum Required Load: 500 lbf
  - g. Category G: Open Design
    - i. Design Load: 10,000 lbf
    - ii. Minimum Required Load: 1,500 lbf
  - h. Category H: Sandwich Beam
    - i. Design Load: 1,600 lbf
    - ii. Minimum Required Load: 500 lbf
3. Geometric Criteria. No exceptions will be taken to these requirements and failure to comply may result in disqualification.
  - 3.1. Criteria for All Categories.
    - 3.1.1. All bridges must be at least 24.0 inches in length. This length must be continuous. Additional pieces of material cannot be bonded on to the bridge

ends to increase the length. Please consider the blade width when trimming the bridge.

3.1.2. The bridges are tested in a modified three-point bend with 23 inch center.

Designs shall not interfere with the loading by bracing against the supports.

3.2. Criteria for I-Beam Bridges. I-Beam bridges shall have a single web with a thickness less than or equal to 0.6 inches. The caps shall have a maximum thickness of 0.375 inches and they do not have to be equal in length, width and thickness. The radius of the web-to-cap fillet shall be not greater than 0.5 inches. The cross section is permitted to vary along the length of the bridge and does not have to follow the centerline if the required dimensions are maintained. The maximum dimensions for I-Beams are shown in Figure 1.

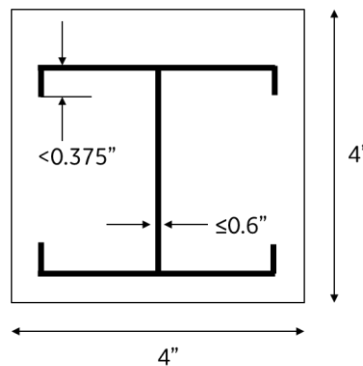


Figure 1. I-Beam Maximum Dimensions

3.3. Criteria for Square Beam Bridges. Square beam bridges are permitted to have a closed or open cross-section but are not permitted to have a solid cross-section along any length of the bridge. Square beams shall have two or three independent webs; webs do not have to be perpendicular to the caps. The webs shall maintain a minimum gap of 0.75 inches and the caps shall maintain a minimum gap of 0.50 inches. Caps are permitted to extend past the web. The maximum dimensions for Square Beams are shown in Figures 2 and 3. The web and cap gap requirements are shown in Figure 4.

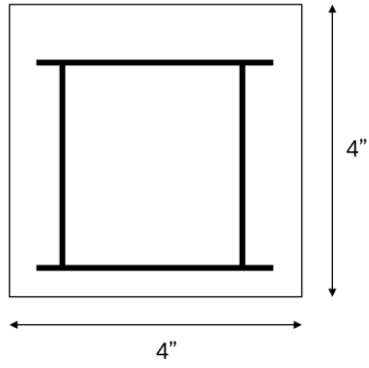


Figure 2. Closed Square Beam Maximum Dimensions

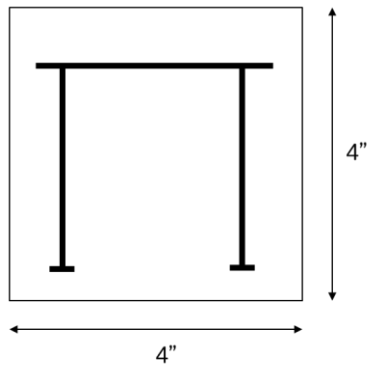


Figure 3. Open Square Beam Maximum Dimensions

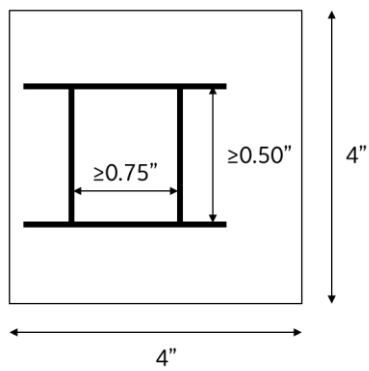


Figure 4. Square Beam Web and Cap Gap Maximum Dimensions

- 3.4. Criteria for Open Design Bridges. The base width of bridge shall not exceed 5 inches in width and the height shall not exceed 14 inches.
- 3.5. Criteria for Sandwich Bridges. Sandwich bridges must maintain a constant cross-sectional area along the length. The cross-sectional width shall be at least 3.0 inches. The facesheets shall be at least 0.010 inches thick. The core shall be at least 0.25 inches thick. The core type may vary within the cross-section and along the length. There shall be no reinforcing webs, trusses or posts through the thickness or perpendicular to the facesheets. The maximum dimensions for a sandwich beam are shown in Figure 5.

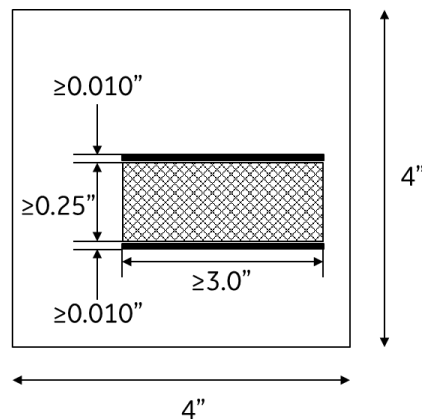


Figure 5. Sandwich Beam Maximum Dimensions

4. Materials and Fabrication. Materials used the manufacturing of the bridges are at the final discretion of the Governing Committee.
- 4.1. Raw Materials. The fiber type permitted for each category is defined in the category name in Section 2. The designated fiber type is intended be the highest strength fiber for the category, but other fiber types are permitted. For example, natural fibers are permitted in glass fiber categories, and natural and glass fibers are permitted in carbon/aramid fiber categories. All modulus carbon fibers (standard, immediate and high) are permitted. All matrices (vinyl ester, polyester, epoxy, etc.) are permitted. Prepreg is not permitted in Categories B and E; for these categories a prepregging machine shall not be used to produce material. For Category C, only boron provided in kits from SAMPE is permitted.
- 4.2. Natural Fiber. Permitted natural fibers must be naturally occurring in fiber form. Basalt and similar fibers are not permitted because they are naturally occurring minerals, not fibers. Animal hair and/or fiber is not permitted.
- 4.3. Core Materials.
- 4.3.1. All Categories Except F and H. Approved core materials include but are not limited to aluminum honeycomb, glass/phenolic honeycomb, foam, solid wood and wood laminates. Wood laminates can be purchased or self-

laminated. Other materials shall be submitted to the Governing Committee for approval.

4.3.2. Category F. Core materials must be naturally occurring, such as solid wood or wood laminates. Wood laminates can be purchased or self-laminated but cannot contain non-naturally occurring reinforcements, fillers or additives between wood layers.

4.3.3. Category H. All core material allowed in 4.3.1 are permitted except for wood laminates (purchased or self-laminated) which are not permitted. In addition, core is permitted to be 3D printed from either acrylonitrile butadiene styrene (ABS) or polylactic acid (PLA) filament. The filament cannot be fiber reinforced or contain additives. A request shall be submitted to the Governing Committee for teams wanting to extrude filament.

4.4. Prohibited Materials. Hazardous materials and metal (excluding honeycomb) Boron fibers are prohibited in all categories, except for Category C and the fiber must be supplied by SAMPE.

4.5. Manufacturing. Acceptable methods of bridge manufacturing include wet layup, compression molding, vacuum assisted resin transfer molding (VARTM) and resin transfer molding (RTM). Processing in an oven, autoclave and press are permitted. Filament winding is not permitted in any category.

5. Testing. Testing parameters may be subject to change the day of the competition by the Governing Committee based on Conference Schedule. If parameters are changed, they will be changed at the start of a new category.

5.1. Setup. Teams are permitted to load and unload their own bridge; two team members maximum are permitted to do so. A time limit of 1 minute is allowed for loading the bridge.

5.2. Parameters. The load rate will be a minimum of 1 inch per minute. To ensure all bridges are tested, testing will end once the design load for the category is exceeded by 100 lbf.

5.3. Equipment. The fixture consists of a base and loading block, shown in Figure 6. Dimensions for the lower contact points are further dimensioned in Figure 7. The corresponding load case is depicted in Figure 7. The fixture will be installed and oriented prior to the competition; adjustments are permitted during the competition.



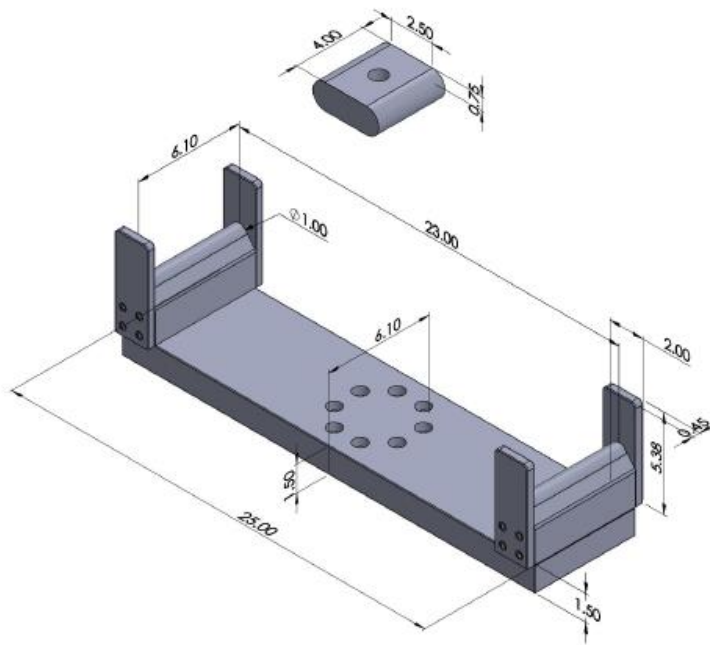


Figure 6. Loading Fixture with Bridge

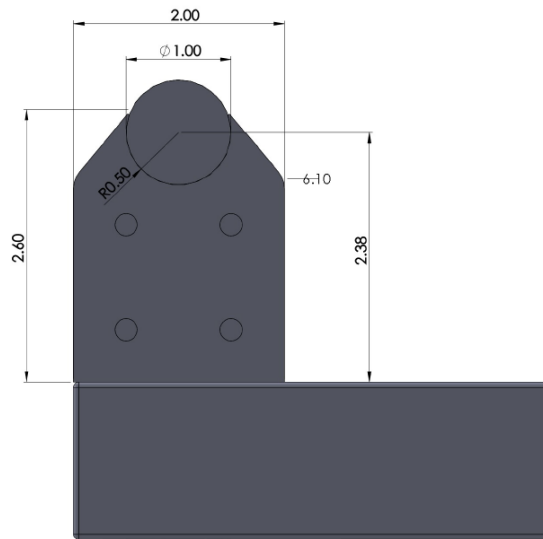


Figure 7. Lower Contact Point

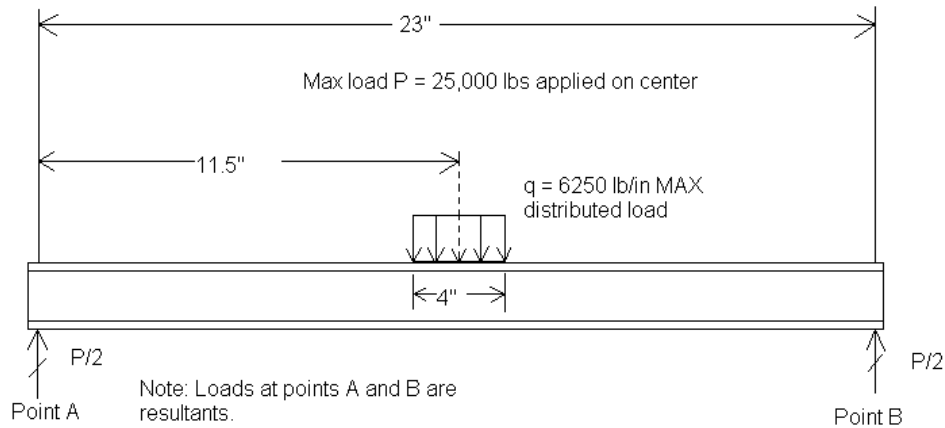


Figure 8. Load Case Free Body Diagram

5.3.1. Base. The span from center to center is 23 inches. The height from top to bottom is 2.88 inches. The support diameter is 1 inch.

5.3.2. Loading Block. Block dimensions are 4 inches by 4.1 inches by 1.5 inches (L x W x H), as shown in Figure 9.

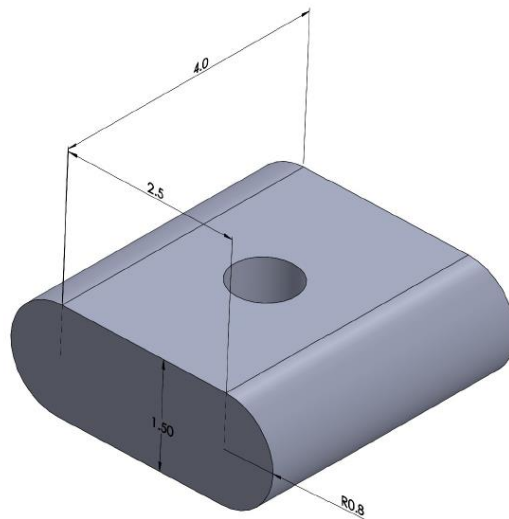


Figure 9. Loading Block Dimensions

6. Registration. To participate in the competition, teams must register online on the Contest Website by **March 19, 2023**. Registration opens on **February 1, 2023**. Late registration at the conference will be available. Registered teams will receive a Bridge Registration Number via email. If you are unable to locate your number, please contact the Governing Committee.

6.1. Proposal. All teams must submit a design proposal for each registered bridge for review and approval by the Governing Committee no later than **March 19, 2023**. Proposals shall include the following elements:

- a. Cover Page. A cover page template can be found in Appendix A. The cover page shall include the following:
  - i. Bridge Registration Number
  - ii. Category
  - iii. School Name
  - iv. Team member names with one team member identified as the team leader. An email address shall be provided for the team leader as a point of contact for the Governing Committee.
  - v. Faculty advisors name and contact information, including email address and phone number.
  - vi. Complete list of Bridge Registration Numbers for the school.
- b. Written Description of Bridge. Please keep the description to one page. The description shall include but is not limited to details about the design, materials used, manufacturing process and analysis (if completed) to assess the structural capability.
- c. Drawing. Drawings with dimensions and different views including a cross sectional view are recommended. Drawings are not required to be done in a CAD based software.
- d. Approval. The Governing Committee will reply to teams either approving the submitted proposal or provide feedback. If feedback is provided, teams may need to clarify details or make changes, and resubmit the proposal for approval.

6.2. Posters. All teams must submit a poster for each registered bridge. The poster shall highlight details about the design, materials used, manufacturing process and analysis (if completed) to assess the structural capability.

6.2.1. Prize Eligibility. Bridge entries without a poster will be tested but are not eligible for prizes. Late poster submittals the day of the competition will not be eligible for poster prizes but will still be eligible for bridge category awards. Posters not meeting the category requirements will also not be eligible for poster prizes.

6.2.2. Poster Categories. Each category will be judged separately. Teams are only required to provide a poster for one of the following categories. Team may choose to submit posters for both categories however only the poster with the best score will be considered for a poster award.

6.2.2.1. Paper Posters. Posters shall be 22"H x 28"W in a landscape (horizontal) format. A poster template can be found in Appendix B. The poster shall include:

- i. Bridge Registration Number in the upper left-hand corner.
  - ii. School Name at the top center.
  - iii. Bridge Category in the upper right-hand corner.
- 6.2.2.2. Video Poster. Videos shall be in a downloadable format, such as MP4, AVI or WMV. If the file is located on a Google Drive, please ensure access is given to the Governing Committee. YouTube videos will not be accepted as a valid submittal.

#### 6.2.3. Poster Submittal

6.2.3.1. Paper Posters. SAMPE will print and cover the cost for posters submitted by **March 31, 2023**. Information regarding poster submittal can be found on <https://www.nasampe.org/page/bridgecontest>. If posters are not submitted by **March 31, 2023**, teams will be responsible for printing their own poster. Posters shall be hung up in the Bridge Contest Area before the start of testing. SAMPE will hang the posters they prints.

6.2.3.2. Video Posters. Videos shall be sent to the Governing Committee by **March 31, 2023**. The videos will be shown during the contest and it is recommended that teams have a copy of their video on a flash drive the day of the competition.

6.3. Material Kits. Material kits will be supplied to teams that request kits during registration. Teams wanting boron in their kits will need to specify this during registration. Material kits vary each year based on donations, therefore the Governing Committee cannot guarantee what will be included. In the past kits have included items such as bagging materials, dry fiber/fabric/braid, neat resin and core materials. If available, neat resin will only be provided to teams in categories where prepreg is not permitted (B, C and F). Teams must register by **February 28, 2023** to receive a material kit.

6.3.1. Shipping. Due to hazardous material shipping regulations, material kits cannot be shipped outside of the continental United States. However, Boron can be shipped internationally.

7. Evaluation Criteria. Bridges and posters are evaluated for 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> place monetary awards. The monetary awards are \$500 for 1<sup>st</sup> place, \$300 for 2<sup>nd</sup> place and \$200 for 3<sup>rd</sup> place. Based on awards for each bridge and poster category, an overall winner for the contest will be awarded to the school with the best overall performance. The overall winner will receive a trophy.

7.2. Bridge Evaluation. The maximum applied load up to the category design load is recorded. If bridges in a category do not meet the design load, rewards are determined by highest applied load that is equal to or greater than the category minimum load. Bridges that do not meet the category minimum load requirement are not eligible for rewards. If bridges in a category meet the

design load, rewards will be determined by minimum bridge weight. The evaluation criterion is not a strength to weight ratio.

7.2.1. Tie Breaker. In the event of a tie, all tied teams will be awarded the same place award. The teams will receive the same monetary award and points towards the overall contest point total.

7.3. Poster Evaluation. Paper and video posters are evaluated by industry professionals. The following criteria are evaluated from 1 to 5 points, for a maximum score of 25 points.

7.3.1. Paper Poster Criteria:

- i. Depth of technical content
- ii. Effective use of images
- iii. Readability (font, text formatting, conciseness)
- iv. Presentation and layout (flow of information)
- v. Relevance to bridge entry

7.3.2. Video Poster Criteria:

- i. Depth of technical content
- ii. Effective use of images and/or video clips
- iii. Clarity and flow of the video
- iv. Creativity
- v. Relevance to bridge entry

7.3.3. Tie Breaker. In the event of a tie, all tied teams will be awarded the same place award. The teams will receive the same monetary award and points towards the overall contest point total.

7.4. Overall Contest Winner. The overall contest winner is determined by a summation of points earned by a school for placing in a bridge category and/or poster category. Three points are awarded for 1<sup>st</sup> place. Two points are awarded for 2<sup>nd</sup> place. And one point is awarded for 3<sup>rd</sup> place.

7.4.1. Tie Breaker. In the event of a tie, the winner will be determined by the school with the most 1<sup>st</sup> place awards. If a tie still exists, the winner will be determined by the school with the most 2<sup>nd</sup> place awards. If a tie still exists, the winner will be determined by the school with the most 3<sup>rd</sup> place awards. If a tie still exists, for each bridge category a mean load will be calculated. For each entry a percent deviation from the category mean will be calculated. The school with the highest average percent deviation from the mean wins; the average is to include all entries from the school, not just winning entries.

8. Contest Details. Information regarding times and location for the contest will be emailed to registered teams prior to the conference. Check-in for the contest is the day before the contest on **TBD**. Please anticipate being at the conference the day before the contest. The contest will be held on **TBD**.

## Appendix A. Proposal Cover Page Template

### SAMPE Bridge Contest Design Proposal

Bridge Registration Number:

Bridge Category:

School Name:

Team Leader:

Email Address:

Team Members:

Faculty Advisor:

Email Address:

Mailing Address:

Phone Number:

Other Bridge Registration Numbers:

Appendix B. Poster Template

