2018 SAMPE Student Bridge Contest Rules

ALL BRIDGES MUST BE AT LEAST 24" IN LENGTH. BRIDGES SHORTER THAN THIS WILL NOT BE TESTED DUE TO SAFETY REASONS. NO EXCEPTIONS.

NEW SANDWICH BEAM CATEGORY – SEE SECTION 9 BELOW FOR INFO

1. The contest will be for enrolled students at an accredited university, college, community college or high school only. Students attending the contest must be 16 years of age or older in accordance to SAMPE conference regulations; younger students may participate as team members but may not attend. The following rules are to be considered an outline of the requirements and are subject to interpretation by the Governing Committee. The contest is intended to provide an opportunity for students to learn and expand their abilities in composite manufacturing and design. Any design or concept which is not consistent with the spirit of these rules will be disqualified. Students are encouraged to ask for clarification of these rules. The governing committee will publish the question(s) and the committee's answer on the SAMPE contest web site: http://www.nasampe.org/?page=bridgecontest.
2. Individual teams shall be composed of **no more than five members** (one team leader and up to four additional members) to allow each student to have a hands-on experience involving design and manufacture of a composite structure. In order to encourage autonomous function of different teams, each entry must meet three requirements:

    a. **Student Fabricated Bridge:** The students are encouraged to solicit advice, instruction, and training from faculty, peers, and industry members during the course of the project. However, **all work involved in fabrication of the entry bridges shall be accomplished by the team members themselves without assistance from any other parties.**

    b. **Unique Team:** Each registered team must have unique student team members for each category. That is, individual student team members may only be on one team per category. All team members for a given entry **MUST** be identified on your Bridge Design Proposal for the Governing Committee's review. All members of the team must be active students at the school entered. As not all design proposals are submitted at the same time, it is incumbent on the students themselves to ensure their team meets this requirement. On Test Day where multiple entries from the same school are entered in a single category, the Governing Committee will compare all approved Design Proposals including the list of Students on the Teams. If two (or more) entries from the same school in the same category are without unique team members, both bridges will be tested, but only the lowest scoring entry will be eligible for awards and points.

    c. **Unique Design:** Each school must enter unique designs in their registered category(s) including the poster category. To compete separately, approval for designs that appear similar **MUST** be obtained during the design proposal phase and will only be granted based on demonstration that the designs are in fact unique. The student team with the

help of their faculty advisor must identify on their design proposal title page any similar entry registration numbers they would like the Governing Committee to approve as unique and eligible to compete against in their category. On Test Day where multiple entries from the same college or university are entered in a single category, the Governing Committee will compare all approved Design Proposals for those entries. If there are two (or more) entries from the same school in the same category which the Governing Committee judges to be of equivalent design and did not receive approval during the Design Proposal Phase, the teams will be given the choice to select a single beam to compete in this category while all other designs deemed similar will be disqualified. If the teams cannot come to a decision, all beams will all be tested but only the lowest scoring entry will be eligible for points or awards.

3. Between **March 1, 2018 and May 16, 2018**, all teams must submit a design proposal for approval by the Governing Committee (email address: SAMPEBridgeContest@gmail.com) for each registered entry. Please submit the entire design proposal, including the drawing, in one Word or PDF document. Drawings submitted in any other format (e.g. a .dwg file) will not be reviewed and your proposal will be rejected.

   Your proposal must include the following elements or they will be returned without review or approval:

   a. A title page with the following information included:
      i. Bridge Registration Number (e.g., 07-XXXX) Note: If you registered online, your Bridge Registration Number was generated and sent to you via email as part of the registration process. If you registered via mail or fax, your Bridge Registration Number will be emailed to the email address provided on your form once SAMPE has received it into the registration system. If you are unable to locate your number, please email priscilla@sampe.org
      ii. Category (e.g., Category A: Carbon I-Beam, Category B: Carbon Square Beam, etc.)
      iii. Name of School
      iv. Names of students on the team (no more than five per entry); Identify which student is the team leader and include their email address. The student team leader's email address will be used by the Governing Committee to provide feedback and/or approval for the proposal submission as well as the Contest Timeline. The Contest Timeline will be sent about a week before the contest which will give details for where to post your poster and check in your bridge, and a timeline for bridge check in and testing.
      v. Faculty advisor Name, email and phone number
      vi. List of any registration numbers from your school that you believe will appear similar but are in fact unique to your bridge entry design (see Rule 2 above)
   b. A no more than one page written description of your design, the manufacturing process used to build it and the analysis process used to develop the structural capability (if performed) of your entry.

c. A drawing(s) of your bridge and the materials list you intend to use to construct it.

The Governing Committee will approve or send instructions for required revisions to attain approval no later than May 19, 2018. Changes may be made to a design after the proposal has been approved; however, the design may be disqualified if the changes violate the spirit of the rules according to paragraphs 1 or 2.

Online registration will be available through May 11, 2018. Late entries made at the competition may still participate. Late entries must be accompanied by a completed design proposal attached to the bridge and are subject to disqualification if they are not fully compliant with the competition rules.

**Students are encouraged to submit design proposals early in order to receive approval and feedback earlier.

4. Material kits will be supplied to teams who request kits during registration. Students may use supplied or other materials at their discretion, **except for recycled Carbon Fiber.**

   A materials list shall be included in the design proposal for approval by the governing committee prior to the contest. Any additional materials may be used without prior approval; however, any unapproved material may be disqualified according to paragraph 1 or 2. No natural fiber is included in the supplied kits. No hazardous materials, metals (except as honeycomb core), or boron fibers may be used in the bridges. **Students who wish to receive a material kit must have their team registered no later than March 2, 2018. Material kits cannot be shipped outside of the U.S.**

   Recycled carbon fiber must be specifically requested on the application. It will not be included in the standard kits. Recycled carbon fiber can be shipped to any team and is not restricted to only the U.S. A preliminary design proposal must be submitted to the committee in order to receive recycled carbon fiber. Only the recycled carbon fiber supplied by the Committee will be allowed for the recycled carbon fiber category (Category C). Teams may not make their own recycled carbon fiber. Due to the limited amount of material, recycled carbon fiber will be supplied on a first come, first served basis. Any questions on this new category and the recycled carbon fiber should be directed to the Governing Committee at:
   SAMPEBridgeContest@gmail.com.

   A sample list of what may be included in the kits is located on the Bridge Website:
   http://www.nasampe.org/?page=bridgecontest

5. Bridge categories and Design Loads: **(NOTE: Some categories have changed.)**
   a. Category A: I-beam carbon and/or aramid fiber,
      i. Design Load: 9,000 lbf.

ii. Minimum Required Load: 1,500 lbf

b. Category B: Square beam carbon and/or aramid fiber (no pre-preg),
    i. Design Load: 9,000 lbf.
    ii. Minimum Required Load: 1,500 lbf
c. Category C: I-beam or Square beam **Recycled** Carbon Fiber (rCF),
    i. Design Load: 9,000 lbf.
    ii. Minimum Required Load: 1, 500 lbf
d. Category D: I-beam glass fiber,
    i. Design Load: 7,000 lbf.
    ii. Minimum Required Load: 1,000 lbf
e. Category E: Square beam glass fiber (no pre-preg),
    i. Design Load: 7,000 lbf
    ii. Minimum Required Load: 1,000 lbf
f. Category F: I-beam or Square beam natural fiber,
    i. Design Load: 3,000 lbf.
    ii. Minimum Required Load: 500 lbf
g. Category G: Open design,
    i. Design Load: 15,000 lbf.
    ii. Minimum Required Load: 1,500 lbf
h. Category H: Sandwich Beam
    i. Design Load: 2,000 lbf
    ii. Minimum Required Load: 500 lbs

For each category, the designated fiber is meant to be the upper limit on materials, i.e., natural fibers may be used in the I-beam glass fiber category, and glass and natural fibers may also be used in the I-beam carbon/aramid category.

Acceptable methods of fabrication include wet layup, compression molding, vacuum assisted resin transfer molding, and resin transfer molding. Prepreg may be used for Categories A, D, F, G and H ONLY. For the categories which specify “no prepreg”, a prepregging machine **may not** be used. Filament winding is not allowed for any category. Questions on fabrication methods should be submitted to the Governing Committee.

6. Core Materials
    a. Core materials may be used, as long as the geometric requirements in Paragraphs 7 and 8 are met.
    b. For all Categories except Category F, core materials may include aluminum honeycomb, glass/phenolic honeycomb, foam, or wood. Others shall be submitted to the Governing Committee for approval.
    c. For Category F (Natural Fiber), the core must be naturally occurring (i.e., balsa wood, etc).

d. For Category H ONLY, in addition to the materials listed in b. above, the core may be 3D printed from either (1) acrylonitrile butadiene styrene (ABS) or (2) polylactic acid (PLA) filament. The filament cannot be fiber reinforced or contain any additives. A request shall be submitted to the Governing Committee if you intend to extrude your own filament.

7. Geometric criteria for Categories A - F:
    a. Testing will consist of a modified 3 point bend on 23" centers. No design shall interfere with the nature of the loading by bracing against the supports or similar method.
    b. Geometric requirements as specified in attached Figures (see below) are simple but will be strictly enforced.
    c. **ALL BRIDGES MUST BE AT LEAST 24" IN LENGTH**. This must be a structurally continuous length, i.e., you cannot bond on a separate piece in order to meet the length requirement. **No exceptions will be allowed**. Be sure to consider the blade width when trimming your bridge.
    d. An I-beam must have a single web less than or equal to 0.6" thickness. Caps are not required to be equal in length, width, or thickness (Bottom cap must be at least 24" in length). Cross section may vary along the length of the bridge and does not have to follow the centerline as long as all required dimensions are maintained. The maximum radius of the web-to-cap fillet is 0.5". Caps may be no greater than 0.375" thick.
    e. A square beam may be of open or closed cross section and will have two or three independent webs. The webs do not have to be perpendicular to the caps. At no point along its length may the bridge have a solid cross section. In order to maintain independence of the webs, a minimum gap between the caps of ½" and the webs of ¾" must be maintained along the entire length of the bridge. Interpreting this rule has been a source of confusion in previous years. The Governing Committee recommends reviewing your design with the Governing Committee early and before you begin building your bridge to ensure compliance.
    f. Students are encouraged to focus on manufacturability and optimization of bridge.
    g. Designs that do not achieve the above requirements for the specified category and the general intent as defined in Rules 1 and approved by the Governing Committee will not be allowed to be tested per that category but may still be permitted to be tested in the Open Design Category at the discretion of the Governing Committee.

8. Open Design (Category G) is intended to encourage creativity in design. The following will be the only restrictions on the design:
    a. Testing will consist of a modified 3 point bend on 23" centers. No design shall interfere with the nature of the loading by bracing against the supports or similar method.
    b. **ALL BRIDGES MUST BE AT LEAST 24" IN LENGTH.** This must be a structurally continuous length, i.e., you cannot bond on a separate piece in order to meet the length requirement. **No exceptions will be allowed**. Be sure to consider the blade width when trimming your bridge.
    c. The loading Base Fixture and Load Block shall be the same as the other categories.

d. The bridge may be constructed from any of the materials permissible in the other categories.
e. The bridge must fit inside loading structure. The width of bridge should not exceed 5 inches at reaction points in order for the base fixture to accommodate it. The maximum height above reaction supports should not to exceed 14 inches.
f. Design must be approved by Governing Committee so as not to put the loading machine in jeopardy.

Entries that are legitimate I-Beams or Square Beams **may not** be moved into Open Design Category just because they are duplicate entries.

9. Sandwich Beam (Category H) is a new category for 2018. The materials and dimensional restrictions on the design are:
    a. Testing will consist of a modified 3 point bend on 23" centers. No design shall interfere with the nature of the loading by bracing against the supports or similar method.
    b. **ALL BRIDGES MUST BE AT LEAST 24" IN LENGTH.** This must be a structurally continuous length, i.e., you cannot bond on a separate piece in order to meet the length requirement. **No exceptions will be allowed**. Be sure to consider the blade width when trimming your bridge.
    c. The loading Base Fixture and Load Block shall be the same as the other categories.
    d. The bridge may be constructed from any of the materials permissible in the other categories.
    e. The overall cross sectional dimensions, including the core and the facesheets shall not exceed 4" x 4". The core must be at least 0.25" and the facesheets must be at least 0.010" thick for at least the middle 16 inches of the beam..
    f. There shall be no reinforcing webs, trusses or posts of fiber reinforced composite running through the thickness of beam or along the edges perpendicular to the facecheets.
    g. See Section 6 for allowable core materials.

10. See Figures 4-6 at end of these Rules for the Fixture Base and Loading Block. Fixture Base dimensions: from center to center = 23"; From top to base = 2.88"; Support diameter = 1" Loading Block dimensions: 4"x4"x2"- 3/8" wall thickness rectangular tube fabricated using steel material stock from www.industrialtube.com. The loading block will be installed and oriented prior to the start of the contest and will remain in place as is for the duration of the contest. modifications may be made by any teams during the contest. Teams may have a maximum of two members load the beam in the test frame. A time limit of 1 minute per beam is allowed for alignment and placement for testing.

11. Check-in will take place on Tuesday afternoon and Wednesday morning. Time and Place for check-in will be sent to the Team Leader using the email address you provided on your Design Proposal at least one week prior to the SAMPE Conference. All Teams should be prepared to check-in your Bridge and hang your poster on Tuesday afternoon. If your Team has missed the

poster deadline, you must bring your poster to the Bridge Check in Area to qualify your bridge entry. All bridge entries must be labeled with your unique Bridge Registration Number. **All Bridges must be checked in with a paper copy of their current Design Proposal**. If a Design Proposal was previously approved but has been revised or the Team wishes to change categories, the Proposal must be re-approved by the Governing Committee during the Design Proposal Phase. Entries that did not gain approval during Design Proposal Phase are at risk of being disqualified on Test Day.

12. Evaluation Criteria for Individual Bridge Category Awards. (Note that evaluation criteria have changed from previous contests.)

    a. Score is taken as maximum compression load P (up to that category's design load) where failure occurs. Please note that this means there is NO advantage to exceeding the design load.

    b. For all the bridges in a category meeting the category's design load, bridge weight shall be used as a tie breaker. Note that this is not P/W, it is simply minimum weight.

    c. If the Design Load is not met, first place, second place, and third place will be awarded to the highest three loads attained in each category, respectively, up to the design load.

    d. In the event of a tie, all tied entries will be awarded the place finish including points towards the trophy in lieu of awarding first, second or third places. (e.g., if three posters tie for 1st place, all three will be awarded a first place finish and there will be no second or third place finishes, etc.)
    e. A bridge must hold the minimum load requirement in order to be eligible for an award.

13. All student team entries must also submit a poster presentation highlighting some material, process and/or design aspects of their bridge. The poster should clearly document manufacturing processes used in the bridge fabrication. **Bridges without posters will be tested but will not be eligible for prizes. Each bridge entry requires a poster. Late posters must be submitted with the bridge upon check-in, the poster will not be judged for the poster category but is required to maintain eligibility for that bridge.**

There are now two options for submitting a poster. Each option will be a separate poster category and will have its own awards. Teams are only required to submit one of the options below. For teams that choose to do both, whichever one scores better will be counted towards the award.

    a. Option 1: The standard way is a printed poster. **ALL POSTERS SHOULD BE 24"X36" LANDSCAPE FORMAT (ORIENT IT HORIZONTALLY).** Posters that are larger than this must be trimmed to meet this requirement or they will not be accepted. Teams should be prepared to submit their posters on Tuesday. Using the email address you provided on your registration form, the Time and Place will be sent to your Team Leader at least

one week prior to the SAMPE Conference. The posters will be prominently displayed on Tuesday, Wednesday and Thursday. The Governing Committee will appoint a panel of industry judges to judge the posters based on technical merit and relevance to the bridge entry. **The poster must include the Bridge Registration Number received upon registration in the lower right corner of their entry. Posters which do not include this number will be disqualified. Posters not hung by the deadline given in the Contest Timeline will not be judged for the printed poster category.**

**Note: Posters should remain up until Wednesday afternoon. If you would like to have your poster returned and need to leave early, clearly write your shipping address onto the backside of your poster and let the Governing Committee know prior to leaving the contest. SAMPE will collect all of the posters after the contest and all posters which have been coordinated to be returned will be mailed to the address provided. All others will be discarded.

i. The 5 evaluation criteria that will be judged include
    1. Depth of technical content
    2. Effective use of images
    3. Readability (e.g., Selection of font, text formatting, concise, etc.)
    4. Presentation and layout (i.e., Informational flow of poster)
    5. Relevance to team's bridge entry

ii. A panel of industry judges will give each poster a rating of 1 to 5 for each criterion. The ratings will be summed to yield a total score for each criterion. The scores from the judges will be a summed and averaged for each poster to derive the entry's total score.
iii. First place, second place, and third place will be awarded to the highest three total scores respectively.

In the event of a tie, all tied entries will be awarded the place finish including points towards the trophy in lieu of awarding first, second or third places. (e.g., if three posters tie for 1st place, all three will be awarded a first place finish and there will be no second or third place finishes, etc.)

b. Option 2: The alternative way is to submit a video. This option is meant to inspire creativity in presenting your bridge's materials, manufacturing, and design. The videos should include all the same information that is included on the printed poster. **The videos must be submitted by May 16, 2018. Videos must be in a format that is downloadable (such as Google Drive) Instructions for video submission can be found on the Bridge Website:**
http://www.nasampe.org/?page=bridgecontest

**Note: The videos will only be viewable by the Governing Committee and the judges prior to the contest. At the contest, the videos will be shown during the testing. If you have any questions, please contact the Governing Committee.

i. The 5 evaluation criteria that will be judged include
    1. Depth of technical content
    2. Effective use of images
    3. Clarity/flow of the video
    4. Creativity
    5. Relevance to team's bridge entry

ii. A panel of industry judges will view the videos prior to the contest. The judges will give each video a rating of 1 to 5 for each criterion. The ratings will be summed to yield a total score for each criterion. The scores from the judges will be averaged to derive the entry's total score.

iii. First place, second place, and third place will be awarded to the highest three total scores respectively.

iv. In the event of a tie, all tied entries will be awarded the place finish including points towards the trophy in lieu of awarding first, second or third places. (e.g., if three videos tie for 1st place, all three will be awarded a first place finish and there will be no second or third place finishes, etc.)

14. Awards for individual Bridge and Poster/Video categories are as follows: Monetary awards for first, second and third place will be given in the form of a check issued to the "Payee" and mailed to the address as identified on your Registration Form. The "Payee" identified for your team during registration will be responsible for distributing the award to the winning team members.

    Awards for each category will be distributed assuming sufficient entries for 1st, 2nd and 3rd place in each category.

15. Evaluation Criteria for Trophy – The Bridge Trophy will be awarded to the university or college which performs best overall in the competition. Their school's name will be engraved on the trophy and they will be allowed to house the trophy through March of the following year under the care of their advisor. (Teams which fail to return or irrevocably damage the trophy will be banned from the competition)

    a. Scoring for the trophy will be as follows: All entries (including poster/video entries) from a particular school will be added together to tally the total points garnered. The school with the most points is the 'best overall in the competition'.

        First place finish – 3 Points

        Second place finish – 2 Points

        Third place finish – 1 Point

b. In the event of a tie breaker, the winner will be determined as the school with the most first place wins. If there is a tie for the number of first place wins, then the winner will be determined among those tied schools as the one with the most second place wins. If there is still a tie between schools, then the winner will be determined among those tied schools as the one with the most third place wins. If there is still a tie, the winner will be determined as follows among the tied schools: For each 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. This average is to include all entries from that school, not just winning entries.

16. Question submission guidelines: **When submitting a question, please reference the relevant paragraph(s) in the rules**, and include any supporting pictures/images in a Microsoft Word document. All questions and responses will be posted to SAMPE website:

    http://www.nasampe.org/?page=bridgecontest

    Submit question(s) for review by the Governing Committee to:

    SAMPEBridgeContest@gmail.com

Figures

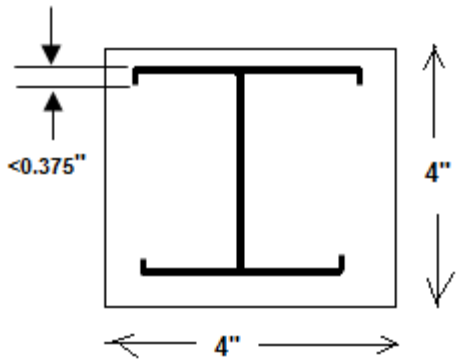


Figure 1: Maximum dimension for I-beam cross-section is 4”x4”

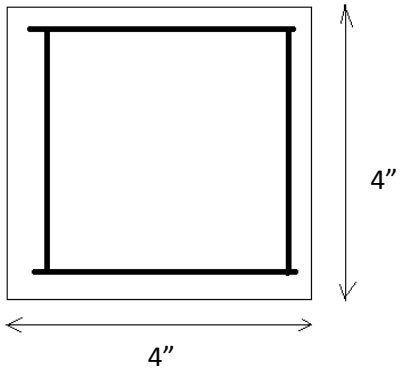


Figure 2: Closed x-section square beam. Maximum dimensions of Box beam cross-section 4”x4”. Note: Caps may extend past webs as long as the cross-section is within the maximum dimensions.

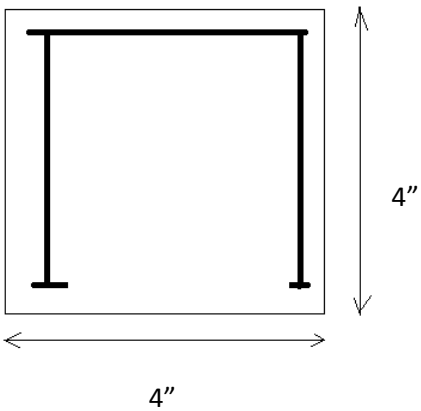


Figure 3: Open cross-section square beam. Maximum dimensions of Cross-section 4”x4”

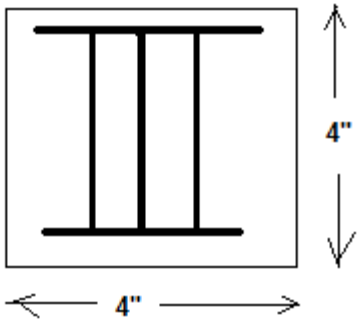


Figure 4: 3 web square beam. Maximum dimensions 4”x4”

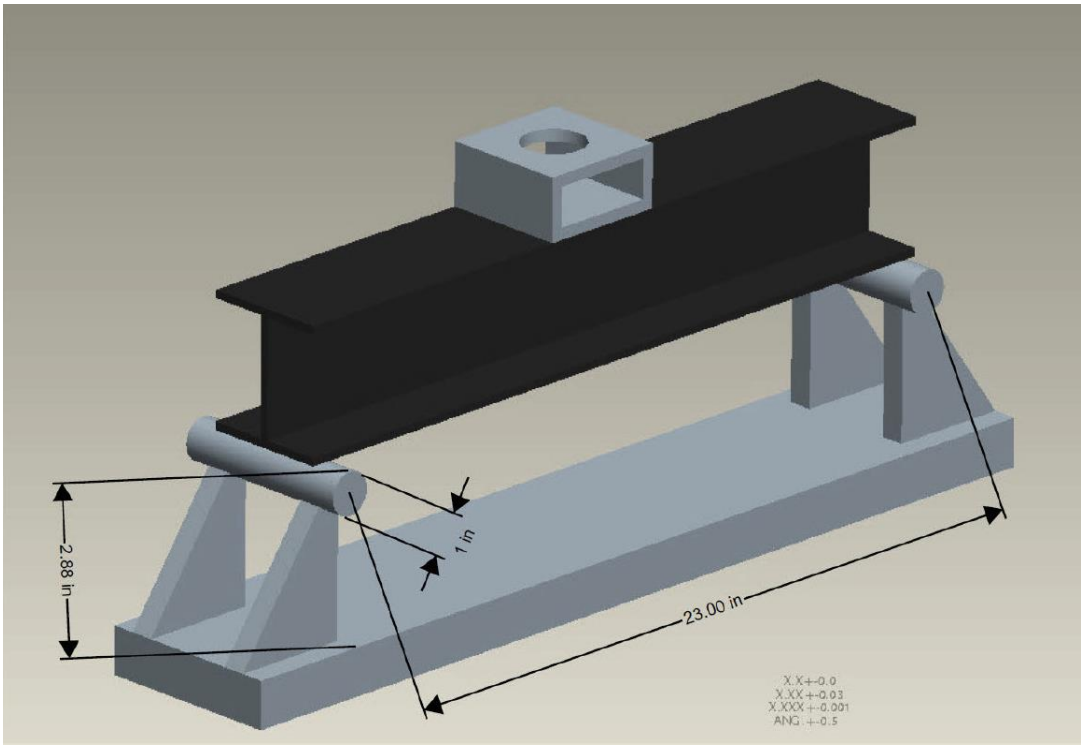
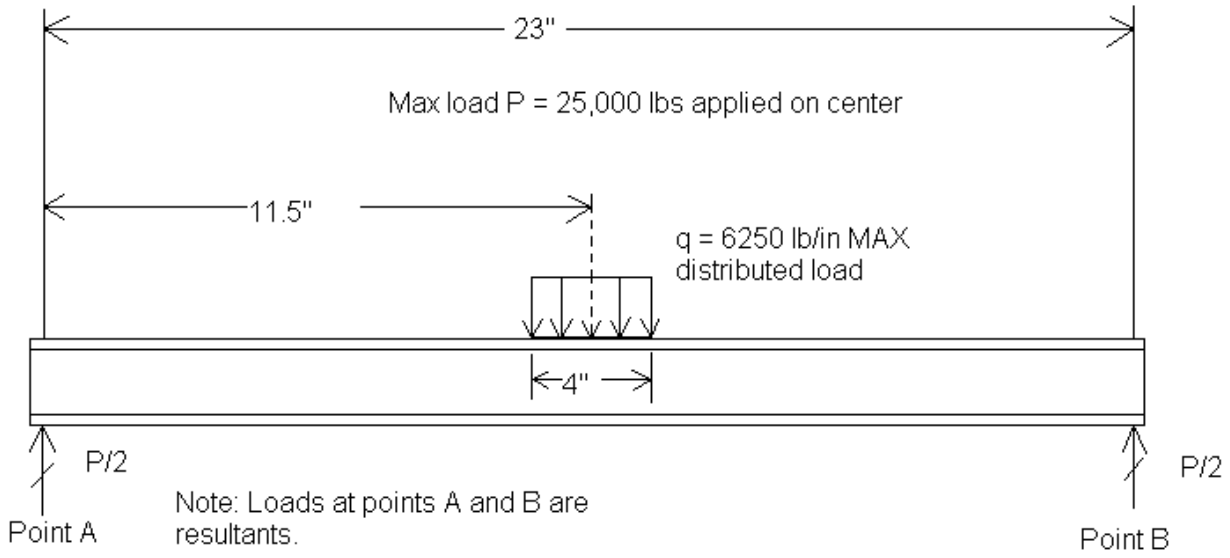


Figure 5: Isometric of a typical bridge with loading fixture

(I-beam as depicted in the Figure 1 cross-section is shown for reference only; all configurations will be loaded in the same manner See Figure 7 for details on the loading block.)



The test fixture load will be applied at the Load Block (see Figure 6 below) using an aligned vertical load with zero degrees of freedom at the load entry point. Freebody depicts the resulting distributed load (q) at the Load Block to Bridge interface, the equivalent load (P) and resultant loads (P/2) at Points A and B.

Figure 6: Free body diagram of basic load case.

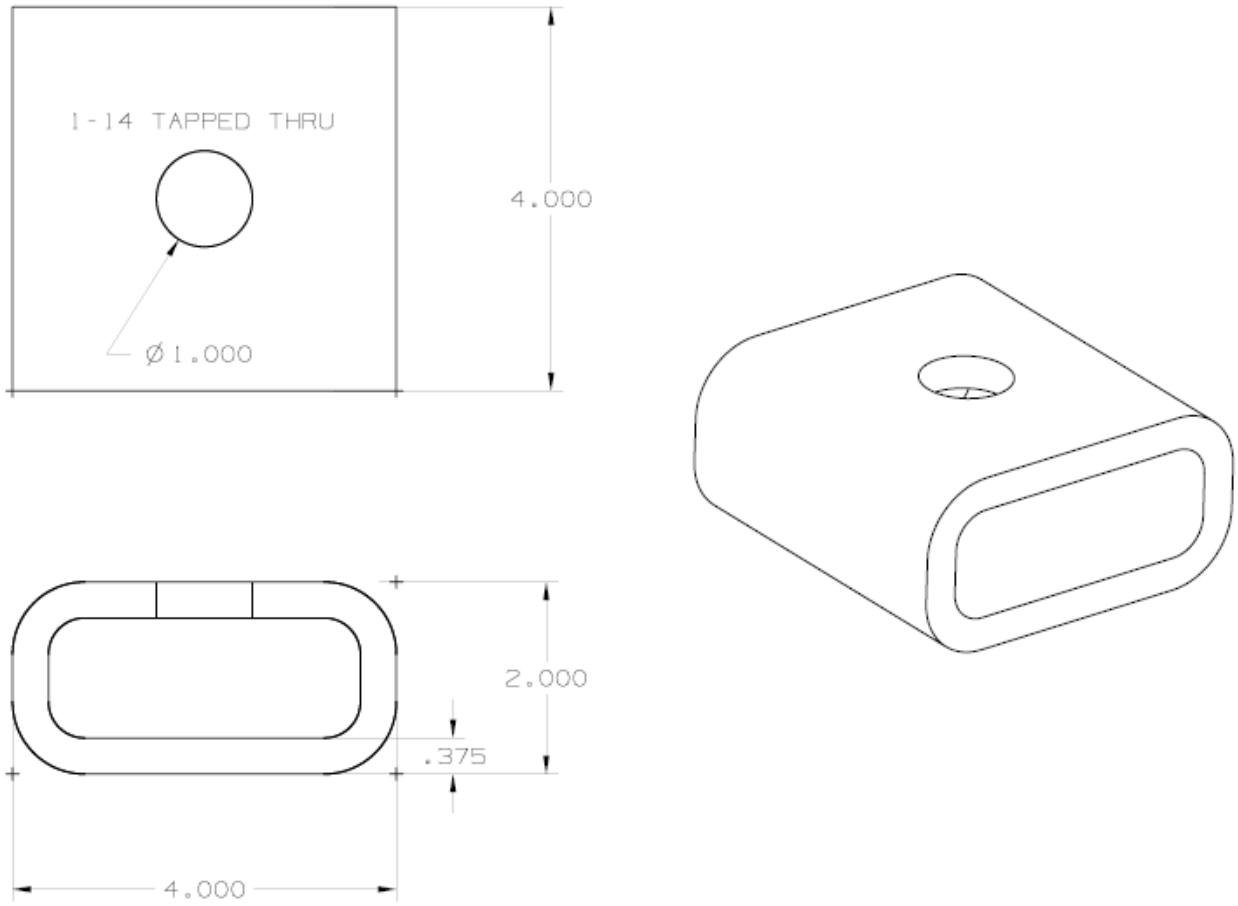


Figure 7: Loading block drawing