Boston Society of Civil Engineers Section

American Society of Civil Engineers

31st Annual Model Bridge Competition

2021 - 2022 Technical Specifications

Model Drop-off Cutoff Date: January 24th, 2022

Competition Date: Saturday, February 5th, 2022

(VIRTUAL COMPETITION WILL BE LIVE STREAMED)

DOCUMENT LAST MODIFIED: 10/13/2021

Register for the competition at www.engineeryourfuture.org

Direct link: CLICK HERE

WELCOME TO THE 31ST ANNUAL MODEL BRIDGE COMPETITON!

The Boston Society of Civil Engineers Section (BSCES) is proud to present the THIRTY FIRST annual Model Bridge Contest. This competition serves the important role of introducing students to the world of engineering and design. Through this contest, the BSCES hopes to provide positive role models for the students and allow students to visualize future opportunities in the STEM and engineering fields.

First, thank you for your interest in the BSCES Model Bridge Competition. This document contains all you will need to know regarding model bridge specifications, basic bridge design concepts, and competition schedule including materials delivery and built bridge delivery information. The following are the rules and regulations to be followed for the Model Bridge Contest. It is the responsibility of the contestants to follow and construct their bridges in accordance with the rules contained herein.

This is our second ever virtual competition, and like last year, we will record the models being tested and the contest will be broadcast online. Information on this will be given closer to the competition day. Students will need to finish their models before January 24th to allow time for the models to be judged before the competition. For those competing in the past, read the rules this year carefully – much has changed to run this competition safely while following COVID-19 restrictions. The biggest changes are:

- Students will need to be sure to follow specifications. Instead of having time to revise models, the "official weight loaded" will be reduced as a penalty for not meeting specifications, but all models will be loaded, and all teams will know the "unofficial weight loaded" as well as the official one. Each student will complete a MODEL BRIDGE INFORMATION FORM due on January 24th. Approximately 2 weeks after the competition, these forms will be returned to the listed educator with all results included. Detailed instructions are on form. A blank form is included as an appendix and all educators will be sent one to distribute to students as a template.
- One improvement over last year: "Teams" this year can be actual TEAMS, having either 2 or 3 members, but if being in contact with other students is an issue, we will allow "TEAMS" OF ONE!
- BSCES Volunteers will be loading the weights. If students have a loading strategy, it must be indicated on the "Model Bridge Information Form". Otherwise the judges will use their discretion as to how to apply the weights.
- While this is always a rule, it needs to be emphasized more than ever: All decisions by judges are final.
- This will be a public event. We will not mention any student last names on the broadcast. If there are any issues with the mention of first names, please email reed.brockman@aecom.com and we will work it out. We are excited (and a bit nervous maybe) to have the contest so visible!
- The competition will make heavy use of the website www.engineeryourfuture.org. Registered educators will be invited to access a special page under the "MORE" tab on the navigation menu for registered Model Bridge educators. Please accept the invitation, as this will give access to all specification updates and allow better communication. Revisions and clarifications do not appear in the document but are considered addenda to the rules. Mentors and teachers can also email bscesmodelbridge@gmail.com and we will answer right away.
- We are happy to help you find mentors for your teams, but this year those mentors will be VIRTUAL.

CONTENTS

BRIDGE SPECIFICATIONS CHECKLIST

This checklist is to help you make sure your bridge complies with specifications. Make sure you read through the full specification!

- ☐ The bridge is completely made of **5mm diameter natural bamboo sticks maximum 36 inches long (commonly referred to as "marshmallow sticks", "campfire sticks" or "s'mores sticks") and natural jute twine (3-ply, 4 lb load limit)**. YOU ARE READING CORRECT – just sticks and twine.

- ☐ The bridge weighs 16 ounces or less. The winner is determined by efficiency ratio (**see the Bridge Specifications Section 1**). You do not need to build up to the weight limit.

- ☐ The bridge height is not greater than 23". Teams needing to ship models will be given boxes 8" x 24" x 48" and the model must fit in that box. The maximum model dimension is 7" x 23" x 47". The minimum model dimension is 4 1/4" wide x NO MINIMUM HEIGHT x 38" long. All dimensions are square to the bridge and the minimum at any point will be considered for the minimum allowable, and the maximum will be considered for the maximum allowable.

- ☐ The bridge length must be greater than or equal to 38". If the bridge is to be placed on the table surface in between the concrete blocks it must also be less than 40" in length. The bridge length should be greater than 42" if the bridge is to be places on top of the concrete blocks. **See the Bridge Specifications Section 3.3** for a figure explaining the bridge lengths and load test setup. There is a penalty for bridges being under 38" in length.

- ☐ The bridge shall have a roadway that either runs through the bridge or runs over the top side of the bridge. The roadway must be along the entire length of the bridge so that a scale truck (4" wide by 4" tall by 8" long) could drive from start to end over or through the bridge. The roadway does not need to be a continuous surface, but make sure there are strong supports for the truck to be placed on at any point along the bridge roadway length!

- ☐ If the roadway goes through the bridge (like a through truss or through arch), the scale truck shall fit along the length of the roadway, and the loading apparatus bars shall extend out the sides of the truck (**See sketches 3A and 3B in the appendix.**).

- ☐ The bridge shall be at least 4 1/4" wide, but not wider than 7". Bridges wider than 7" may interfere with the loading device chains, which could cause the bridge to fail. If the bridge is a through truss or through girder type, the roadway between the main carrying members must be 4 ¼" wide.

- ☐ If being shipped, the bridge has been returned in the supplied box on or before January 24, 2022. Also, all models must be fully built regardless by that day.

- ☐ **THE BRIDGE MODEL PARTICIPATION FORM IS RETURNED BOTH ELECTRONICALLY (DUE 1/24/2022) AND/OR A COPY IS INCLUDED WITH THE MODEL IN THE SUPPLIED BOX**

SECTION 1: INTRODUCTION

The goal of this competition is to design and construct a structure with the specified materials that can adhere to the following:

- Span a gap between 2 tables spaced 36 inches apart (to avoid length issues, all bridges must be at least 38" long). This can be done in one of three ways:
    - 38" – 39 ¾" without packing shims made of index cards between the bridge and the concrete blocks at the back of the loading device, which are 40" apart, as horizontal end restraints
    - 39 ¾" to 40" using index cards packed between the bridge and the concrete blocks to provide horizontal end restraint.
    - 42" to 47" (lengths between 40 and 42" have short bearing areas and may fail by sliding off under deflection).

  See Section 3.3: Bridge Span for more information.
- Fit a model truck (4" wide x 4" tall) through the bridge or along the topside of the bridge. To accomplish this with the truck interior to the bridge cross section, the bridge roadway (space between trusses or through girders) must be minimum 4 ¼". **See Section 3.4 & 3.5 for more information**.
- Hold at least the weight of the model truck plus loading device (approximately 9 ½ lbs total).
- Weighs at most 20 ounces. Although a scale is not provided, using 50 sheets supplied with 2 rolls of tape, this requirement will be met. For reference sake, 50 sheets of the cover stock weigh 18.73 ounces and the 2 rolls of tape supplied, not including the center core, weigh 1.07 ounces. Combined, this is 19.8 ounces, or just under 20 ounces.

At the end Prizes will be awarded based on the following categories:

- **Most Efficient:** Bridge efficiency is defined as the ratio of total load supported to self-weight of the bridge. The winner of this award will be the bridge with the highest efficiency value. In the event of a tie, the bridge with the higher aesthetic ranking will be declared the winner.
- **Most Aesthetic:** Aesthetics is based on craftsmanship, creativity, and display of sound design principles. The winner will be determined by the judges. In the event of a tie, the more efficient bridge will be declared the winner. This year, judges will select their top choices prior to the competition, pending the ability of the bridges to satisfy the minimum loading requirement. In the event of a tie, the bridge with the highest efficiency will be the winner.

SECTION 2: COMPETITION PARTICIPANTS

This competition is available for students Between the 5th grade and 12th grade in the greater Massachusetts area. **For this year, teams of 2 or 3 are preferred, but individuals will be allowed as a "Team". No teams bigger than 3.** This will be changed back in future years, as having a team of one teaches nothing about the value of teamwork. BSCES strives to emphasize the importance of working in a group which is essential to engineering. Participants shall not register more than one bridge for the competition.

All design and construction work for the model bridge (including devices that assist in fabrication, such as templates) shall be done only by the team members. Teachers, parents, and mentors are encouraged to provide education and guidance; however, they should not take control of design and construction. The overall goal of the competition is for students to learn how to think like an engineer and feel the pride that an engineer feels as they successfully build a model bridge of their own design.

Being a virtual competition, volunteers will load all bridges, as no students will be present. We realize this is not ideal. Each participant will fill out a form with input as to how they would load the bridge, and the volunteers will do their best to follow the requests, only adjusting to positively affect outcomes, in a way that it would expected any competitor would.

Because the contest is limited to 100 students competing, the registration filled up fast and there is a waiting list. **ANY EDUCATOR SEEING THAT NOT ALL SLOTS REQUESTED WILL BE FILLED ARE ASKED TO NOTIFY BSCES (REED.BROCKMAN@AECOM.COM) RIGHT AWAY TO ALLOW STUDENTS OFF THE WAITING LIST.**

SECTION 3: BRIDGE SPECIFICATIONS

All the rules and specifications within this section must be followed in order to qualify for this contest. **BSCES will test all bridges, but if specifications are not met, "official loaded weight" will be reduced as per Section 3.7 - Deductions.**

3.1 Materials

1. Bridges shall be built entirely of the following materials

    a. **5mm diameter natural bamboo sticks maximum 36 inches long (commonly referred to as "marshmallow sticks", "campfire sticks" or "s'mores sticks")** These can be cut, and we will send you either scissors or a utility knife upon request, but we realize that the X-acto knives were not x-actly a great idea last year, so we will not be sending cutting tools unless requested. These sticks can also be bent / warped. What we do not want is drilling – we fear this could cause injury (so we do not want to see any twine passing through any holes in the bamboo members—the twine can pass through end slots, but not holes). Sanding is fine and everyone will receive a sanding sponge. We love creativity, and these sticks can be stained / drawn upon, but not wrapped or coated in any material that could be perceived as giving strength. Any bridge decorated with any disrespectful messaging will be disqualified, not that we should need to say that. Please do not use any cutting tools or equipment that you would envision as giving an advantage to your team: no dremels, no lathes, no laser cutters, etc. We will allow utility knives and we understand these can be hazardous. Educators, please make sure it is okay with the student's parents/guardians that the use of this tool is acceptable and encourage parental supervision when being used. ONLY THE ACTUAL PARTICIPANTS CAN MAKE THEIR OWN MODEL – NO OTHERS MAY DO THEIR CUTTING OR EVEN DRAW OUTLINES TO BE CUT.

    b. **Natural jute twine (3 ply, maximum 4 lb working limit)** This brings in the very useful skill of knot tying, and we strongly suggest teams research that fascinating world. If knots involve notches in the members, those notches must be done using knife, scissors or sandpaper, but not a power tool. Twine can be used for both connections and as members, and there is no rule against some members being comprised of both twine and bamboo. If twine is used for the roadway, there needs to be enough twine to support the "truck" along the entire length of the bridge.

Use of any other material may be grounds for disqualification, if deemed intentional by the judges. Schools will be provided with enough supplies to build the number of bridges initially requested, which is 30 sticks and 208 feet of twine per team. Upon request, teams can also be sent scissors or utility knives. If there is an issue shipping materials, educators or mentors may purchase materials and BSCES will reimburse them up to $10 per team, as per submitted receipts. Because there is a 100 model limit, teachers are asked not to allow additional teams to

compete without clearance from BSCES. There was a waiting list of students wishing to compete last year.

2. Structures may not be brushed, sprayed, or dipped in any coating material. This includes, but is not limited to, coatings such as paint, stickers, glue, fabric, or any filmlike coating. Non-structural decoration (markers, pens, pencils, crayons, etc.) of the bridges is allowed. All questionable materials should be checked with the model bridge coordinator (bscesmodelbridge@gmail.com) before being used. BSCES requests that any decorations be tasteful and appropriate. Inappropriate markings on the bridges will be grounds for disqualification at the judging panel's discretion.

3. Once the bridges are loaded, another inspection of the bridges by the judging panel can be made to ensure that the proper materials were used that were not visible prior to testing.

4. The BSCES volunteers are also working remotely as the schools typically are. In general, all students should follow this as a rule of thumb: if you feel you are bending the rules, please don't. Which leads us to the last rule:

ALL DECISIONS OF THE JUDGES ARE FINAL

3.2: Bridge Weight Limit

The total weight of the structure shall be no more than 16 ounces. Bridges that exceed this weight limit will have their official load applied reduced at a rate of double the amount that it is overweight. For example, if a bridge weighs 18 ounces (2 oz. overweight) and its official load taken is 80 lbs., because it is 12.5% heavier than allowed, the 80 lbs. will be reduced by 25%, which is a 20 lb. reduction, so its official load will be 60 lbs. The weight of all supplied building materials for each team is slightly under 16 ounces, so if only supplied materials are used, this limit will be met. Not giving too much of a hint here, but it is sometimes strategic to make bridges well under the weight limit.

3.3: Bridge Span

The bridge will span between tables that are 36 inches apart. There will be 7 5/8" tall concrete (CMU) blocks that will be secured to each table 2" from the edge. The bridge may rest on the top surface of the table between the concrete blocks OR may sit on top of the concrete blocks. The bridge cannot be adhered or attached to the blocks in any way, however it may contact and bear on the blocks. The bottom of the bridge ends (the bearing area) must be level and stable and the bridge must be able to stand on its own under the effects of gravity when set onto the loading device.

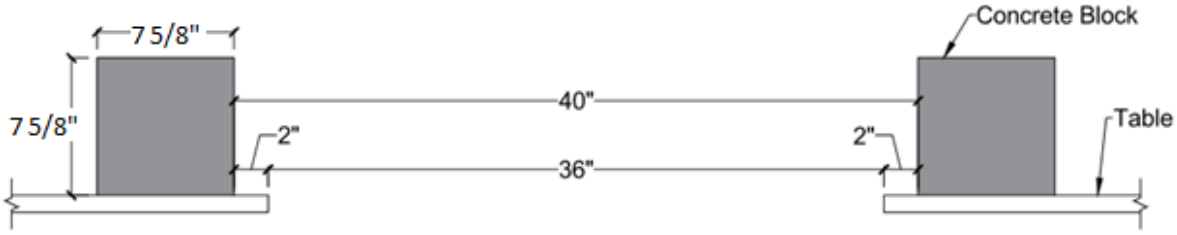

Figure 1: Span of Bridge

Bridges Placed on the Table Surface: If the bridge rests on the table surface, it will need to span across the 36" gap, but shall be less than 40". It is recommended that bridges designed for this setup be at least 38" in length to allow for proper bearing area on the table. If a model is between 39 ¾" and 40", it must be indicated on the "Bridge Model Information Sheet" that the ends will be shimmed with index cards to resist horizontal thrust.

Bridges Placed on Top of Concrete Blocks: If the bridge rests on top of the concrete blocks instead of the table, it will need to span across the 40" between blocks. This means that the bridge deck will need to be longer than 42", having enough length to rest on each block. To assure models can fit in box and be protected during shipping, models can be no longer than 47".

3.4: Bridge Configuration

1. No portion of the bridge shall extend more than 23" above the table surface (15" above the top surface of the concrete blocks)

2. No portion of the bridge shall extend below the top surface of the table. Bridges will be permitted to extend below the top surface of the table only if it is due to incidental deflection of the bridge under loading (but note the amount of deflection permitted due to load is limited). **See *Failure of Bridge* Section 3.6** for more information.

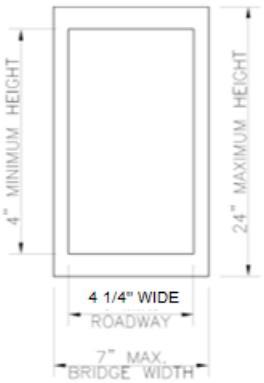

Figure 2: Cross Section of Bridge with Roadway through Bridge

3. The overall width is limited to 7 inches maximum. The roadway width shall be a minimum of 4 1/4 inches. The roadway is defined as the distance between the sides of the bridge (in the case of a through truss) or the overall width of the bridge when the roadway is on top of the bridge. **See Figure 2 and Figure 3a.**

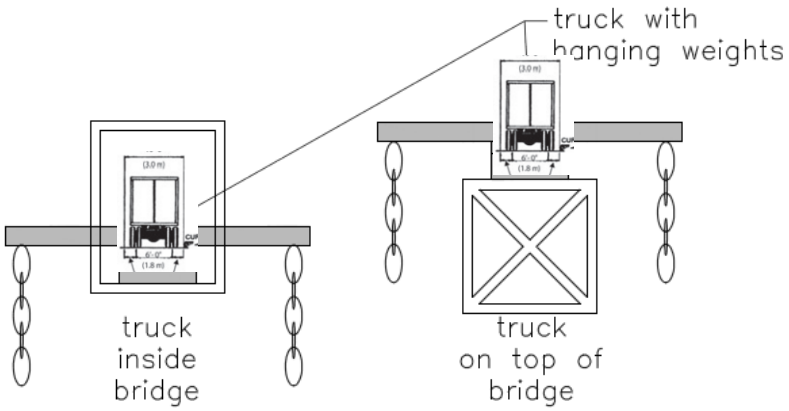

Figure 3a: Different Ways to Load the Bridge - Section Views

4. The roadway/loading surface must be provided at all potential wheel support locations (refer to Figure 7). Since the truck that is loaded has "wheels" that are each 2" wide, the roadway shall

have enough material to prevent the wheel from falling through. There should not be any obstructions that would prohibit the truck from "driving" across the bridge span.

5. The 4 1/4" minimum shown in Figure 2 shows a roadway inside the bridge. The same width rule of 4 ¼" minimum applies if the roadway is on top, which coincides with the minimum width rule for a bridge being 4 ¼". See Figure 3.

3.5: Loading the Bridge

We are well aware that this particular section gets a little abstract, being that students will only see these images herein and their bridge being tested during a webcast, but reading this section carefully will allow the bridges to be safely loaded up with weights and also allowing students to avoid deductions. The model truck that will be placed on the bridge has the following dimensions and properties:

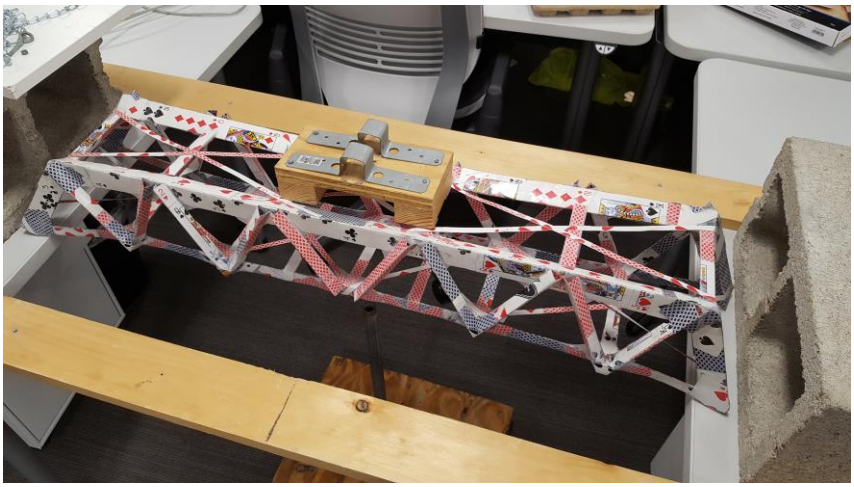

Figure 3b:

Top: Example of Loading device placed on top of bridge. (Obviously – this is not this year's materials but the same loading device!)

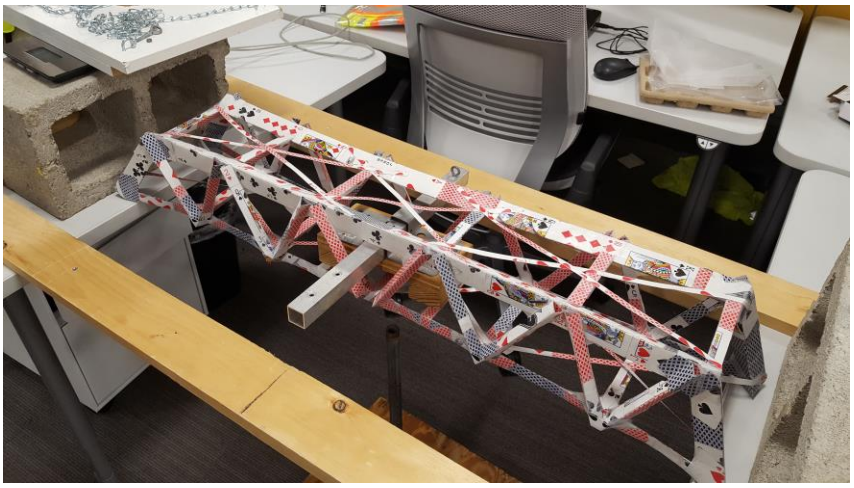

Figure 3c:

Bottom: Example of loading device located inside the bridge. There must be room for the loading device to fit inside the structure as well as room for the transfer bar to fit in between truss members.

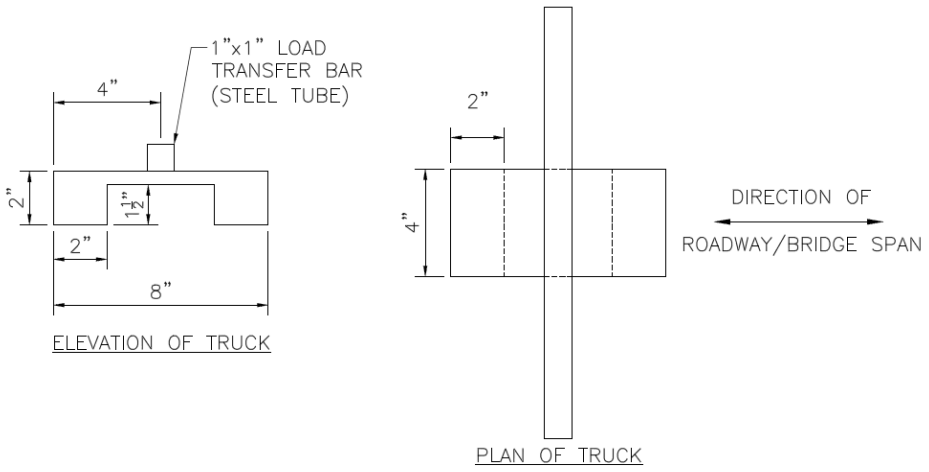

Figure 4: Details of Truck

1. In order to be loaded, the bridge shall (at a minimum) be capable of supporting an initial weight of the loading apparatus (approximately 2 lb truck + 7.5 lb loading platform = 9.5 lbs).

2. The truck will be placed on the loading surface at a point that will be determined by the roll of a die, which will take place at the time all bridges are received (see Figure 7). The random point will remain the same for all teams. A load transfer bar will be placed across the top of the truck with chains connected at each end extending downward to connect to a loading platform beneath the structure. Volunteers will test each structure by placing the supplied weights onto the loading platform until failure. All bridges will be checked to assure the crossbar will fit prior to the competition and if the truck needs to be shifted, a deduction will be assessed.

3. Loading is limited to 250 lbs. of free weights. Loading is also limited to the top of the center support pole (18.5”). Lighter weights, when stacked, will take up more height than heavier weights, when stacked so keep this in mind when selecting which weights to load. Once loads are applied (touch the weight below), they cannot be removed. Any load being applied at the time of bridge failure will not be counted towards the recorded loading. At the moment a newly applied weight touches the weights below it all weights below are official. It is completely the responsibility of the design team to decide how best to apply the loads, and they can communicate their plans for loading through the linked form.

4. The loading apparatus (truck + loading platform) must be capable of being supported on the loading surface (roadway) as shown in the diagram. This means that your structure MUST have enough roadway surface for the truck to be placed at one of the six locations along span (see Figure 7), but each bridge does not need a continuous surface. The roadway should be reasonably level (some arch is permitted) from one end of the bridge to the other without obstruction. Bridges with roadways that have excessive slope causing the truck to slide off of the bridge will not be aided in the loading process and tested as best possible, with a deduction.

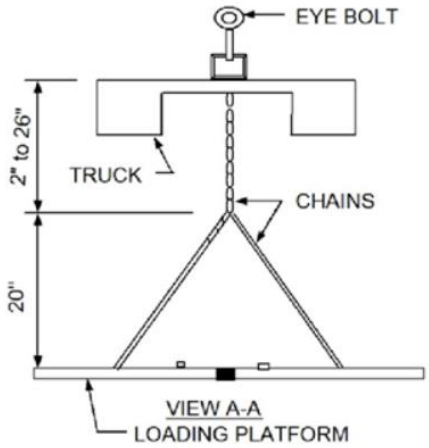

Figure 5: Loading Apparatus with Truck

5. If the roadway surface is not along the top of structure, the design must allow for a 1" x 1" load transfer bar (see Figure 4) to be passed through the bridge transversely with the bar's underside 2" above the loading surface, without causing interference with the structure during testing. The design must accommodate the truck being placed in any of the possible loading areas.

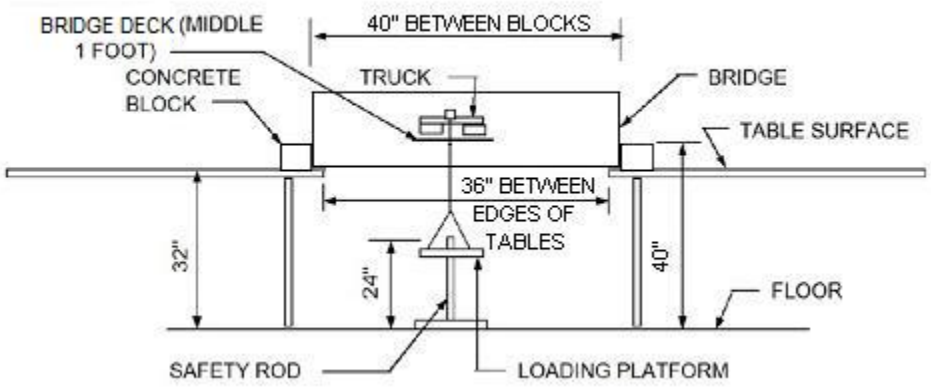

Figure 6: Sketch of Bridge with Roadway Surface through Bridge

6. The concrete blocks provided on the loading tables are there for bridges that exert a horizontal force (e.g. arch bridges). These concrete blocks will be restrained and unable to slide apart. In cases where the bridge exerts a horizontal force on the blocks (e.g. thrust from arch bridges), the blocks can be counted on to resist horizontal forces. If your design intent is to utilize the concrete blocks to resist horizontal thrust, please limit the end to end length of your structure to be under 40" by at least 1/16". The judges will fill the small gap with index card shims. It is the responsibility of the designers to have gaps of consistent width. Each shim will be placed alongside and parallel to each other.

7. Make sure your bridge fits between the concrete blocks or on top of them. The blocks will be placed in the loading frame on the tables and will not be removed at any time during the competition.

8. In order for a bridge to be selected as the most aesthetically pleasing bridge, it must carry the minimum specified weight (9.5 lbs = loading device + truck).

The random loading points shall be as shown in the figure below:

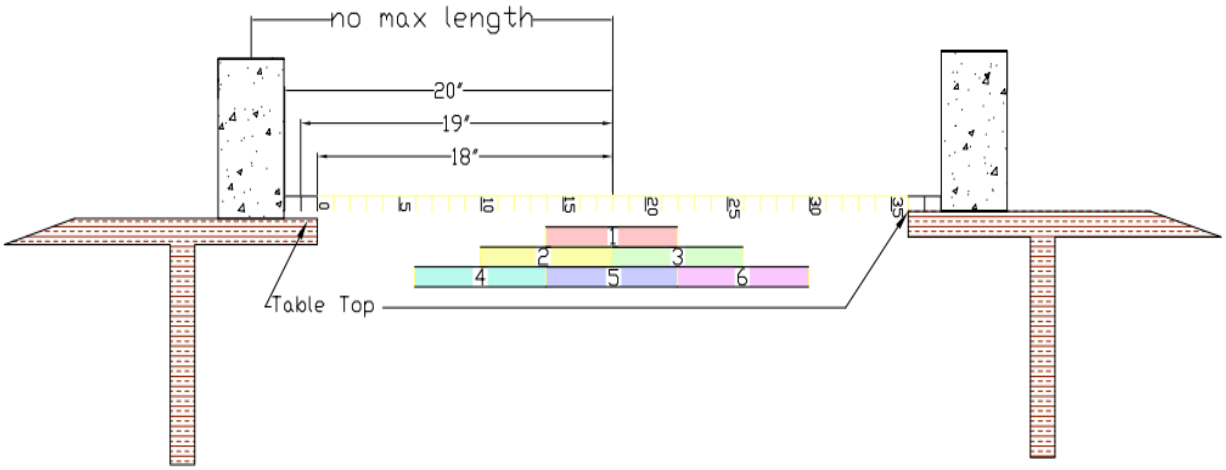

Figure 7: Possible Loading Positions

The various colored blocks represent the 8" long truck, each color representing a possible loading position. Position 1 and 5 are centered on the bridge. All other positions are 4" intervals of position 1.

3.6: Failure of the Bridge

1. Failure is defined as a fracture of the members or deflection of the structure causing the truck to settle more than 4" (dropping the weights to the base). Slippage from the bearings or overturning of the structure is also considered failure.
2. Settlement is measured as the difference between the initial height (with the 9.5 lb load) and a final height of the loading truck (with the 9.5 lb initial load plus additional weights) to the surface below.

The bridge fails when it is incapable of supporting any additional load without exceeding the deflection or fracture limit.

3.7: Deductions

BRIDGE OVER 16 OUNCES: For every percent of the weight over 16 ounces, the official recorded load (weight of bridge + weight of loading device + sum of applied weights) will be reduced by double that percent.

BRIDGE TOO SHORT: If the bridge is too short to span between tables, the bridge will be left until the end of the competition and tables moved closer together to test the bridge. The official recorded load will be reduced by the twice the square of the ratio of the bridge length / 38" (the specified minimum bridge length).

BRIDGE CANNOT FIT OR CROSSBAR INTERFERES WITH TRUSS WEB MEMBERS: At the discretion of the BSCES volunteers loading the bridges, it may be loaded differently without penalty. If it is deemed that the bridge cannot be loaded without negatively affecting the capacity, the bridge will be loaded at the nearest place that is possible and the official recorded load will be reduced by twice the square of the ratio of the distance moved / 38" (the specified minimum bridge length).

DRILLED HOLES – The effect will be assessed per bridge by the judges. Please, just don't do this.

INAPPROPRIATE OR DISRESPECTFUL MARKINGS ON A BRIDGE MODEL – Disqualification.

CHEATING – Using a stronger material in a clandestine manner, using any reinforced tape or strong packaging tape, or any other action that upon judge review is considered cheating is grounds for disqualification. Please, don't cheat.

INAPPROPRIATE OR DISRESPECTFUL COMMENTARY TOWARDS ANYONE posted during the YouTube broadcast will be grounds for disqualification. If there are such postings, the site will be reviewed, the responsible party disqualified, and the rankings re-worked.

SECTION 4: MATERIALS DELIVERY, PRE-COMPETITION DELIVERABLES / REQUIREMENTS, AND MODEL DELIVERY INSTRUCTIONS

MATERIALS DELIVERY

Around Halloween, materials will be delivered to each educator. It is up to the educator to distribute materials to students. To avoid shipping costs, BSCES may contact educators to deliver materials, but many may be shipped.
For every model, the following will be supplied:

- 30 bamboo sticks
- 1 roll jute twine (208 feet)
- Blank "Bridge Model Information Form"
- Copy of Handbook

MODEL DELIVERY

IF YOU ARE GIVEN A SHIPPING BOX, DO NOT THROW AWAY THE SUPPLIED BOXES AND BUBBLE WRAP!

Students will need the box to return the model to the BSCES for the competition, so educators please reinforce this point with participants! If models are not returned in box with bubble wrap, the bridge may get damaged. BSCES is not responsible for damage during transportation unless we really do damage the model. In that case, we will work with educator / participant to assure tested model is as intended. Boxes are intentionally larger than the maximum model dimensions so all models must fit in boxes.

If a box is lost by the participant or educator, it is up to the student or educator to work out how to return the model to BSCES.

To avoid shipping costs, educators can contact reed.brockman@aecom.com **to arrange delivery other than shipping. AECOM will reimburse costs for shipping models, but scanned receipts must be emailed to** reed.brockman@aecom.com **for the reimbursement to be processed, and the mailing address / name of person to be reimbursed must also be included. Additional materials may be included to protect the models, but please do not add anything heavier than crushed paper as shipping is very expensive (over $20 per model). Ship models with bubble wrap and BRIDGE MODEL INFORMATION FORM hard copy to:**

Reed Brockman
AECOM
One Federal Street, 8th Floor
Boston, MA 02110

ELECTRONIC AND HARD COPY BRIDGE MODEL INFORMATION FORM SUBMISSION INSTRUCTIONS

Students must fill in the participant form. One copy must be included with the model and the form should also be emailed to reed.brockman@aecom.com. PDF is the preferred format. The electronic file should be FULL SCHOOL NAME – FULL STUDENT NAME. By full name, we mean not abbreviations – name must be of a length to adequately identify the school or student. A file named MHS – RB.pdf is not acceptable.

POST-COMPETITION PACKAGE DELIVERY FROM BSCES

Prizes, results, T-shirts, etc. will be sent within 2 weeks after the competition. All packages will be delivered to the teachers for distribution. Model bridges will not be returned.

SECTION 5: BRIDGE MODEL INFORMATION FORM

Each participant is required to fill in a "Bridge Model Information Form", and that needs to be submitted both as a printed copy placed in the box with the model AND electronically. A minimum of 6 photos of each bridge is expected as part of this form. This form is attached at the end of this handbook as an appendix, and can be downloaded from a drobox that educators are invited to join. Completed forms can be emailed to reed.brockman@aecom.com or shared in any way that can be worked out between us and the teacher, really.

We strongly recommend every participant reviews the form closely and spends an appropriate amount of time filling it out. And, of course, every participant needs to assure it gets to us. We will reply with confirmation as each is received.

SECTION 6: MOST AESTHETIC MODEL JUDGING

The aesthetics will be judged using information supplied by each participant on the BRIDGE MODEL INFORMATION FORM. Each student must return that form in both hard copy and electronic format with the name FULL SCHOOL NAME – FULL STUDENT NAME.pdf to be judged for the MOST AESTHETIC AWARD.

The judges in general consider the following factors equally in judging this award:

- Craftsmanship (symmetry where appropriate, precision cutting/folding/connecting)
- Sound design practices (wider hollow members in compression areas and thinner in tension areas, adequate bracing, high moments of inertia of areas in high bending, thickened cross sectional members in areas of high shear / crushing, etc.)
- Visual appearance

SECTION 7: COMPETITION DAY

February 5th, 2022, 9 AM – noon

This competition will be via Microsoft Teams; details will follow. This competition will be open for public viewing. No student last names will be used during the competition.

All bridges will be weighed, measured, checked/scored for deductions and judged for the "Most Aesthetic" award prior to the start of the competition at 9 AM.

Format: Virtual competitions are new to the organizers of this competition. For ease of viewing, the order in which the bridges will be loaded will be predetermined, but actual times will not be known. Because there is no needed time for model adjustments, and no time needed for aesthetic judging, the contest should have no more than 15 minutes of introduction and rules review before the loading will begin. The plan is to have the bridge information including the first names of the team members on screen along with the basic statistics, plus the active loading will be on display with an announcer doing voiceover. The order of the bridges will be preset in a slide deck so reordering will not be likely. Our hope is that this contest will be viewable by the entire public, so we will not mention full names of students in the broadcast. While this online broadcast is a challenge for our organizers, we think it will be exciting for viewers to watch and expect the networks to fight for the rights next year.

Challenges: Designers and their educators will be notified of deductions prior to the start of the competition. Each deduction will be paired with a clear explanation. All deductions will be emailed to competitors at least 3 days before the competition, and competitors have until 5 pm on February 4th to challenge the deduction. The page on which the deductions will be calculated is part of the "Bridge Model Information Form", and educators are invited to read that form closely at any time from now until December 12th to question the logic behind deductions listed on that form. On the day of the competition, there will be no time and no method of challenging any deductions.

Because of the virtual nature of the competition this year, it must be clear that the volunteers are doing the best they can, have no bias, and with that, there can be no challenges as to the loading of the bridges.

The judges' decisions will be final. Any challenges, complaints, or appeals after the modification time period will not be allowed.

The only ways to disqualify this year are to have inappropriate markings, to intentionally strengthen a bridge in a way considered by judges to be clearly cheating, or to post a completely inappropriate comment online during the contest. These models disqualified in these ways will not be load tested and the educators will be sent a note explaining what happened. There is no challenging disqualifications.

Aesthetic: The bridges will be examined for the most aesthetic award (see criteria elsewhere in this handbook) before any bridges are load tested. Please note that for a bridge to be selected as the most aesthetic bridge, it must carry the minimum load of ***9.5 lbs (the weight of the loading apparatus).***

Load Testing: Each bridge (aside from those requested not to be tested fully) will be loaded as previously described until failure. Failure is defined as fracture, inability to support loads, or deflection of the structure causing more than 4" of deflection (measured from the original elevation of the "truck" assembly). The maximum load supported by the bridge (ultimate load) prior to failure will be recorded. Individuals that do not want their bridge tested to failure may request this on the linked form. We recommend loading

the bridges to failure. There is no set plan for preserving bridges after the competition anyway, other than in video and photographic form. The volunteers will be instructed to follow the style recommended by the designer on the "Bridge Model Information Form".

SECTION 8: FINDING A MENTOR AND OTHER BSCES ASSISTANCE

Schools wanting mentors have already indicated that they are interested, and the matching process is underway.

While we expect that your school will CORI check volunteers, we also check on our volunteers and have them take a training about working with school children (see the "Flip the Switch" effort, sponsored by gymnast Aly Raisman). https://www.fliptheswitchcampaign.org/

As of the time of publication, there will be no in-person mentoring arranged by BSCES. In general, it is between the educator and mentor to arrange virtual meetings with competitors. Mentors are not to be working with competitors without a teacher involved.

The BSCES also runs hands-on activities to help teach about a wide variety of bridges and run tours of the bridges in Boston. Unfortunately, this is all on hold for this year.

As an added bonus for those who read things until the end, here are some helpful hints that the volunteers developing this year's rules came up with: (a) the sticks are smooth and even tight lashings may naturally slide along them, and worse, lashings at ends of sticks can pop off. Drilling is not allowed but notching into the wood is allowed, and where multiple sticks are used in parallel, there may be some logic to having the twine run between sticks and catch on internal notches. (b) the twine wants to unwind on its own if left alone after the package is open, and this can be stopped by tying loose knots at the end or using a binder clip. (c) this material sounds easy but it has its challenges, so take the time to experiment and see how it behaves. (d) sometimes a truss or arch bridge member has both tension and compression components. (e) sometimes twine or bamboo can serve as spacers between lashings. (f) a tight lashing can serve to block one stick from sliding against another. (g) the bamboo is can be cut with standard scissors but can very easily be snapped at a given length by squeezing a pair of notches into them with a scissors. (h) friction can be gained between the twine and bamboo with longer "development lengths" of the lashings. (i) thin members buckle if they have excessive unbraced lengths. (j) you cannot push on a rope. We could just keep going – these materials are similar to the ones with which our ancestors built bridges; they managed to figure it out, and so shall we!

MOST IMPORTANT RULE: HAVE FUN!

APPENDIX: BRIDGE MODEL INFORMATION FORM

BRIDGE MODEL INFORMATION FORM – FORM DUE JANUARY 24TH		
NAME THIS FILE AS FOLLOWS: SCHOOL FULL NAME – STUDENT FULL NAME AS FILLED OUT BELOW. PDF FILE IS PREFERRED, BUT IF NOT POSSIBLE, OTHER FORMATS ACCEPTABLE		
EMAIL THIS FORM TO REED.BROCKMAN@AECOM.COM AND INCLUDE PRINT OF FORM IN BOX WITH MODEL. IF A PRINTER IS NOT AVAILABLE, HANDWRITE ANSWERS ON PAPER INCLUDED WITH MODEL. IF NO FORM IS INCLUDED, THIS WILL CAUSE EXTENSIVE CONFUSION AS BRIDGE WILL NOT BE READILY TIED TO A PARTICIPANT. IF THERE IS AN EMAIL ISSUE, CONTACT REED.BROCKMAN@AECOM.COM RIGHT AWAY.		
Two weeks after the competition this form will be sent back to your educator. At the end of this document are the scoring pages – these will be filled out with results when returned.		
School or Organization Full Name (not appreviations)		
Student Full Name		
Educator Name		
Student Grade		
Name of Bridge		
Bridge Length (maximum horizontal length) – MAX 47" (INCHES)		
Bridge Height (Measured with bridge sitting on table, height from table surface to highest point on bridge) – MAX 23" (INCHES)		
Bridge Width (at widest point) – MAX 7" (INCHES)		
Have you made sure that this bridge is designed such that when on loading device, no part of the bridge will be lower than the surface of the table on which the loading device is placed? (Yes or No)		
Do you want the "truck" placed on top or in the interior of your bridge? (TOP OR INTERIOR)		

LOADING METHODOLOGY (Type X in appropriate column):

AESTHETIC ONLY	Place 2 ½" weights until load reaches 10 pounds and stop loading. (This is not recommended, as there are no provisions to return bridges anyway, and what fun is NOT loading bridges to failure?)	
Light Increments	Use 2 ½" pound weights only until failure. Note that with each weight being about ½", bridge will not be able to be loaded beyond 60 pounds.	
Medium increments	Use 5 pound weights until significant deflection is evident, then load 2 ½ pound weights to failure. This should allow loadings up to 120 pounds	
Heavy increments	Use 25 pound weights until deflection is significant, then use 5 pound or 2 ½ pounds as appropriate until failure. This is for bridges expected totake 120 pounds to 200 pounds (the maximum loading that will be applied).	
NOTE: The word "significant" is subjective and will be determined by the volunteer loading the bridges. All persons loading bridges have extensive knowledge of structural engineering and of bridge design.		

PHOTOS

NOTE THAT PHOTOS OF THE STRUCTURE ARE REQUIRED TO BE CONSIDERED AS MOST AESTHETIC. SIX PHOTOS ARE REQUIRED: BOTH ELEVATIONS (SIDE VIEWS), TOP, UNDERSIDE and EACH APPROACH (END VIEW).

ELEVATION 1:

ELEVATION 2:

PHOTO FROM ABOVE:

PHOTO FROM BELOW:

APPROACH (END VIEW) 1:

APPROACH (END VIEW) 2:

ADDITIONAL PHOTOS OF BRIDGE (OPTIONAL, MAX 4 PHOTOS. WRITE LONG TITLES IF YOU THINK IT WILL BE HELPFUL)

ADDITIONAL PHOTO 1 (DESCRIBE HERE):

ADDITIONAL PHOTO 2 (DESCRIBE HERE):

ADDITIONAL PHOTO 3 (DESCRIBE HERE):

ADDITIONAL PHOTO 4 (DESCRIBE HERE):

SKETCHES AND OTHER WRITING ABOUT DESIGN (Optional – add as desired if you believe it will assist the judges in understanding the aesthetics of the bridge)

FOR JUDGES ONLY:

PRE-COMPETITION:

WEIGHT (includes additional weight penalty for tape used as structural member @ 1oz. per 6” member)

BRIDGE WEIGHT (POUNDS, 2 DECIMALS)	POUNDS
DEVICE WEIGHT	9.50 POUNDS
APPLIED LOAD WITHOUT WEIGHTS	POUNDS

DEDUCTIONS

BRIDGE CANNOT FIT OR CROSSBAR INTERFERES WITH TRUSS WEB MEMBERS: At the discretion of the BSCES volunteers loading the bridges, it may be loaded differently without penalty. If it is deemed that the bridge cannot be loaded without negatively affecting the capacity, the bridge will be loaded at the nearest place that is possible and the official recorded load will be reduced by twice the square of the ratio of the distance moved / 38” (the specified minimum bridge length).

ALL AS DETERMINED PRE-COMPETITION, LEAVING TLA AS A VARIABLE. (TLA = TOTAL WEIGHT APPLIED = WEIGHT OF BRIDGE + WEIGHT OF TRUCK/LOADING DEVICE + TOTAL OF WEIGHTS APPLIED)

BRIDGE OVERWEIGHT	SELF WEIGHT – 1.25 LBS:	DEDUCTION = 2 X (SELFWEIGHT – 1.25 POUNDS):
BRIDGE TOO SHORT	UNDERLENGTH =LENGTH – 38”:	DEDUCTION (WEIGHT IS A VARIABLE) = 2 X TLA X (UNDERLENGTH/38)^2:
BRIDGE CANNOT BE LOADED WITH TRUCK PLACED AT DESIGNATED POSITION	DISTANCE SHIFTED (INCHES):	DEDUCTION (WEIGHT IS A VARIABLE) = 2 X TLA X (DISTANCE SHIFTED/38)^2:
DEDUCTION EQUATION	LEFT IN TERMS OF TLA	OVERWEIGHT DEDUCTION + (OTHER DEDUCTIONS X TLA):

FOR JUDGES – COMPETITION DAY

BRIDGE NAME	
SCHOOL	
PARTICIPANT	
GRADE	
EDUCATOR	
ROADWAY LOCATION	
SELF-WEIGHT	
AESTHETIC RANK (N/A IF NOT TOP 5)	
LOADING METHODOLOGY SELECTED	
TOTAL WEIGHTS APPLIED (Last weight added at failure does not count)	POUNDS
TOTAL LOAD APPLIED (TLA) (SELF WEIGHT, LOADING DEVICE AND WEIGHTS)	POUNDS
DEDUCTION	POUNDS
COMPETITION WEIGHT USED FOR EFFICIENCY (TLA – DEDUCTION)	POUNDS
EFFICIENCY RATIO (COMPETITION WEIGHT / SELF WEIGHT OF BRIDGE)	