

Student Steel Bridge Competition

2020 Competitors Guide



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General Competition Information

The intention of this document is to explain the competition preparation and procedures for competitors. Certain key aspects of the Rules are highlighted. This is not a complete explanation of the Rules. Competitors should refer to the [Rules](#) while reading this guide. If there are any discrepancies between the Rules and this guide, the Rules shall govern.

Rules

All of the Regional Events, as well as the National Finals are based on the same [Rules](#) document that describes the competition and states the official rules.

The rules are developed by the SSBC Rules Committee and are changed every year. The current rules must be used without modification for every Regional Event and the National Finals. This is necessary so that bridges from all regions may compete nationally without disadvantage.

AISC maintains a website, www.aisc.org/ssbc, where the rules can be downloaded and rules questions are addressed. Rules questions may be submitted only through the official online forms. Rules questions are reviewed by the SSBC Rules Committee, and the Rules Committee's clarifications are posted online for access to all competitors.

People

Competitors

Student teams from approximately 200 schools are expected to participate in the SSBC at the regional level. These teams consist of undergraduate and/or graduate students from colleges and universities with an engineering program. Each team should designate a captain. The top teams at Regional Events will advance to the National Finals.

Host

The host school is responsible for all aspects of planning and setup of the event. This includes making venue arrangements, communication with participants, recruiting of volunteers, fundraising, setup and cleanup, and coordination with AISC. The host school invests a great deal of time and resources into preparation for the event in addition to participating in the event with a competing team of students.

Well in advance of the competition, the host school should alert participants of any local conditions that may affect the competition. The host school should provide each

competitor with a schedule of events, map to the contest site, and travel recommendations.

Judges

Judges assist the head judge with the conduct of the competition, safety and interpretation of the rules. Judges are assigned to moderate each event of the competition: aesthetics, construction, lateral loading, vertical loading and weighing. They have complete and final authority for enforcing the rules of the contest, scoring and rating bridges, resolving ambiguities in the rules and settling disputes. Judges are directed and empowered to halt any activities they deem hazardous.

The host school recruits volunteers that serve as judges. Competitors should be respectful of the judges at all times.



Judge giving instructions at load station



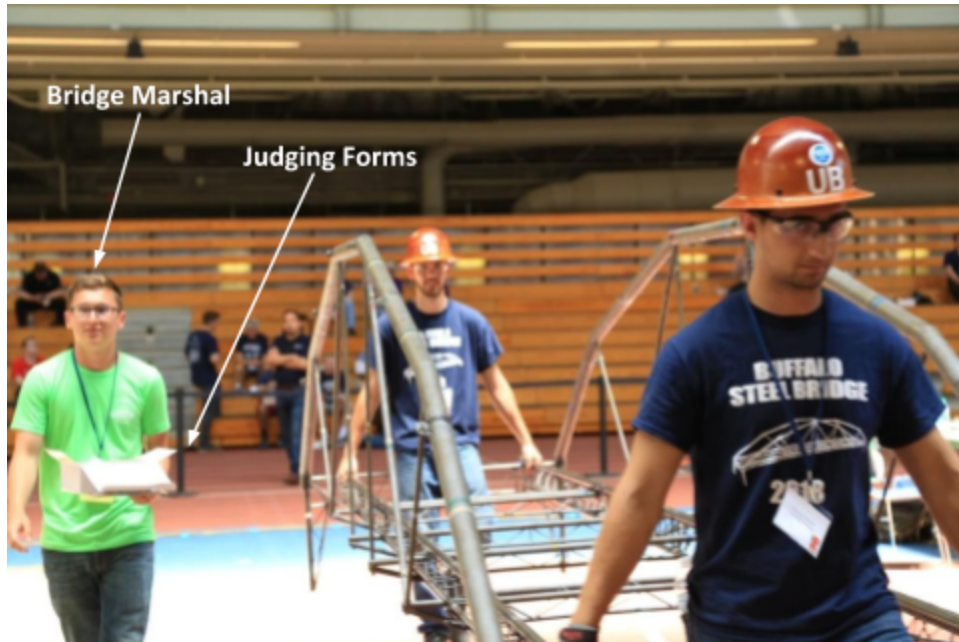
Judges at work during bridge construction

Head Judge

The head judge is the person with full authority over the conduct of the competition, safety and interpretation of the rules. There is a head judge at each Regional Event. The National Head Judge serves as the head judge for the National Finals.

Marshals

At the National Finals and some Regional Events, marshals are used to escort bridges through the complete construction and testing sequence. The duties of the marshals are to carry the judging forms from station to station, ensure that the bridge is not altered or enhanced after the erection phase, note damage to bridge as it is moved, and to assist the data entry people in resolving any questions regarding the completed judging forms.



Other Volunteers

The host may have other volunteers at the competition that work on a variety of tasks such as registration of teams, equipment preparation, and venue setup and cleanup.

AISC Representatives

There is at least one AISC representative at each Regional Event to observe the competition.

Support

AISC provides limited funding for the competition in the form of stipends to teams that compete at Regional Events and the National Finals as well as stipends to schools that host Regional Events and National Finals. Competitors and host schools generally solicit additional support from a variety of sponsors. AISC can help schools connect with steel industry companies to form partnerships to assist with funding, fabrication, and more. You can find help with sponsorship under the [Team Resources](#) section of the AISC website for the SSBC. Entry fees are often charged by host schools to close the gap between the cost of hosting the competition and what they are able to raise from sponsors.

Guidelines for Competitors

It is the responsibility of the competitors to design, fabricate, and compete with a bridge that meets all the requirements of the Rules, and meet the needs of the client.

The client, in this case, is the Rules Committee. Their need is articulated in Section 3 of the Rules.

To maximize student learning, all design, project management, fabrication and construction should be performed by students.

Competitors should realize that personnel at the competition are volunteers and are a part of this competition as a service to the competitors. Many are giving up valuable work and/or vacation time in addition travel costs to be there. Many of the judges are less familiar with the rules than are the competitors. Competitors are strongly encouraged to be patient, collegial, professional, and ethical in their interactions with judges, hosts and other volunteers.

Design Tips

This section is intended to provide basic design tips for those teams that have little to no experience with this competition. These are some basic guides to help teams get started and avoid unintended consequences. One of the great objectives of this competition is to help you connect what you learn in class with real life. Statics really is true, as are the concepts learned in your structural mechanics, structural analysis, and materials courses.

Finding the Critical Contest Parameters

Scoring is based on three parameters: Lightness, Stiffness, and Speed. These are combined to determine Economy, Efficiency, and ultimately Overall Performance. Before getting too deep into your design, you should run some scenarios to decide which is the critical parameter. Knowing this will have a big effect on which way you go with your design.

One way to do this easily is to download the [scoring spreadsheet](#) and create entries for your various designs. You will need to estimate things such as weight, time of construction, and stiffness, and compare the resulting scores. Note: if you do this and find an error in the spreadsheet please report it ASAP so that the spreadsheet can be updated.

Avoiding Clearance Problems

Every year, teams are penalized by a matter of a sixteenth of an inch or less. Teams often push the clearance limits, and then things don't line up during construction which results in a penalty. It is **STRONGLY** recommended that you think twice (or more) before you commit to building a bridge that is intended to precisely meet the spatial limits. It generally won't hurt your overall performance to leave some construction and fabrication tolerance.

Finding Economical Steel

The Rules Committee comes under pressure regularly from competitors and sponsors to outlaw expensive steels, such as Chromalloy because there is a perception that somehow these steels give an unfair advantage to chapters with money to spend. Writing an enforceable rule restricting the type of steel has proven to be difficult.

These expensive steels seem to be used primarily because they can be obtained in lighter sections. They have generally the same Modulus of Elasticity, E , as other steels. However, going to lighter sections may have a detrimental impact on stiffness because

of reduced AE or EI . They do come in higher tensile strengths than some of the other steels; however, the required strength of most members is not very high. If member strength is based on buckling, then higher strength steels have no advantage over lower strength steels. In the end, we find some very competitive bridges at the National Finals that do not use these steels.

Here are some strategies for saving money on material:

- Reuse parts of last year's bridge and look for scrap steel from other student projects. If your university has a salvage yard or recycling program, you may be able to get scrap from research projects. Used steel retains its original strength and stiffness unless it has been distorted, heavily stressed thousands of times, or severely corroded beyond the surface.
- Some scrap metal dealers sell to the public. Selection is limited but prices are low. Search under "scrap metals."
- Steel service centers may offer lower prices than building supply and hardware stores. You can find a service center at www.aisc.org/steellavailability/steel-service-centers. Prices may vary from one service center to another so get quotes from several, if possible.
 - Service centers charge for cutting, so you may save by ordering full mill lengths. Order all your steel at the same time to minimize processing and delivery charges.
 - Service centers give big discounts to big customers. Therefore, you may get a lower price by ordering through your university's purchasing department rather than directly from the service center.
- A local steel fabricator may be willing to order your steel and sell it to you at cost, passing on the company's discount as a service to engineering education. You can find a local fabricator at www.aisc.org/aisc-membership. Search the member directory under the fabricator category. You can also contact AISC for assistance in locating and approaching local fabricators.
- Steel is available in various grades which differ in properties and cost. For example, AISI 4130 tubing is stronger (higher yield and ultimate stresses) but much more expensive than ASTM A513 tubing. However, the unit weight and stiffness (modulus of elasticity) are the same. If you design your bridge to minimize the structural cost score, C_s , you will find that the stress in most members is much less than the yield limit of the less expensive grades of steel. Therefore, a bridge made primarily from those grades can be a winner. However, there is a competitive advantage to using high-strength, expensive grades for members or parts of members that are highly stressed, if there are any. Judicious use of small amounts of expensive grades may improve performance without an excessive increase in cost.
- Some sizes of tubing are available in AISI 4130 but not in ASTM A513. However, you can duplicate the weight and stiffness of a 4130 tube with a built-up or milled-out A513 section.

Changes to Rules

Each year the Rules are modified by the Rules Committee. Frequently, we encounter teams which have not picked up on nuances of changes found in the current year's Rules and acquire significant penalties. Careful attention should be paid to this year's Rules.

Scoring the Competition

Judges should be provided with data sheets for recording all raw data (deflection measurements, construction time, penalties, etc.). The data is transferred to an Excel scoring spreadsheet for making all the competition scoring computations. The team captain is able to verify the data before signing off. The final spreadsheets are sent to the Rules Committee at the conclusion of the competition in order for invitations to the National Finals to be extended.

The same spreadsheet is used at the Regional Events as well as the National Finals. On the [Official Scoring Spreadsheet webpage](#), you can download the spreadsheet file and find instructions on how to use the spreadsheet. Judges and competitors should familiarize themselves with the spreadsheet. Please contact ssbcscorekeeper@aisc.org as soon as possible if an error is found.

Team Captains Meeting

Competitor Preparation

- Send the Team Captain to the meeting. Check with the host if more team members wish to attend.
- Be to the meeting on time.
- Bring a copy of the Rules and the current Official Clarifications with you to the meeting.
- Be polite and respectful of others--especially the judges.



Head judge listens to a question



Student asks a question

General Information

This meeting includes any final questions from the competitors regarding the Rules and Official Clarifications. The flow of the competition, competition order, and competition floor layout are usually discussed at this meeting. Local site conditions are also discussed and if any modifications have been made.

It is a critical event that takes place before teams take to the floor to build their bridges, and therefore, all captains are required to attend. The captain should report back to his/her team and inform them of pertinent information that was discussed.

This meeting is typically conducted by the head judge who may invite other judges. Participation in this meeting is often restricted to just team captains and the judges for reasons such as room size limitations.

Aesthetics

Competitor Preparation

- Have a bridge meeting the requirements of the competition.
- The name of the school displayed clearly on the bridge (see Rules Section 6.2.1.1).
- A poster meeting the requirements of the aesthetics rules (Rules Section 6.2.1.2). Make sure that all the itemized requirements are met.



Bridge with school name clearly labeled and poster

General Information

This section is designed to help host schools and their judges learn about the aesthetics ranking process. Aesthetics consists of three parts.

Appearance

This is very subjective and is based solely at the judges' discretion.

Name

The name of the school should be displayed on the bridge so that it is easily identified by the judges. It is recommended that letters are at least 1 inch tall and that the full name of the school is used in order to avoid confusion between schools with similar

abbreviated names. Bridges that do not have names clearly identifying the school or with names that do not match the poster will receive a low score.



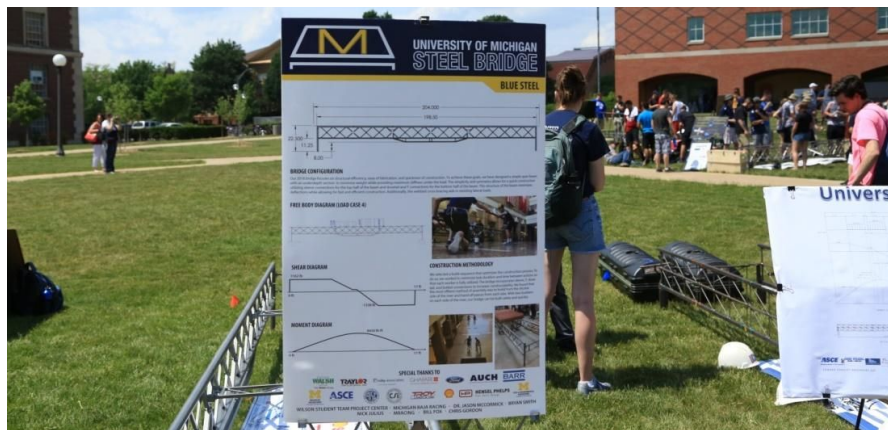
Good example of school name on bridge



Good example of school name on bridge

Poster Board

The Rules list required components for the poster.



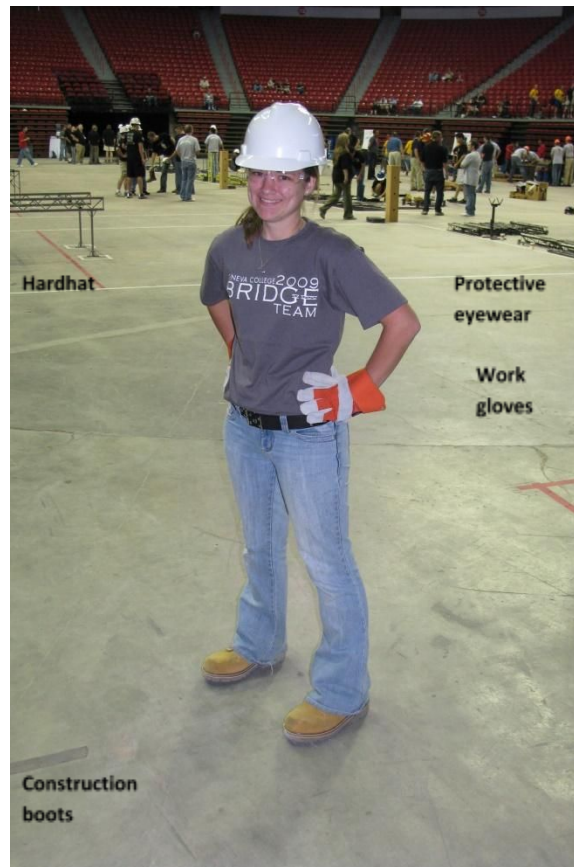
Poster at Aesthetics

The Rules do not give any specific guidance on how to combine these three components to arrive at a final ranking of the participating bridges. The head judge at each Regional Event can determine the process that will be used. At the National Finals where 40+ bridges are ranked, the official [scoring spreadsheet](#) is used to determine aesthetics scores and the aesthetics rankings.

Safety Gear

Competitor Preparation

- Review Rules Sections 10.1.5 and 11.2.1.3
- Competitors should read the Rules to determine what equipment is required during construction and loading.



Student dressed in proper safety gear

General Information

Before the start of Construction and Vertical and Lateral Loading, judges should verify that all participating team members are wearing proper safety equipment. Proper safety equipment includes:

- Hardhat
- Protective eyewear
- Work gloves
- Construction boots

Pre-Construction

Competitor Preparation:

- Be at the site on time and with all your bridge parts, pieces, tools, etc., and all the required safety equipment.
- When directed by the judges, move your bridge pieces into the designated staging area.
- Lay out your members, fasteners, piers, and tools according to the Rules.



Staging area with bridge ready to go

General Information

Once the team begins to move their equipment and materials into the staging area, the judges can start checking the members for compliance with the Rules using the data entry sheets. Everything that goes into the staging area is subject to the Rules whether it is used in the bridge or not. Any noncompliant item will be penalized.

Judges should verify that competitors are wearing the required safety equipment correctly. See Rules Section 10.3.2 for details.

Competitors are responsible to make sure that members, fasteners, tools, piers (if applicable per Rules), and other items are placed in the staging area as specified in the

Rules. Competitors are encouraged to be efficient in laying out their items so as to not inhibit the flow of the competition.

After the judges have completed the check, the team captain is to sign the bottom of the pre-construction checklist. The team captain's signature indicates that they understand and accept any penalties that have been levied. The team captain should be given time to check the Rules and make any appeals necessary to the head judge before signing the form.

Common Violations

There are several common violations. Some are design issues and others are either fabrication or erection issues. The following sections are intended to alert the judges and competitors. Read the [Rules](#) for complete information.

Member Size Limits - Rules Section 8.2.2.2

It would appear that the majority of violations to this rule result from designers pushing the specified limits. The judges will try to orient the member in the most advantageous position to get it in the box, but if it doesn't fit EASILY into the box, a penalty is imposed.



Bolt, Nut and Hole Specifications – Rules Sections 8.2.3, 8.2.4, and 8.2.5

Bolts and loose nuts must not be modified in any way (they may be painted) from their purchased condition. Bolts may not be ground to a point on their ends. Nuts may be welded to members. Holes must meet certain requirements specified in the Rules.

Tool Size - Rules Section 10.2.4

A tool must not weigh more than 20 pounds. Tools must fit into the same member box. However, after timed construction has started, tools may be assembled to form a larger tool.

Item Layout - Rules Section 10.6.1

There are a number of specific requirements about where particular types of items can be placed. Watch for how competitors lay out their items in the staging yard.

Certain items are to be in designated locations in the staging yard, and nuts and bolts may be in contact with each other. However every member, tool, loose nut and bolt must be in contact with the ground. In the provided image, some of the nuts and bolts are not in contact with the ground and hence are illegal. This must be fixed before timed construction.



Permissible way to lay out items



Illegal way to lay out items

Construction

Competitor Preparation:

- Many schools aim to complete fabrication several weeks prior to the competition to leave themselves time to practice construction of the bridge.
- You must be familiar with the Rules that govern the construction sequence.
- The actual local conditions may vary, so it is important to be prepared for slight changes in local conditions.
- Searching [Youtube](#) for "steel bridge competition" allows you to see a variety of competition and construction videos.



Team during construction



Team during construction

General Information

The team captain notifies the lead lane judge that the team is ready to start. The lane judges verify that the site is ready, and then they start the team with a countdown.

One lane judge should have primary responsibility for the stopwatch. If any judge calls out "stop," the stopwatch is paused as well any activity on the floor. Judges will stop the erection of the bridge if any of the rules in Section 10.7.1 are violated. As specified in the Rules, the team captain is told the reason for the stop work order and is given a short time to consider with the team how they can build the bridge without violating the Rules.

At no time should the judges or spectators make suggestions to the team on how they can comply with the Rules. Judges shall only tell them what the Rules will not allow them to do.

If the team is unable to find a means for constructing the bridge according to the Rules, then the head judge is called in to rule the bridge as being ineligible to compete. The head judge marks the applicable ineligibility on the construction checklist and has the team captain sign the bottom of the form. If a bridge is ruled as being ineligible, it is removed from the remainder of the competition and does not proceed to the subsequent stations and load tests.

'Accidents' as defined in the Rules do not result in stop time. One lane judge should have primary responsibility for keeping the checklist for construction and will record accidents as they occur. Judges will call out accidents as they occur.

Accidents must be rectified immediately. For example, if a builder drops a fastener in the water, a builder must retrieve the fastener immediately. If a builder has to create another accident by stepping in the water to retrieve the errant fastener they are not assessed for the necessary accident. If a builder does not move to rectify the accident, then the judge may call the accident again and again until it is rectified. See Rules Section 10.4 for a full explanation of accidents.

Time is complete when the team captain indicates that they are done and the judges ensure that all items and people are where they should be per the Rules Section 10.9.1.

Post-Construction

Competitor Preparation:

- Make sure that your bridge meets all clearance and spatial requirements during design and fabrication.

General Information

Once the team captain turns the bridge over to the judges for the post-construction check, the team can do no more work on the bridge. The judges then inspect the bridge for compliance under the Rules Section 9. Any violations are recorded on the judging form. Teams are only allowed to repair certain violations as dictated in Section 9.4 of the Rules. Certain violations must be fixed. If it is not possible to fix these problems, then the bridge will be ruled ineligible for any awards by the head judge and will not be approved for load testing.

Once the judges finish their work, they meet with only the team captain to review the results. If the team captain disputes the findings or asks for clarifications, he/she works with the lane judges to resolve the issues. If the disputes are not resolved, the head judge is called in to make a ruling. At the end of this process, the team captain is to sign the bottom of the form which, along with the rest of the judging forms, is moved with the bridge to the next station. Teams may appeal certain decisions after the competition by following Rules Section 15.

Common Violations

There are several common violations that seem to occur. Some are design issues, others are either fabrication or erection issues. The following sections are intended to warn bridge designers and judges of these persistent problems. For reference the SSBC 2019 Rules can be found [here](#).

Clearance - Rules Sections 9.3.4, 9.3.5, and 9.3.8:

There is a passage way above the decking support and also a navigation clearance under the bridge. There have always been clearance problems at the competition as teams, feel the need to push these limits.

The clearance is measured with plywood templates. Alternatively, the judges may measure from a taut string line if there is a question of the flatness of the floor. The

height of this clearance varies from year to year and is likely to be different than shown in the accompanying images.



Plywood templates for passageway and ground clearance checks

Connection Safety - Rules Section 9.4

Be sure to read this Rules section carefully. We tend to see quite a few violations of these rules each year.

Transportation from Station to Station

General Information

While transporting the bridge from the erection site to the loading areas, it is possible that the fasteners may fall off or other damage occurs. If this happens, the marshal or a judge should notify the head judge at once. There is a penalty for falling fasteners.

Also, care should be taken during transport and staging to ensure that the bridge is not 'preloaded' either by bouncing or other means that would remove as-built slack from the bridge. Marshals and judges should make sure that no one leans or sits on a bridge. At Nationals, if such situations arise, the head judge will make the team disassemble their bridge and start over again. There are safeguards put in place to ensure that the rebuild cannot improve on the original performance (but you can do worse!). So, don't mess with the bridge!



Competitor sitting on a bridge

Lateral Load Test

Competitor Preparation:

- Make sure that your bridge is sufficiently stiff to pass this test.
- Team members participating in this test must be wearing all the safety gear stated in the Rules.
- Review the Rules to determine the number of team members allowed to participate in the load test.
- It is wise to practice this test prior to the competition.



Lateral load test station

General Information

At the load station, the judge makes sure that all team members have the required safety gear. One piece of grating and 75 pounds of load are added to the bridge as specified by the Rules. The judge installs the laser plumb bob and paper target. The competitors may provide lateral restraint to the bridge.

Competitors may provide their own lateral restraint devices (Rules Section 11.4.1) to resist sliding. Note that any device used must only prevent sliding and cannot prevent uplift or rotation. The devices must not do damage to the floor. It is most common for competitors to use their feet as the restraining devices.



Foot of competitor used to prevent sliding



Use of an object (steel angle) to resist sliding



Pushing down on bridge is not permitted

A pulley system is used to apply the lateral load to the bridge. The lateral load pulley stand should be set up next to the bridge. On one end of the pulley, a dog collar is attached to the bridge stringer. On the other end of the pulley, loading plates are applied. One team member should stand on the stand in order to prevent slip of the pulley stand.



Lateral load pulley stand

Vertical Load Test

Competitor Preparation:

- Make sure that your bridge is sufficiently stiff to pass this test.
- Team members participating in this test must be wearing all the safety gear stated in the Rules.
- Review the Rules to determine the number of team members allowed to participate in the load test.
- Many teams perform a load test prior to the competition to avoid any surprises at the competition.



Vertical load station

General Information

At the load station, the judge ensures that all team members have the required safety gear. The judge then will have the team position the bridge in the loading area.

The load judge will place safety supports under the grating in such a way that prevents the grating from falling more than a few inches in case of failure while still permitting the maximum allowed deflection. These safety supports are modified jack stands.

Once the safety supports are in place, the load judge will carefully locate the decking on the bridge and have the team apply the preload.

The sway targets and vertical deflection measuring devices are then installed and initial readings taken and recorded on the judging form for the load station. The Team Captain should be invited to verify the setup and initial readings.

Loading is done manually by team members. Once loading starts, it should be accomplished in a safe, smooth, and continuous manner. Teams should not be allowed to stop the loading to look at gages or develop strategy. All teams should load in the same manner. Judges may stop loading for safety reasons or if the bridge exceeds sway or deflection limits.

At the end of the load stage, the judge will record the deflection readings and allow the team captain to verify them.

After the last deflection reading, the team should unload the bridge safely and quickly. Note that the bridge does not pass the load test until it is fully unloaded. If it collapses at any time it will be penalized according to the Rules.

Do not touch the deflection measurement devices. If the devices are compromised in any way by anyone during load testing, then the bridge must be disassembled and the team must start the entire competition sequence again in accordance with Rule 11.5.4. The reason for this is that the initial loading will take out any slack in the joints and reloading the bridge has the potential to result in smaller deflections than would have been seen in an uninterrupted first loading.

When all is done and recorded, the judge reviews the data form with the team captain. The team captain signs the form when all questions have been resolved and the forms are given to the marshal who accompanies the bridge to the next station.

Bridge Weight

Competitor Preparation:

- Show up with your bridge.



Bridge on the scales to measure weight

General Information

The goal at this station is to determine the weight of the bridge to the nearest pound. A scale will be positioned under each leg of the bridge.

The judging forms and [scoring spreadsheet](#) have space to record four measurements. The weighing judge should not add up the values. The spreadsheet will compute the total weight.

The team captain should verify all weight measurements and certify the results by signing the judging form. The judging forms are then sent with the team captain to the data entry station, if this is the end of the judging, or to the next station.

Data Entry

Competitor Preparation

- Only the Team Captain goes to the data station
- You may use a calculator to check the spreadsheet computations.



Data from score sheets is entered to the computer spreadsheet

General Information

Only the marshal (if assigned) and the team captain should go to this station. The marshal may help resolve any issues that the data entry person has with interpreting the handwriting of the judges. A judge should also be assigned to either oversee or actually do the data entry.

It is best if the team captain reads off the data as the computer operator inputs the values. The two of them should verify that all data is entered correctly.

Once the data is input, the data entry person prints out a copy of the results for the team captain to review. The team captain is responsible for verifying that the scoring computations are correct.

If there is a problem with the [scoring spreadsheet](#), do not modify the spreadsheet. Send an email to ssbcscorekeeper@aisc.org with a contact phone number and a description of the problem. The issue will be resolved as soon as possible which may be after the competition. Keep all raw data in the data entry sheets.

Once all concerns are resolved, then the team captain signs the printout and returns it to the data entry person who staples the print out to the judging forms. The marshal is free to go at this point.

An additional copy of the results are printed so that the team captain has something to take to show the team. A PDF version of the team results can also be emailed to the faculty advisor and local contact whose email addresses are entered into the spreadsheet. The team captain is informed that the results are not final until after a second check on data entry is made after the competition.