



Student Steel Bridge Competition

Competitors Guide



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Steel.**

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General Competition Information

The Student Steel Bridge Competition (SSBC) is an annual competition that challenges student teams to develop a scale-model steel bridge. The team must determine how to fabricate their bridge and then plan for an efficient assembly under timed construction conditions at the competition. Bridges are then load-tested and weighed. The bridge must span approximately 20 ft, carry 2,500 lbs, and must meet all other specifications of the competition rules. Judges also consider a bridge's aesthetic qualities.

This document explains the competition preparation and procedures for competitors. It highlights certain key aspects of the *Student Steel Bridge Competition Rules*, but this is not a complete explanation of the *Rules*. You should refer to the *Rules* while reading this guide. If there are any discrepancies between the *Rules* and this guide, the *Rules* take precedence.

Rules

All of the regional competitions, as well as the national finals, are based on the same rules to ensure fair competition on a national level. The SSBC Rules Committee updates the *Rules* every year.

AISC maintains a website, aisc.org/ssbc, where you can download the *Rules* and ask for or review clarifications. The SSBC Rules Committee only reviews questions submitted through the official online form; their clarifications are available to all competitors online.

People

Organizing Sponsors

The SSBC began in the 1980s as an AISC competition between three universities in Michigan. Over the years, it has expanded to include over 200 participating schools. Today, the American Institute of Steel Construction (AISC) and the American Society of Civil Engineers (ASCE) jointly sponsor and organize the competition.

Teams and Guest Teams

Teams consist of undergraduate and/or graduate students from colleges and universities in North America. All teams must designate an official captain.

To be eligible, schools must have an ASCE student chapter and be in good standing with ASCE. Refer to the *Rules* for the full eligibility requirements.

Generally speaking, competition regions follow ASCE Student Conference divisions, and regional competitions are held during ASCE Student Symposia.

Schools that do not meet the full eligibility requirements may send a guest team to the regional competitions, at the discretion of the host school and ASCE. Guest teams are not eligible to continue on to the national finals. See Section 4 of the *Rules* for more information on participation as a guest.

Host School

Host schools are responsible for all aspects of planning and setup of the event. This includes making venue arrangements, communicating with participants, recruiting volunteers and judges, fundraising, setup and cleanup, and coordinating with ASCE. 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, and ASCE and AISC are both extremely grateful to them. SSBC simply couldn't exist without our host schools.

Well in advance of the competition, the host school will alert participants of any local conditions that may affect the competition. The host school also typically provides each team with a schedule of events, map to the contest site, and travel recommendations.

Head Judge

The head judge has full authority over the conduct of the competition, safety, and interpretation of the rules. There is a head judge at each regional competition. The national head judge serves as the head judge for the national finals.

Judges

Judges assist the head judge with the conduct of the competition, safety, and interpretation of the rules. Judges moderate each aspect of the competition: aesthetics, construction, lateral loading, vertical loading, and weighing. They have complete and final authority for enforcing the rules of the contest. Judges are directed and empowered to halt any activities they deem hazardous.

These judges are volunteers--they donate their time to ensure that SSBC competitions are safe, fair, and enjoyable for all. Please be respectful to them at all times.



Judge giving instructions at load station

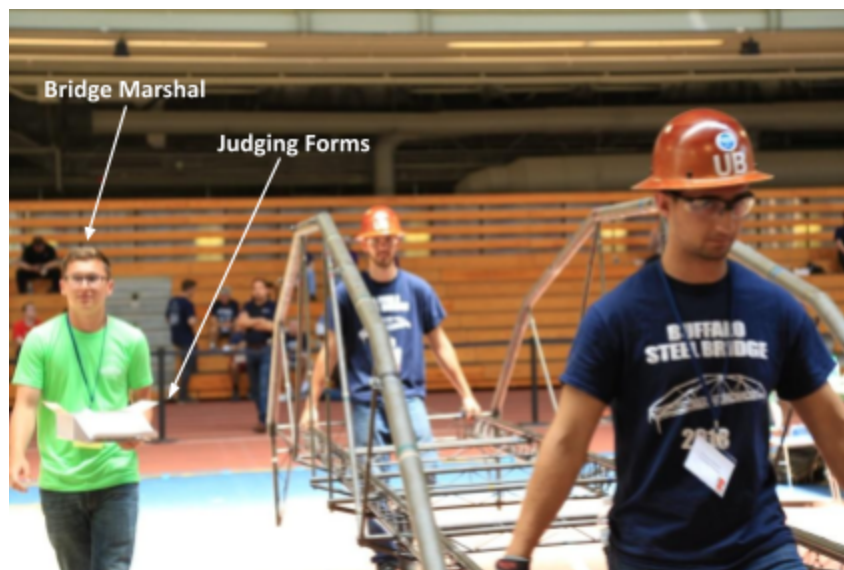


Judges oversee bridge construction

Marshals

At the national finals and some regional competitions, marshals escort bridges through the complete construction and testing sequence. The marshals carry the judging forms from station to station, ensure that the bridge is not altered or enhanced after the erection phase, note any damage to the bridge as it is moved, and help the data entry team resolve any questions about the completed judging forms.

Marshals are also volunteers who have donated their time. Again, please be respectful.



Other Volunteers

The host school may have other volunteers at the competition who help with other tasks such as registration of teams, equipment preparation, and venue setup and cleanup.

AISC Representatives

There will be at least one AISC representative at each regional competition to observe the competition.

Financial Support

Team Participation Stipend

Eligible teams will receive limited funding for the competition in the form of a stipend. AISC provides stipends to eligible U.S.-based teams that compete at regional competitions in North America and to U.S.-based schools participating in the national finals. ASCE provides stipends to eligible teams that are located outside of the U.S.

To receive the participation stipend, teams must complete ASCE's SSBC Participation Form in the fall preceding the competition. Look for the link in the first mailer you'll receive from the host school.

Host Stipend

AISC also provides stipends to schools that host regional competitions in North America as well as the national finals to help offset the costs of the event. Host schools frequently charge participating team entry fees to close the gap between the cost of hosting the competition and what they are able to raise from sponsors.

Other Sources

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 for funding, fabrication, and more. If you'd like help reaching out to a local fabricator, fill out the partnership request form in the [Team Resources](#) section of aisc.org/ssbc.

Guidelines for Competitors

It's your responsibility to design, fabricate, and compete with a bridge that meets all the requirements of the *Rules*. Students on your team must perform all design, project management, fabrication, and construction--this is about learning, after all!

During competitions, please remember that many of those running the event are volunteers. They do this to help you have a great experience and often give up valuable work or vacation time in addition to out-of-pocket travel costs to be there. When interacting with judges, hosts, and other volunteers, please be professional, collegial, ethical, and patient.

Getting Started

The SSBC is a unique opportunity to bring what you learn in class to life, and that can be a tricky transition. Here are some things to keep in mind:

Identify the Critical Contest Parameters

Scoring is based on three parameters: lightness, stiffness, and speed. Judges combine these to evaluate your bridge's economy, efficiency, and ultimately overall performance.

Before getting too deep into your design, consider running some scenarios to decide the critical design parameters. Estimate things like weight, time of construction, and stiffness, then compare the resulting scores. Identifying critical design parameters could have a major influence on the direction of your design.

Avoid Clearance Problems

Teams often push the clearance limits, and then things do not line up during construction, which results in a penalty--every year, teams earn penalties for a sixteenth of an inch, or sometimes even less. Generally, leaving a bit more construction and fabrication tolerance will not hurt your overall performance. We *strongly* recommend that you think twice before committing to building a bridge that is intended to precisely meet the spatial limits.

Find Economical Steel

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--that's one of the things that makes it so special!
- 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 in the directory at aisc.org/aisc-membership. AISC

can also help connect you to a local fabricator; see the [Team Resources](#) section of aisc.org/ssbc for more information.

- Steel service centers are warehouses that stock large quantities of steel. They may offer lower prices than building supply and hardware stores. Visit aisc.org/steelavailability/steel-service-centers to find the nearest service center. 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 money by ordering full mill lengths. Order all your steel at the same time to minimize processing and delivery charges. Service centers also give big discounts to big customers. You may get a lower price by ordering through your university's purchasing department rather than directly from the service center.
- Some scrap metal dealers sell to the public. Selection is limited but prices are low.
- 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) properties are the same. If you design your bridge to minimize the structural cost score, C_s , you will likely find that the stress in most members is much less than the yield limit of the less expensive grades of steel--in short, a bridge made primarily from the less expensive grades can be a winner. You can judiciously use small amounts of expensive grades to improve performance without an excessive increase in cost; the higher strength, more expensive grades can be reserved for any members or parts of members that are highly stressed.
- 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.

The Rules Committee comes under pressure regularly from competitors and sponsors to outlaw expensive steels, such as Chromoly, because there is a perception that somehow these steels give an unfair advantage to chapters with money to spend. There are exceptional bridges made without these steels at the national finals every year, so think carefully before investing in these expensive materials.

Generally, teams buy these pricier steels because they are available in lighter sections, but they usually have the same Modulus of Elasticity, E , as other steels. The lighter sections may, however, be an actual detriment to your bridge due to their reduced AE or EI . They do come in higher tensile strengths than some of the other steels, but 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.

Every year, student engineers like you make remarkable bridges with steel at all price points.

Double-check the Rules Each Year

Each year, the Rules Committee modifies the *Rules*. Frequently, teams do not pick up on the nuances of changes found in the current year's rules, which can result in significant penalties. Pay careful attention to this year's rules.

Other Team Resources

Finding a Mentor through NCSEA

The National Council of Structural Engineers Associations (NCSEA) is a great resource for the entire structural engineering profession--and they may be able to help you find a practicing engineer to mentor your team.

Mentors will not design or build your bridge, but they may be able to give you advice and support your bridge project. A mentor may be able to help with one or more of the following:

- Offer advice on structural analysis software
- Review your design calculation package
- Volunteer as a general mentor for the main competition
- Serve as a guest speaker at a virtual team meeting to discuss real projects and careers in structural engineering

NCSEA comprises 44 structural engineering associations throughout the United States. Each structural engineering association has a delegate that will help local SSBC teams find a mentor. Visit aisc.org/ssbc-ncsea to get started.

More Guides and Videos

The [Team Resources](#) section of aisc.org/ssbc provides additional guidance. At the start of each school year, AISC hosts a kickoff webinar with an introduction to the program and highlights of rule changes. For teams that are newer to the program, short videos on topics such as basic terminology may be helpful to navigate the rules for the first time. For teams that fabricate their own bridges, review the fabrication safety recommendations before you start your work.

AISC posts the top three videos in the Video Award Category in the [Special Awards](#) section of aisc.org/ssbc website. Teams can watch these videos to learn how other teams approach the design and fabrication challenge.

Scoring the Competition

It's very important to us that all teams across the country compete on an even playing field. Our judging process is designed to ensure fairness, wherever you are.

SSBC uses the same scoring spreadsheet for all regional competitions and the national finals. The official scoring spreadsheet will be posted on aisc.org/ssbc in the spring. In the meantime, if you are curious about estimating your bridge's score before the competition, you can easily program your own spreadsheet using the equations in the *Rules*.

Judges at your competition will record raw data (like deflections measurements, construction time, bridge weight, and penalties) on a form. That data is then transferred to the scoring spreadsheet; your team captain will have the opportunity to verify that the data in the scoring spreadsheet matches the form that will be completed during the course of the competition.

The Rules Committee reviews all scoring spreadsheets from the regional competitions to determine which teams qualify for the national finals.

Cost Estimation

SSBC challenges teams to estimate their overall performance rating before regional events and/or the national finals.

Each team must submit their estimate for the six possible load cases prior to the selection of the load case (i.e., the die roll). Typically, the host will collect the information through an online form before the competition or at the start of the captains' meeting. The host school will input the values into the scoring spreadsheet.

The team that has the smallest absolute value between their estimate and their actual performance will win an award.

To do:

- ❑ Submit cost estimation for all six load cases by the deadline established by the host school

Team Captains' Meeting

At the beginning of each competition event, team captains gather with the head judge to review the *Rules* and official clarifications. This is also a final opportunity to ask the head judge any questions you might have. These meetings usually also detail the flow of the competition, competition order, competition floor layout, and local site conditions.

All captains must attend this meeting, and they should convey any pertinent information to the rest of their teams.

The head judge typically conducts this meeting, and the other judges may be invited to attend. Room size limitations may restrict the number of participants to only the team captains and judges.



Head judge listens to a question



Student asks a question

To do:

- ❑ Send the team captain to the meeting. Check with the host school if more team members wish to attend.
- ❑ Arrive at the team captains' meeting on time.
- ❑ Bring a copy of the *Rules* and the current official clarifications to the meeting.
- ❑ Be polite and respectful of others--especially the judges.

Aesthetics

Aesthetics judging typically takes place before the main competition. During aesthetics judging, all of the bridges are erected and on display at the same time in the same location. (This is a great opportunity to meet students from other teams and discuss their bridges!)

Judges are looking for three things: your bridge's appearance, whether it displays your school's name, and an informational poster about your bridge.

The head judge at each regional competition will determine the process by which judges will rank participating bridges; because there are more than 40 bridges to rank and score at the national finals, judges will use the official scoring spreadsheet.



Bridge with school name clearly labeled and poster

Appearance

The judge will score your bridge for its attractiveness based on his/her/their evaluation. This is subjective, but judges generally reward bridges that are elegant in both design and engineering approach.

Name

Your school's name should be displayed on your bridge so the judges can easily identify it--after all, you want your hard work to be properly attributed! We suggest you use letters that are at least 1-in tall and that you use the full name of your school to avoid confusion between schools that may have similar abbreviations. Bridges that do not clearly identify a participating school or are not labeled to match the poster will receive a low score.



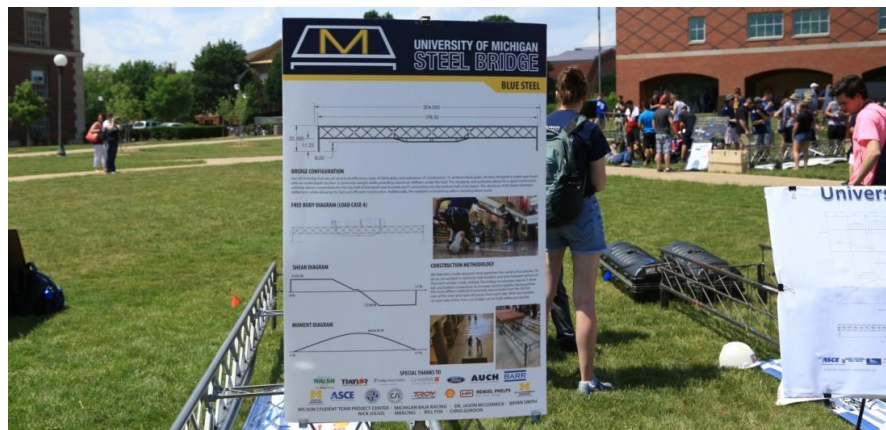
Good example of school name on bridge



Good example of school name on bridge

Poster Board

You've worked hard--show off what you've done! A poster is your opportunity to explain your design process to the judges. The *Rules* list required components for the poster.



Poster at aesthetics judging

To do:

- Ensure that your bridge meets the requirements of the competition.
- Clearly display the name of your school on the bridge
- Provide a poster that meets the requirements of the *Rules*

Pre-Construction

General Information

Once the team begins to move their equipment and materials into the staging area, the judges can start checking all items for compliance with the *Rules*. Everything that goes into the staging area is subject to the *Rules*, and any noncompliant item will be penalized and documented on the data forms. Judges should also verify that competitors are properly wearing the required safety equipment.



Staging area with bridge ready to go

Competitors are responsible for making sure that all bridge components and construction aids are placed in the staging area as specified in the *Rules*. Competitors are encouraged to be efficient in laying out their items so they do not inhibit the flow of the competition.

After the judges complete the check, the team captain signs 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.

Safety Gear

Before construction and loading (vertical and lateral), judges will verify that all participating team members are wearing proper safety equipment which may include the following depending on the stage of the competition: a hardhat, protective eyewear, work gloves, and steel or composite toe boots that extend above the ankle or steel or composite toe caps over leather work boots. Refer to the *Rules* for requirements.



Student dressed in proper safety gear

Common Violations

Some violations that occur during pre-construction are design issues, and others are either fabrication or erection issues. Here are some common pitfalls to avoid. Refer to the *Rules* for complete information.

Member Size Limits

All members must fit into a box with dimensions specified in the *Rules*. The judges will try to orient the member in the most advantageous position to get it in the box but will impose a penalty if it does not fit EASILY into the box. The majority of violations to this rule result from designers pushing the specified limits.



Bolt, Nut, and Hole Specifications

With the exception of painting, bolts and loose nuts must not be modified in any way from their purchased condition. Bolts may not be ground to a point on their ends. Holes must meet certain requirements as specified in the *Rules*.

Tool Size

All tools must meet the requirements specified in the *Rules*.

Item Layout

There are specific requirements about where particular types of items can be placed in the staging yard. Nuts and bolts may be in contact with each other, but every member, tool, loose nut, and bolt must be in contact with the ground. In the example 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.



Illegal way to lay out items



Permissible way to lay out items

Appeals

Teams may appeal certain decisions after pre-construction by following the *Rules*.

To do:

- ❑ Arrive on time with all your bridge parts, pieces, tools, and 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*.

Construction

Your team captain will tell the lead construction lane judge when you are ready to start. The lane judges verify that the site is ready before starting the countdown.



Team during construction



Team during construction

One lane judge will have primary responsibility for the stopwatch. If any judge calls out "stop," that judge will pause the stopwatch (obviously, your team's activity on the floor must also stop). Judges will stop the construction of the bridge if any of the *Rules* are violated. The judges will tell the team captain why they stopped work. Your team will have a short time to discuss how to build the bridge within the parameters of the rules.

At no time should the judges or spectators make suggestions to the team on how they can comply with the *Rules*. Judges will only tell the team what rules they are violating.

If your team can't find a way to construct your bridge in compliance with the *Rules*, the head judge will determine whether you may continue the competition. The head judge will mark any applicable ineligibility on the construction checklist, and the team captain must sign the bottom of the form. If a bridge is ruled ineligible, it is removed from the remainder of the competition and does not proceed to the subsequent stations and load tests, unless otherwise allowed by the head judge.

The *Rules* define some penalties as accidents; judges will call these out as they occur and one judge will be responsible for recording them on the data form. If, for instance, you drop a fastener in the water, the timer will keep running but you will continue to earn additional penalties unless you rectify the situation immediately. If you commit an additional violation while resolving the first (for instance, if you must step in the water

to retrieve a dropped fastener), you will not be penalized for the second accident. See the *Rules* for a full explanation of accidents.

The timer will stop 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*.

Appeals

Teams may appeal certain decisions after construction by following the *Rules*.

To do:

- ❑ Review the *Rules*.
- ❑ Practice the construction sequence for your bridge. Many schools aim to complete fabrication several weeks prior to the competition to leave themselves time to practice construction.
- ❑ Visit youtube.com/aiscsteeltv or search YouTube for "steel bridge competition" to see a variety of competition and construction videos.

Post-Construction

General Information

You may not do any further work on your bridge after timed construction ends. The judges will inspect the bridge for compliance with the *Rules*, then record build time and any clearance violations on the data forms. Teams may be allowed to repair certain violations as dictated in the *Rules*. Certain violations must be fixed, and if it is not possible to fix these problems, then the head judge will rule the bridge ineligible and the bridge will not be approved for load testing, unless the head judge allows.

Once the judges finish their inspection, they meet with only the team captain to review the results, ask for clarifications, or dispute the findings. The head judge may resolve disputes between team captains and lane judges; further appeal processes are detailed in the *Rules*. At the end of this process, the team captain will sign the bottom of the data form, and the team will move its bridge to the next station.

Common Violations

Clearance

Judges will typically use a plywood template to evaluate clearance, though they may also use a taut string in cases where the floor may not be perfectly flat.

Clearance problems arise when teams push the limits defined in the *Rules*. Note that the height and type of clearance varies from year to year. The following images likely do not reflect the requirements for the current competition year.



Plywood templates for passageway and ground clearance checks

Connection Safety

We also see several connection safety violations each year. Be sure to read this section of the *Rules* carefully and refer to the *Connection Safety Examples* document in the [Team Resources](#) section of aisc.org/ssbc.

Appeals

Teams may appeal certain decisions as detailed in the *Rules*.

To do:

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

Transportation from Station to Station

Your team must move your bridge to the various judging stations after construction. Take care! If fasteners fall out or the bridge is damaged, marshals or judges should inform the head judge immediately. The head judge may determine that a bridge that is damaged or missing a fastener is ineligible to finish the competition.

Take care to ensure that the bridge is not preloaded 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 the national finals, 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).



Don't do this!

Lateral Load Test

At the lateral 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--that is, you may brace it to prevent it from sliding.



Lateral load test station

Competitors may provide their own lateral restraint devices 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. Competitors usually use their feet as 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

You'll use a pulley system to apply lateral load to your bridge. A dog collar (provided) will connect one end of the pulley to the bridge stringer. A team member will apply loading plates to the other side of the pulley. This person should stand on the pulley stand in order to prevent it from slipping during loading.



Lateral load pulley stand

To do:

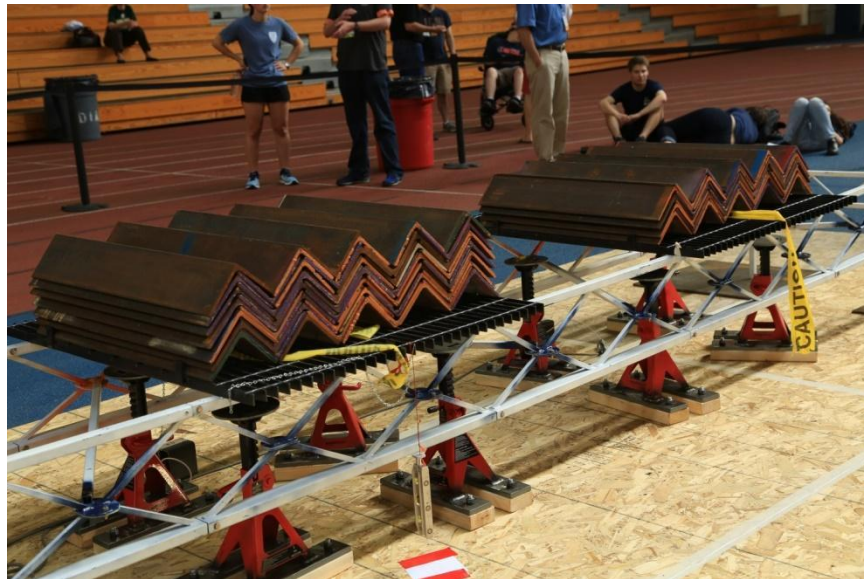
- ❑ Review the *Rules*.
- ❑ Wear the required safety gear while participating in this load test.
- ❑ If possible, practice the lateral load test prior to the competition.

Vertical Load Test

General Information

At the vertical load station, the judge will confirm that all team members have the required safety gear.

The load judge will place safety supports (i.e. modified jack stands) below the bridge. The supports will be positioned to permit the maximum allowable deflection and such that the grating will not fall more than a few inches in the event of failure.



Vertical load station with safety supports, grating, and loading angles

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

The lane judge will record initial readings after the sway targets and vertical deflection measuring devices are installed. The team captain should verify the setup and initial readings.

The team members will manually load the bridge; this process should be conducted in a safe, smooth, and continuous manner. All teams should load in the same manner. Teams should not be allowed to stop the loading to look at gauges or develop a

strategy. 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 the readings.

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, the team will be penalized according to the *Rules*.

Do not touch the deflection measurement devices during loading or unloading. If the devices are compromised in any way during load testing, then the bridge must be disassembled and the team must start the entire competition sequence again in accordance with the *Rules*; 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 bridge gets moved to the next station.

To do:

- Review the *Rules*.
- Wear the required safety gear while conducting this load test
- If possible, practice this test prior to the competition.

Bridge Weight

Your team will position your bridge atop four scales to determine its weight, rounded to the nearest pound.



Bridge positioned on scales to measure weight

The weighing judge will record the four measurements on the data forms. The weighing judge should not add up the values; the scoring spreadsheet will automatically compute the total weight.

The team captain should verify all weight measurements and certify the results by signing the judging form.

Data Entry

After judges evaluate a bridge at all stations, the team captain (and the marshal, if assigned) will proceed to the data entry station with the official data form. This is where information from the data forms ends up in the official scoring spreadsheet.

A judge will be assigned to either oversee or actually do the data entry. It is often best for the team captain to read off the data as the computer operator inputs the values. Together, they should verify that all data is entered correctly. The marshal may help resolve any issues with interpreting judges' handwriting.



Information from data forms is entered to the computer spreadsheet

After the data is entered, the data entry person will print the results for the team captain to review and verify. The team captain will sign the printout and return it to the data entry person, who will staple the printout to the data forms. The marshal is free to go at this point. An additional copy of the team's results can be printed so that the team captain has something to share with the team. An electronic version may also be shared.

The results are not final until the national scorekeeper makes a second check after the competition.

At the end of the competition, the head judge (or someone designated by the head judge) will review the data forms and scoring spreadsheet to double-check that all data was entered properly. If a discrepancy is found during this later check, judges will contact the relevant team captain before the awards ceremony.

Additional Help

The sheer amount of information contained within the *Rules* can be overwhelming. Please visit aisc.org/ssbc to find more about all aspects of the competition, submit a question to the Rules Committee, or access additional team resources.

Good luck!