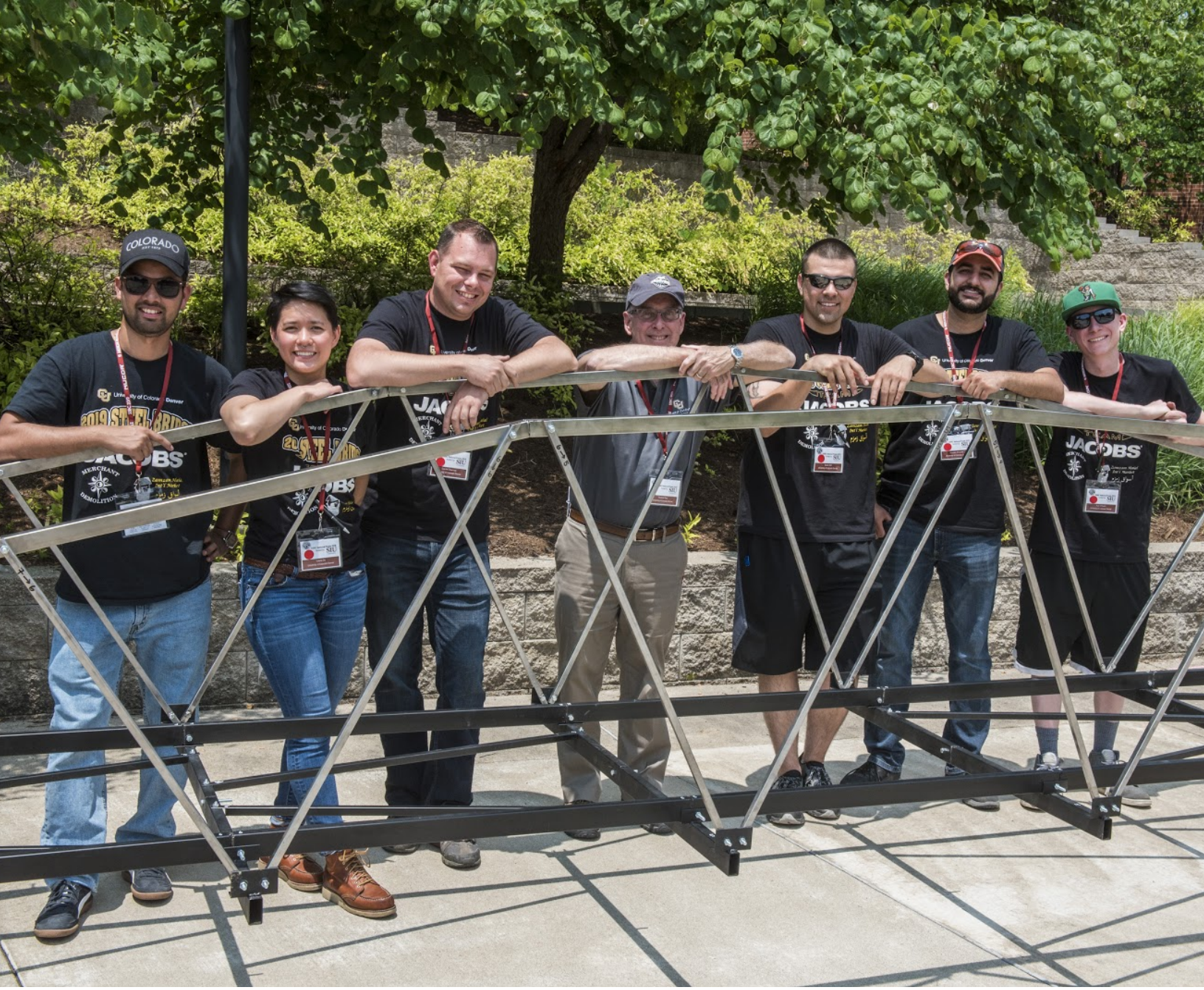

Student Steel Bridge Competition

Faculty Advisor Guide

Smarter. Stronger. Steel.

SSBC Faculty Advisor Guide

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This guide provides an introduction to the Student Steel Bridge Competition (SSBC) for faculty advisors in the format of a Question and Answer session with an experienced faculty advisor. For additional information about faculty advisor expectations, please visit aisc.org/ssbc.

Cover image taken by Steve Buhman, New Leaf Studio.

The Basics

This is the first year that students from my university will enter the Student Steel Bridge Competition (SSBC). I'm excited to be the team's faculty advisor, but I have a few questions. Can you briefly describe the competition?

Student teams design and fabricate a scaled steel bridge to satisfy detailed specifications and performance criteria. The bridge spans approximately 20 ft, and teams must consider several factors that contribute to an overall score, as they are judged on construction speed, lightness, and stiffness. Teams then meet in the spring for intercollegiate competition where they race to erect their bridges for inspection and load testing.

That certainly was brief! Where can I find more information?

Start at aisc.org/ssbc, which has the current Rules and Clarifications, along with a Competition Guide for Participants, details about the Regional Events and the National Finals, and other useful information to support your team. Articles about SSBC are archived at aisc.org/ModernSteel. Web searches for "student steel bridge competition" and #SSBCxAISC can also be productive.

How does SSBC benefit participating students?

The primary objective is education. The competition provides comprehensive, student-driven project experience where students can practice structural analysis and design, steel fabrication, construction planning, time management, teamwork, and leadership. While conventional courses include those topics, understanding is greatly reinforced by designing, building, and interacting with the spatial complexities of a real structure. Students are attracted by opportunities to create a physical product and to compete against teams from other universities. Practicing engineers in both the building and bridge disciplines often describe the competition as the highlight of their undergraduate education.

What are my responsibilities for the technical aspects?

At some universities, the faculty advisor oversees a professional advisor (i.e. practicing structural engineer) who consults with student designers and a university technician who supervises fabrication. At other universities, the faculty advisor mentors both design and fabrication. Whether they are faculty, staff, or design professionals, the advisors guide valuable learning experiences and provide support to the team but should not diminish the educational value by taking over.

What's in it for me?

Your understanding of teamwork, leadership, design processes, and fabrication will deepen as you observe students in action. You will also become more closely acquainted with students, which may help you identify potential undergraduate research assistants and recognize needs for improvement to courses and curriculum. Compensation and work-load considerations vary across universities and should be negotiated with your department.

Resources

What resources do we need?

You will need (1) a core group of dedicated students willing and able to invest many hours over the entire academic year, (2) funds for tools, material, and competition travel, (3) space for fabrication and erection practice, and (4) a professional design advisor and/or university technician if you choose to delegate supervision.

How does the team get started and proceed?

Let's assume that you have recruited several student leaders who can devote many hours for the full duration of the academic year. They should study the Rules and the Competition Guide for Participants, commence design as soon as possible, procure funding, and recruit additional students (especially those who can participate in future years). Fabrication begins when the design is complete, followed by load testing, erection practice, and culminating in competition. The Faculty Advisor must pre-register the team for competition at aisc.org/ssbc before November 15. Upon pre-registering, the team will receive a $500 SSBC Participating Team Stipend from AISC in support of SSBC activities

What is the best way to structure the team and support their activities?

It is important to have the support of your department since efforts will require some of your valuable time, and the team will likely need to tap into department or school resources. There are many possible ways to structure your team, and the format will depend on how your department chooses to support and implement the activities. Participation may be part of a class or it may be an extracurricular activity through a student club; for some teams, it is a combination of the two.

Why is diversity and inclusion important for the team?

A team that creates a respectful, welcoming, and inclusive environment, and is not predisposed to defined roles and biases, will benefit greatly from the creativity that diversity affords. As the faculty advisor, you can facilitate a diverse environment by recruiting and encouraging team members with unique perspectives and experiences. We challenge you to promote and support an inclusive environment where innovation has the opportunity to develop and thrive. Please refer to the Rules and Clarifications for more information and for AISC's statement on diversity and inclusion.

Do you have any suggestions regarding fundraising?

Yes, there are numerous ways to start fundraising. In addition to the $500 SSBC Participating Team Stipend, AISC will provide hotel reimbursement to one Faculty Advisor from each school to travel with their team to attend their Regional Event. Other suggestions include talking to your department and school about any available funding, organizing fundraisers on campus, and soliciting sponsorships from alumni networks, engineering firms, steel fabricators, and local companies.

Does the team need to be part of an official AISC Student Club to participate?

No. SSBC teams can complete without being an official AISC Student Club, and AISC does not have restrictions about what type of club can support SSBC activities. Many teams find it beneficial to be associated with a student club on campus, especially when it comes to managing funds, but it is not required to be associated with a club. If your team chooses to participate under another established club, we highly recommend that you check with the national organization that supports your club for their approval.

What exactly is an AISC Student Club?

College-level students are now offered a way to formally organize and develop a student organization that is recognized by AISC and the AISC Education Foundation. Each AISC Student Club is formally affiliated with AISC. Clubs will receive tax exempt status, insurance coverage for official Club activities, and the support of AISC staff and our extensive membership network. An AISC Student Club is not required to participate in the SSBC, but the Club may support activities like SSBC. For more information or to apply for AISC Student Club status, visit aisc.org/studentclubs.

What if my team does not have access to a shop on campus?

We encourage students to be as actively involved in the fabrication process as possible. However, not all teams will have full access to a shop on campus. A relationship with a local fabricator may help fill some of those gaps, including assistance with material procurement, shop training, and space for fabrication and erection practice. Note that some fabricators may offer to fabricate most or all of the components for the bridge, but we strongly recommend that the students participate in as much of the fabrication process as possible. They will have the opportunity to learn new shop skills (such as welding) and will also gain valuable experiences that can only be learned while working through things such as tolerances and fit-up issues.

Can AISC help my team get connected with a local fabricator?

Yes! AISC's Adopt-a-School program matches steel fabricators with college faculty and students. The program encourages long-term relationships that can improve students' learning experiences both in and out of the classroom. Opportunities may include team sponsorships, material donation, shop tours, and fabrication training. Visit aisc.org/adoptaschool to learn more.

Who can I contact if I have any other SSBC-related questions?

AISC has a dedicated SSBC team! Please reach out to them with any other questions.

Design

What are the design objectives?

The bridge should be designed to meet specifications and performance criteria described in the competition Rules. Requirements change from year to year. Designers must assure that the bridge can be fabricated with available tools and erected in accordance with regulations in the Rules.

How long does it take to design a competition bridge?

Because students lack experience, they may have difficulty getting started and struggle with every step. Therefore, they should be encouraged to create a plan of action with deadlines. Scheduling completion of the design by Thanksgiving may be reasonable. If the design process drags on too long, there will not be sufficient time for fabrication.

What analysis programs are useful?

Mastan is a program that is free, easy to use, and may be downloaded with a tutorial at www.Mastan2.com. Other commonly used programs include STAAD.Pro (by Bentley Systems), VisualAnalysis (by IES), LARSA 4D BRIDGE (by LARSA), SAP2000 (by CSI), and RISA-3D (by RISA).

The steel shapes in the AISC Steel Construction Manual seem too heavy for such a small structure. What materials are more appropriate?

Smaller shapes are available from steel service centers, which typically publish online catalogs of sizes and properties. A directory is available at aisc.org/SteelAvailability/Steel-Service-Centers. Your university may have a pricing agreement with a service center, or your fabricator partner may be willing to use its discount to order the team's steel. Economical low-carbon steel (e.g., A36, A513) is typically adequate.

Sizing members seems straightforward. Are there other challenges?

Yes! The first is deciding on a style (i.e. deck bridge vs. through truss) and alignment of members. Dimensioning should not be a major challenge, except that students tend to assume perfectly precise fabrication and therefore design exactly to specified limits, which guarantees a high probability of penalized violations. Unsuccessful load tests usually are caused by lateral instability or connection rupture. Prototyping connections and considering erection limitations may be helpful. These can be pretested at a component scale (say two members connected in the middle), before all the final bridge components are fabricated.

What's the final design product?

Shop drawings that are sufficient to direct fabrication of every part and assembly. Improvisation during fabrication wastes time and invites error.

Fabrication

What are the options for fabrication?

Education is maximized if the team fabricates the entire bridge. If that is impossible, the team may provide shop drawings and observe fabrication by others, e.g. a university technician or commercial fabricator. Although by doing so, your students will miss the biggest opportunity to gain the most from this competition, i.e. designing something is only "half the battle." Therefore, they should be given the opportunity to make fabrication mistakes, plenty of mistakes…

What tools are needed?

Necessary equipment includes a drill press, horizontal band saw, belt sander, welding machine (MIG, a.k.a., GMAW, is easiest for beginners), helmet and gloves for welding, hand-held grinder, face shields, files, wrenches, pliers, hack saw, c-clamps, tape measure, spirit level, and first aid kit for minor scratches and burns. In addition, access to a vertical band saw, shear, press brake, and mill may be helpful. It is highly unlikely that none of the students ever worked with such tools, so even with their limited experience, they can become the fabrication team leaders!

Novices operating machine tools and welding! Isn't that dangerous?

Safety is the top priority. To minimize risk, students should be trained in safe use of tools and wear appropriate personal protective equipment. Safety glasses and closed-toe shoes are necessary at all times. Most universities have staff qualified to provide safety training. Student fabricators should be observed regularly to assure that they are working safely. At most universities students are only allowed to work in the workshop during regular business hours, when the labs are staffed with lab technicians.

How much time is needed for fabrication?

That depends on the design, number of students, schedule, and organization. Students tend to underestimate person-hours, so conservative consideration of contingencies should be encouraged. Fabrication should be scheduled to allow adequate time for subsequent load testing and erection practice. Some teams decide to use machined connections, which allow greater precision – this can be accomplished by collaborating with their mechanical engineering peers, and perhaps, using their machine shops.

Load Testing and Erection Practice

What are the objectives of load testing?

The load testing objectives are to assure that lateral and vertical deflections are within specified limits and that the bridge will not collapse under full vertical load. Deficiencies can be corrected before traveling to the competition. Since these pretests often result in the biggest surprises to the teams (many times connections fail, members yield, bridge undergoes permanent deformation, etc.), it is essential that the bridge deck is secured against sudden and catastrophic failures. This can be accomplished by providing adequate supports throughout the length of the bridge, just a few inches below the deepest members.

What's the procedure for load testing?

The loading instructions in the Rules should be followed.

What additional equipment is needed for load testing?

Necessary equipment includes a luggage scale for lateral load testing, plumb bob, gloves, hard hats, safety supports, decking units, and load, as described in the Rules. Your fabricator partner may be able to help procure decking and load. Consistent use of safety supports prevents personal injury and limits damage to the bridge if it collapses.

The bridge did not perform as anticipated. Now what?

This happens even with the most experienced teams – do not be discouraged! These "failures" offer the greatest teaching opportunity, when the advisor can point out the unwanted behavior of steel structures, such as bolt shearing, compression member buckling, connection plate block shear, weld rupture, to name a few. If this pretest is done early enough (say 2-3 weeks before the regional competitions), this will allow the teams to modify their bridge accordingly and maybe even perform one last pretest.

What are the objectives of erection practice?

The goal is to optimize the competition construction score by developing the best procedure and construction team. The bridge may also be modified to improve performance.

What resources are needed for erection practice?

You will need space to accommodate the construction site specified in the Rules. This could be indoors or outdoors, with site details delineated by masking tape or chalk. Time is saved if those markings remain between practices. Students often use less frequented areas of parking decks, and practice until they are comfortable with their roles within the construction team.

Competition

What are the levels of competition?

There are two levels of the Student Steel Bridge Competition: Regional Events and the National Finals. The Regional Events typically take place in April and are held throughout the United States of America (USA). Teams are required to pre-register at aisc.org/ssbc by November 15 in order to compete in the Regional Event for the following year. Each confirmed participating school will be assigned to a local region. For the most up-to-date information on your Regional Event dates and locations, visit the Regional Events section of aisc.org/ssbc. Outstanding performance in Regional Events per the Rules qualifies eligible teams for the Student Steel Bridge Competition - National Finals.

If the team and I fly to the competition, how is the bridge transported?

TSA is suspicious of parts and tools in personal luggage, but the bridge and tools may accompany as air freight (verify this with the airline). Alternatively, the bridge and tools may be shipped by commercial carrier. Packing boxes can be constructed or purchased, but size and filled weight of each should be within the airline's or carrier's limits.

When not actively competing, what should the team do?

Observe bridges and erection procedures of other teams, and take notes and photographs. Aesthetics judging is a great time to see other teams' bridges up close and to talk to students from other teams.

SSBC was instructive and fun, and the team wants to compete again next year. How can their performance be improved?

Students who attended the competition and will participate next year have an advantage. In addition, the current team can assist its successor by documenting observations on design, fabrication, and erection. Most successful schools have members as young as freshmen or sophomores who will provide adequate continuity to the work that is being done from one year to another. Think early about who will lead next year's team and mentor them so that they have an understanding of all that is involved with the role. Rules change every year; the new version is usually published in August. The successor team should begin by carefully reviewing the new rules and the observations of the current team before beginning their design.