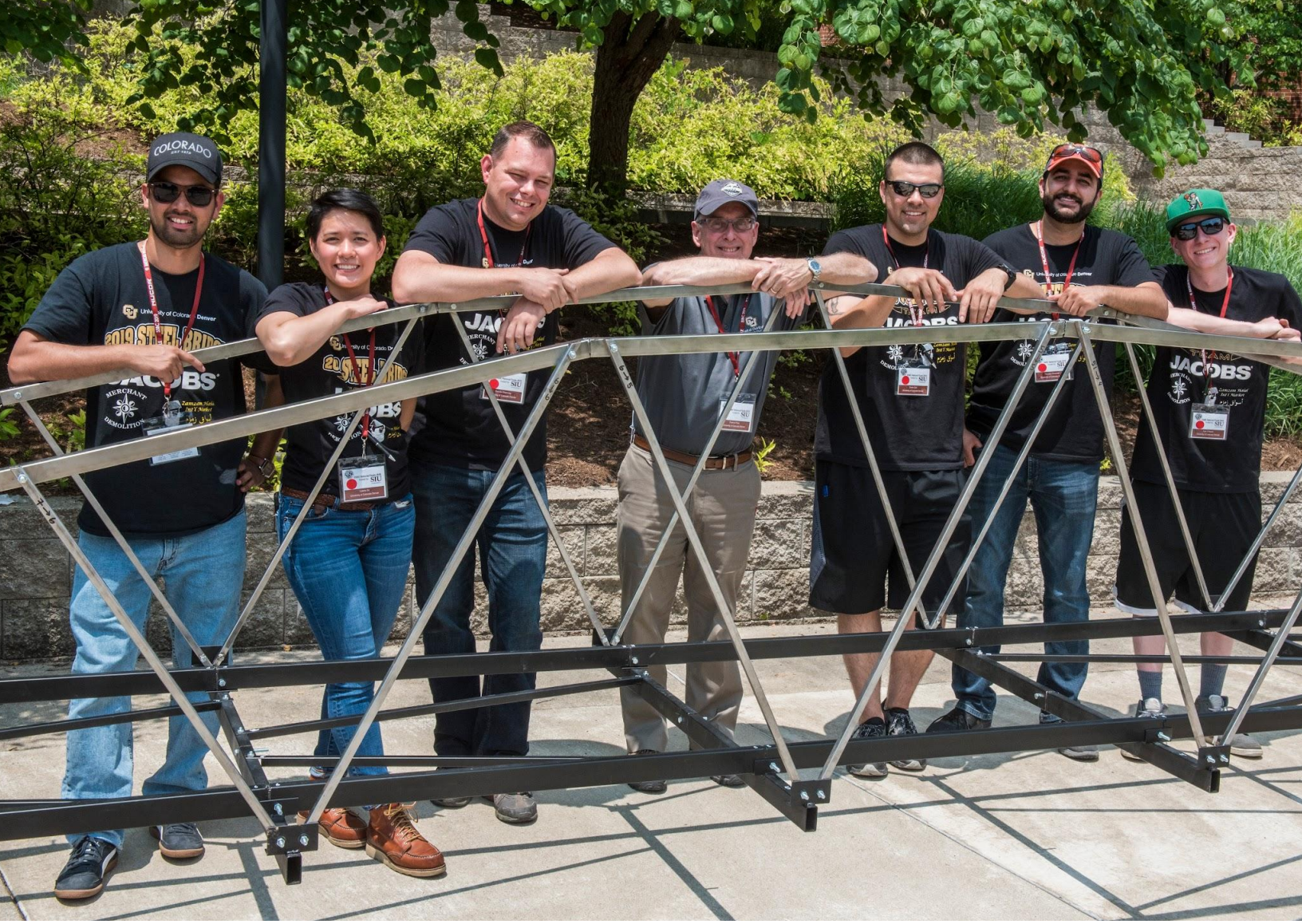

Student Steel Bridge Competition

Faculty Advisor Guide

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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.

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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 official clarifications, along with a competition guide for participants, details about the regional competitions 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" 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 construction 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 Competitors Guide, 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, construction practice, and culminating in competition.

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. Note that there are eligibility requirements based on participation as ASCE student chapters and AISC student clubs.

Does the team need to be part of an ASCE student chapter to participate?

To be eligible for full participation in the regional competitions (and thus to be eligible for advancement to the national finals) -- yes. The ASCE student chapter must be located in North America and be in good standing with ASCE (i) prior to the competition through annual dues payments and submission of a full Annual Report and (ii) at the conclusion of the competition through good faith participation in the annual Student Conference Business Meeting and the Student Symposium Paper Competition.

What if my school does not have an ASCE student chapter?

The team may be eligible to participate as a guest competitor in the regional competitions, either as an AISC Student Club or as a school that has submitted a *Statement of Intent to Establish an ASCE Student Chapter* to ASCE. Schools with ASCE student chapters located outside of North America would also be considered guest competitors. Note that any guest participation is at the discretion of the host school and ASCE, and guest competitors are not eligible to advance to the national finals.

What exactly is an AISC Student Club?

College-level students are 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 the SSBC. For more information or to apply for AISC Student Club status, visit aisc.org/studentclubs.

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 the statement on diversity and inclusion.

Do you have any suggestions regarding fundraising?

Yes, there are numerous ways to start fundraising. Eligible teams in the U.S. will receive a $750 SSBC Participating Team Stipend from AISC in support of SSBC activities. (ASCE provides stipends to eligible teams that are located outside of the U.S.) 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.

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 construction 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.

We have also partnered with the Ironworker Management Progressive Action Cooperative Trust (IMPACT), and IMPACT facilities across the country are opening their doors to support SSBC teams. Local IMPACT facilities may be able to provide welding and other fabrication skills training, provide space and access to tools for fabrication, and/or allow the team to practice constructing their bridge. Learn more at aisc.org/ssbc-impact.

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

Yes! AISC has a strong fabricator membership who are always looking to support students. If you would like assistance with securing partnerships with local fabricators, complete this fabricator partnership request form. AISC will provide you with a list of contact information for AISC Member Fabricators in your area, as well as a letter template to assist in your solicitation request.

Where can my team find additional mentors for the structural design aspect?

Practicing structural engineers can be a great resource for consultation on the design and analysis of the bridge. Check with your school's alumni, especially those who participated in the SSBC as a student. AISC has also partnered with the National Council of Structural Engineers Associations (NCSEA), which comprises 44 structural engineering associations throughout the United States. Each structural engineering association has a delegate that can help local SSBC teams find a mentor. Visit aisc.org/ssbc-ncsea to learn more and to request the contact list.

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

If you have questions about the regional competitions that are hosted in conjunction with ASCE Student Symposia, contact ASCE at student@asce.org.

Contact AISC at universityprograms@aisc.org with questions about the general program, fabricator partnerships, and team and faculty resources. AISC can also answer questions about the national finals.

Any questions specifically about the *Rules* are reviewed by the Rules Committee and must be submitted using the official form on the SSBC Rules and Clarifications page.

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 construction 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. Refer to the SSBC Safety Awareness Guide for Fabrication for additional general guidelines to consider when planning for the safety of students.

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 construction practice.

Load Testing and Construction 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.

In 2021, SSBC teams competed from the safety of their own campuses in light of the COVID-19 pandemic. The *2021 Compete from Campus Guidelines* contain some helpful information about options for loading materials (specifically pages 5-6). Additionally, this webinar about the 2021 Compete from Campus option provides examples and more information about the load tests (between 14:45-20:15 of the recording). Note that the actual *Rules* and loading locations may vary from the current year, but the overall concepts for vertical and lateral load testing will be the same.

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 construction 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 construction 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 competitions and the national finals. The regional competitions typically take place in April and are held throughout North America. For the most up-to-date information on the dates and location of your regional competition, visit the regional competitions section of aisc.org/ssbc. Outstanding performance in regional competitions per the *Rules* qualifies eligible teams for the 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 construction 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 construction. 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. The *Rules* change every year; the new version is usually published in August or September. The successor team should begin by carefully reviewing the new rules and the observations of the current team before beginning their design.