Student Steel Bridge Competition
2020 Rules
WELCOME

This document, which is available at www.aisc.org/ssbc, describes the Student Steel Bridge Competition (SSBC) and states the 2020 rules for both the Regional Events and National Finals. Clarifications, which include any revisions to the rules, are published at www.aisc.org/ssbc and do not appear in this document although they are formal addenda to the rules. The website includes the form for requesting clarifications and other information. Information at the website takes priority over any other source except as herein noted. Cover Image taken by T. Bart Quimby. Rules Revision 1 published August 15, 2019.

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GLOSSARY

Accident. Fault committed during timed construction and subsequently penalized.

Aesthetics. Award category based on the presentation of the bridge exactly as it will be erected during timed construction with all parts of the assembled bridge visible for judging and the poster describing the design.

Aggregate deflection. The sum, rounded to the nearest 0.01 inch, of the absolute values of deflections measured at \( D_1 \) and \( D_2 \).

Assembled Tool. A tool that is created by combining two or more tools during timed construction.

Bolt. An unaltered, commercially available rigid connector that contains a head and has external threads around its full circumference, but the threads need not extend over its full length.

Box. A right-rectangular prism made out of non-deformable material that is used to measure the maximum allowable size of tools and members.

Bridge. Structure constructed of members, loose bolts, and loose nuts that spans the river and is supported by piers.

Builder. Undergraduate or graduate student who constructs the bridge and is part of a competing team. See Section 4, “Eligibility”.

Captain. One builder designated to represent the team for the entire competition, and who signifies when the builders are ready to start timed construction, declares the finish of timed construction, and signs the data forms.

Constructed portion. Two or more members in contact with one another, with or without loose nuts and loose bolts, and is assembled during timed construction by builders on the ground in the construction zone.

Construction cost. Dollar amount used to determine a bridge’s construction economy based on the number of builders, construction time, total time and load test penalties.

Construction economy. Award category based on construction cost.

Construction site. The location where all construction activities occur comprising the river, construction zones, transportation zones and the staging yards.
Construction speed. Award category based on the total time required for construction modified by construction penalties.

Construction time. Time required to complete construction of the bridge without consideration of construction penalties.

Construction zone. Location in the construction site where builders put the members together to construct the bridge.

D1, D2. Locations where the vertical deflections are measured during vertical load testing.

Data form. Forms printed from the official scoring spreadsheet used by judges to record data collected for each team throughout the competition.

Decking. Grating that spans transversely between stringers and is used to hold load placed on the bridge.

Deflection. Vertical translation of the bridge or parts of the bridge under load.

East end. End of the bridge designated by a random process after construction (e.g., coin flip) from which L1, L2 and S are measured.

Footing. Areas marked on the ground within the construction zones where the bridge may contact the ground.

Ground. Floor inside the site boundary, including footings, construction zones, transportation zones, and staging yards, but excluding the river.

Guest team. A team from a school that is not eligible to compete per section 4.3.2, but has obtained the approval of AISC and the Regional Event host school to participate.

Head Judge. Person with full authority over the conduct of the competition, safety and interpretation of the rules.

Judge. Person who assists the head judge with the conduct of the competition, safety and interpretation of the rules.

L1, L2. Dimensions for positioning decking units for the vertical load test that also define locations of observed deflection and sway during the vertical load test.

Lateral restraint. Means of inhibiting sliding of the bearing surfaces during lateral loading applied by the loading crew.

Lightness. Award category based on the total weight of the bridge.
Load. Weight applied to the bridge to assess its stiffness and strength.

Loose bolt. Bolt not installed in or welded to the constructed portion of the bridge.

Loose nut. Nut not installed on a bolt or welded to the bridge.

Measured weight. The weight of the bridge, not including decking, tools, lateral restraint devices, and posters, as determined by scales provided by the host school.

Member. A rigid component of the bridge.

North side. Side of the bridge relative to the east end that corresponds to the location where measurement D2 is taken and sway is observed during vertical loading.

Nut. A commercially available, mechanically unaltered portion of a connector that has the shape of a hexagonal prism over its full length and contains internal threads around its full circumference over its full length.

Overall performance. Overall award category based on the sum of construction cost, structural cost, and any fines incurred as a violation of a Team Contract.

Personal protective equipment. An article of clothing that a team provides for safety.

Poster. Informative flat display that must be posted and is judged during aesthetics judging.

Pouch. Optional article of clothing that is used to carry nuts, bolts, and tools and includes tool belts, magnets, lanyards, and other accessories worn by builders having the same function.

River. A restricted natural feature in the construction site that builders are not allowed to enter.

S. Dimension for positioning the decking unit for the lateral load test that also defines the location where lateral load is applied and sway is measured during the lateral load test.

Safety. Prevention of personal injury and damage to the competition location.

Safety supports. Equipment provided by the host school used to limit the consequences of a bridge collapsing.

Scales. Calibrated equipment provided by the host school used to measure the measured weight of the bridge.

School. College or university that a student team represents.
Scoring spreadsheet. Official location where a team’s score is input by the scoring official at the end of the team’s competition.

Site boundary. Border of the construction site.

South side. Side of the bridge relative to the east end that corresponds to the location where the lateral load is applied and sway is observed during lateral loading as well as where measurement D1 is taken during vertical loading.

Staging yard. Location within the construction site occupied by builders, tools, and materials at the start and finish of timed construction.

Steel. Iron alloy that is strongly attracted to the magnet provided by the host school.

Stiffness. Award category based on the bridge’s aggregate deflection under vertical loading.

Stringer. Contiguous decking support aligned longitudinally along the bridge.

Structural cost. Dollar amount used to determine a bridge’s structural efficiency based on its total weight, measured weight, aggregate deflection, and load test penalties.

Structural efficiency. Award category based on structural cost.

Sway. Horizontal translation of the bridge.

Team. Group of students from the school that they are representing who are undergraduate or graduate students during all or part of the fall through spring of the current competition academic year.

Template. Equipment provided by the host school to measure clearances within the passageway of the bridge.

Tool. A device provided by a team that is used during construction of the bridge, but is not part of the completed bridge.

Total time. Time required for construction modified by construction penalties.

Total weight. Sum of measured weight and weight penalties.

Transportation zone. Portion of construction site between the construction zones and staging yards over which builders carry members, tools, nuts, and bolts.

West end. End of the bridge that is opposite the east end of the bridge.
Section 1
MISSION AND SUMMARY

VISION
Empower students to acquire, demonstrate, and value the knowledge and skills that they will use, as the future generation of design professionals, to contribute to the structural steel design community and construction industry in the United States.

MISSION
Challenge students to extend their classroom knowledge to a practical and hands-on steel design project that grows their interpersonal and professional skills, encourages innovation, and fosters impactful relationships between students and faculty, and students and industry professionals.

SUMMARY
Civil Engineering students are challenged to an intercollegiate competition that supplements their education with a comprehensive, student-driven project experience from conception and design through fabrication, erection, and testing. This experience culminates in a steel structure that meets client specifications and optimizes performance and economy. The Student Steel Bridge Competition increases awareness of real world engineering issues such as spatial constraints, material properties, strength, serviceability, fabrication, erection processes, safety, aesthetics, project management, and cost. Success in competition requires application of engineering principles and theory, and effective teamwork. Future engineers are stimulated to innovate, practice professionalism, and use structural steel efficiently.

Students design and erect a steel bridge by themselves but may consult with faculty and other advisors. Students gain maximum benefit if they fabricate the entire bridge themselves. However, because appropriate shop facilities and supervision are not available at all schools, students may use the services of a commercial fabricator if they develop the work orders and shop drawings and observe the operations. Students are encouraged to maximize their involvement in fabrication.

Safety is paramount. AISC requests that competitors, advisers, hosts, and judges take all necessary precautions to prevent injury to competitors, judges, host personnel, and spectators. Risky procedures are prohibited. Load testing is stopped if sway or deflection exceeds specified limits, or if collapse is imminent. Bridges that cannot be constructed and loaded safely are withdrawn from competition and are only eligible for awards in aesthetics. In addition, the rules identify and penalize construction errors that represent accidents in full-scale construction.
The Student Steel Bridge Competition provides design and management experience, opportunity to learn fabrication processes, and the excitement of networking with and competing against teams from other schools.

The competition has a long-established tradition of ethical behavior, professionalism, civility, and respect for people and property. Teams, their associates, judges, and all other participants are expected to maintain and build upon this tradition.

**STATEMENT ON INCLUSION**

AISC supports and encourages the equitable opportunity for participation in the Student Steel Bridge Competition (SSBC) by all interested and eligible individuals without discrimination based on race; color; religion or faith; sex; gender identity or expression; sexual orientation; age; national origin; disability status; citizenship status; socio-economic background; genetics; protected veteran status; or any other characteristic protected in accordance with applicable federal, state, and local laws. Participation should be inclusive, open, and fair to all interested and eligible students.
Section 2
INTRODUCTION

The rules simulate a request for proposal that requires a scaled model to demonstrate the efficacy of competing designs. Section 3, “Problem Statement,” relates the rules to realistic challenges encountered in bridge design and construction.

Sections titled “Material and Component Specifications,” “Structural Specifications,” and “Construction Regulations” set standards for strength, durability, constructability, usability, functionality, and safety that reflect the volumes of requirements that govern the design and construction of full-scale bridges. Criteria for excellence in the award categories of stiffness, lightness, construction speed, aesthetics, structural efficiency, and construction economy are listed in “Scoring.” Competition judges and the SSBC Rules Committee take the role of the owner or owner’s agent and have authority to accept and reject entries.

The rules accommodate a variety of designs and encourage innovation. Designers must consider the comparative advantages of various alternatives. For example, a through truss bridge may be stiffer than a deck bridge but slower to construct. Successful teams compare alternatives prior to fabrication using value analysis based on scoring criteria. The rules are changed every year to renew the challenge and ensure that competitors design and build new bridges.

The rules are intended to be prescriptive but may require interpretation. The procedure for requesting clarification of the rules is described in Section 13, “Interpretation of Rules.” Competitors, judges, and host personnel are encouraged to read this rules document from beginning to end and then review the Host and Participant Guides at www.aisc.org/ssbc. That site also is the source of the official scoring spreadsheet which generates data forms for recording data. Judges should be familiar with those data forms prior to competition.

Results of the previous year’s National Finals are posted at www.aisc.org/ssbc.

Members of the Student Steel Bridge Competition Rules Committee are

- Christopher Garrell, P.E., Chief Bridge Engineer, NSBA
- Christina Harber, S.E., P.E., Director of Education, AISC
- Lawrence F. Kruth, P.E., Vice President of Engineering and Research, AISC
- Joel Lanning, Ph.D., PE., Asst. Professor of Teaching, University of California, Irvine
- Jason McCormick, Ph.D., P.E., Assoc. Professor, University of Michigan
- John M. Parucki, Structural Steel Consultant
- Craig Quadrato, Ph.D., P.E., Senior Associate, Wiss, Janney, Elstner Associates
- Matthew Schultz, S.E., P.E., Wallace Engineering Structural Consultants
- Kimberly Stillmaker, Ph.D., Asst. Professor, California State Univ., Fresno
Section 3
PROBLEM STATEMENT

The Katy Trail State Park, located in Missouri, contains a recreational rail trail that runs along the former corridor of the Missouri-Kansas-Texas Railroad. The state park and trail offer opportunities for walkers, joggers, bicyclists, and equestrians to enjoy while stretching 240 miles between Clinton, MO and Machens, MO, much of which follows the Missouri River. Along the trail are a number of historic steel bridges such as the Lamine River Bridge, a through truss bridge built in 1910, and the Rivaux Creek Bridge, a parker pony truss bridge built in 1896, which serviced the railroad prior to the establishment of the Katy Trail State Park.

Historic floods along the Missouri River during the spring and summer of 2019 associated with heavy winter snowpack in the upper midwest and above average precipitation have led to a wash out along the Katy Trail. In order to maintain the functionality of the trail for all users, a steel bridge to cross a new waterway created by the flooding is proposed. Steel is chosen as the structural material because of its versatility, ease of prefabrication, ability for rapid erection, superior strength to weight ratio, durability, and high level of recycled content. Due to the configuration of the existing trail and the location of the new waterway, the bridge must be skewed with the new waterway running parallel to the skew.

A feasibility study is being conducted that includes a competition to identify the best design for the limited access bridge. Your company is invited to compete by submitting a 1:10 scale model to demonstrate its concept. The bridge must have the ability to support pedestrians, bicyclists, equestrians, park vehicles, and emergency vehicles. Private motor vehicles are prohibited. Scale models will be erected under simulated field conditions and will be tested for stability, strength, and serviceability using standardized lateral and vertical loads. Structural cost, construction cost and duration, and aesthetics are important considerations. Virtual costs are assigned to critical features, including a sliding scale for material that promotes robustness without wastefulness. Engineers associated with the park will judge the competition and will award the design/build contract to the company whose model satisfies specified requirements and best achieves the project objectives.

Designs with permanent or temporary piers in the river will not be considered. Soil conditions near the banks of the river also preclude temporary piers elsewhere, as well as restricting the location of footings and the size of construction zones. Remote staging of material and equipment is required and the size and quantity of members to be transported is limited. Models will not include deck, foundations, and approaches.

Design companies are encouraged to create diverse teams and treat everyone with respect. 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.

Any attempt to gain advantage by circumventing the intent of the competition as expressed by the rules, including this problem statement, will be grounds for rejecting a model and terminating that company’s eligibility.
Section 4
ELIGIBILITY

4.1 REQUIRED CONDUCT

All competition participants shall act professionally and respectfully at all times. Failure to act appropriately can result in letters of reprimand, mandatory behavior management plans, and loss of invitations to future competitions for individual institutions.

4.2 LEVELS OF COMPETITION

There are two levels of the Student Steel Bridge Competition: Regional Events and the National Finals. The Regional Events are held throughout the United States of America (USA). Schools shall pre-register at www.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. Outstanding performance in Regional Events, and only participation in those events, qualifies eligible teams for the Student Steel Bridge Competition National Finals.

4.3 REGIONAL EVENTS

4.3.1 Only one bridge per school may compete in a Regional Event, and a school may compete in only one Regional Event.

4.3.2 A school is eligible to compete if it has an ABET accredited engineering program and is licensed or chartered in the USA or a territory of the USA.

4.3.3 A team shall consist only of undergraduate and graduate students enrolled at the school for which they are representing during all or part of the fall through spring of the current competition academic year.

4.3.4 The official scoring spreadsheet shall be used, and all teams shall be listed on that spreadsheet. The official scoring spreadsheet may be downloaded from www.aisc.org/ssbc.

4.3.5 The host school shall promptly submit scans of the individual team’s data forms and the completed official scoring spreadsheet file for the Regional Event to ssbcscorekeeper@aisc.org. Teams from that Regional Event will not be invited to the Student Steel Bridge Competition National Finals until the data forms and scoring spreadsheet file are received and eligibility is confirmed.
4.4 NATIONAL FINALS

4.4.1 A team is eligible to be invited to compete in the National Finals if it is ranked for all awards at its Regional Event.

4.4.2 The maximum number of eligible teams from a Regional Event that will be invited to compete in the National Finals is based on the number of non guest teams at that Regional Event that competed (that is, presented bridges and staged them for timed construction).

(1) The single eligible team with the best overall performance rating will be invited from a Regional Event in which two to five teams competed.

(2) The top two eligible teams in overall performance will be invited from a Regional Event in which six to eleven teams competed.

(3) The top three eligible teams in overall performance will be invited from a Regional Event in which twelve to seventeen teams competed.

(4) The top four eligible teams in overall performance will be invited from a Regional Event in which eighteen or more teams competed.

4.4.3 A team competing at the National Finals shall consist only of undergraduate and graduate students who were enrolled at the school for which they are representing during all or part of the academic year leading up to the National Finals.

4.4.4 Bridges may be modified in preparation for National Finals.
Section 5
SAFETY

Safety has the highest priority; risk of personal injury will not be tolerated. Judges are empowered to halt and prohibit any activity that they deem to be hazardous. If a bridge cannot compete safely, it must be withdrawn from competition.

Sub-Sections 9.4, 9.5, 10.2, 10.3, 11.1, 11.2, and 11.5.2 of these rules identify hazardous conditions and actions that will result in withdrawing a bridge from competition if not corrected. Judges will document these safety violations by checking the appropriate boxes on the data forms. If the problem is not listed, a judge should write a brief description of the problem on the data form.

Students are requested to practice safe fabrication procedures and seek appropriate instruction and supervision. The Sub-Section 8.2 footnote warns of a welding hazard, and precautions listed in Sub-Sections 11.1, 11.2, 11.5.1.2, and 11.5.2 guide safe load testing prior to competition.
Section 6
SCORING

6.1 RECORDING DATA, ANNOUNCING RESULTS, SUBMITTING SCORES

Scoring data shall be recorded for every team that competes, using the data forms printed from the official scoring spreadsheet downloaded from www.aisc.org/ssbc. Data from those forms are then entered in the scoring spreadsheet. After all scoring information has been collected for a team, the scoring official reviews each data entry with the captain of that team. The captain is given adequate time to verify the data before signing the form. Then a paper or electronic copy of the team’s “Computation” worksheet from the scoring spreadsheet is given to the captain, as soon as possible.

Formulas and links in the scoring spreadsheet shall not be modified.

The “Rankings” worksheet from the spreadsheet summarizes the performance of all teams and is distributed at the awards ceremony, electronically or as paper copies.

Scans of the individual team’s data forms and the completed official scoring spreadsheet file for a Regional Event shall be submitted to ssbcscorekeeper@aisc.org by the host school as soon as possible after the competition. Regional Event results are not final until the data forms and scoring spreadsheet file are submitted. Questions and comments regarding the spreadsheet should be sent to ssbcscorekeeper@aisc.org.

The original data forms shall be retained by the Regional Event host school until the scanned files are submitted and a confirmation email is received indicating that the hard copies are no longer needed.

6.2 COMPETITION CATEGORIES

Competition categories are aesthetics, construction speed, lightness, stiffness, construction economy, and structural efficiency. In addition, overall performance is rated.

6.2.1 Aesthetics

An award is given for aesthetics. All bridges presented for aesthetics judging and staged for timed construction are eligible for this award. The bridge’s appearance and a poster describing the bridge design contribute to the Aesthetics ranking. Aesthetics is judged by the following criteria.
6.2.1.1 Bridge appearance.

6.2.1.1.1 The bridge appearance includes its balance, proportion, elegance, and finish. Fabrication quality, including welding, shall not be considered because some bridges may be fabricated professionally rather than by students.

6.2.1.1.2 The bridge is presented exactly as it will be erected during timed construction and all parts of the assembled bridge must be visible during aesthetics judging.

6.2.1.1.3 Permanent identification of the bridge consisting of the school’s name is required. The name shall be formed from steel or applied to steel with paint or decals and should be easily legible (lettering at least 1” high is recommended). A bridge that lacks appropriate identification will receive a very poor aesthetics rating.

6.2.1.2 Poster describing design.

6.2.1.2.1 The poster shall present the following

(1) identification of the school, using the same name that appears on the bridge,
(2) brief explanation of why the overall bridge configuration was selected,
(3) scaled, dimensioned side view of the bridge,
(4) free-body diagram of a single beam that represents one of the bridge stringers, with the same end-to-end length, supports at appropriate locations to represent the piers, loads for one of the cases specified in Sub-Sections 7.1(7) and 11.5, and reaction forces,
(5) shear and moment diagrams of the beam corresponding to the free-body diagram, showing peak magnitudes,
(6) brief explanation of the team’s use of Accelerated Bridge Construction (ABC), such as design features, construction sequencing, and procedures intended to minimize construction time, or Lean Construction, such as reduced or eliminated unnecessary movement, inventory, waiting during production, and scrap, and
(7) acknowledgement of the school’s technicians, faculty, and others who helped fabricate the bridge or provided advice.

6.2.1.2.2 The poster shall

(1) be flat with maximum dimensions of two by three feet,
(2) present all information on one side,
(3) not have attached pages that must be lifted or turned, and
(4) be in English.
6.2.1.2.3 Additional information may be included on the poster. Names of financial sponsors may be shown on the *poster* or on an optional second *poster* that can accommodate their logos. The additional information or second poster will not factor into *aesthetics* judging.

6.2.1.2.4 The *aesthetics* rating will be very poor if there is no *poster* or if it is grossly inadequate. The *poster* is not part of the *bridge* but must be displayed during *aesthetic* judging. The *poster* and its contents only will be judged. Supports used for the *poster* will not be considered in judging the *poster*.

6.2.1.2.5 If English is not the dominant language where the competition is conducted, an optional additional *poster* may be displayed that is a translation into the local language of the required English language design *poster*.

6.2.1.3 *Aesthetics* is the tie breaker for all competition categories. *Judges* shall not declare ties in *aesthetics*.

6.2.2 Construction Speed

The *bridge* with the lowest *total time* will win in the *construction speed* category. *Total time* is the time required for construction modified by construction penalties prescribed in 9.4, 10.4.2, 10.4.3, 10.8.1, and 10.9.3. There is an upper limit on construction time (see 10.8.2).

6.2.3 Lightness

The *bridge* with the least *total weight* will win in the *lightness* category. *Total weight* is *measured weight* plus weight penalties prescribed in 8.2, 9.3, and 10.4.2. *Decking, tools, lateral restraint* devices, and *posters* are not included in *measured* or *total weight*.

6.2.4 Stiffness

The *bridge* with the lowest *aggregate deflection* will win in the *stiffness* category. *Aggregate deflection* is determined from measurements as prescribed in 11.5.

6.2.5 Construction Economy

The *bridge* with the lowest *construction cost* ($C_c$) will win in the *construction economy* category. *Construction cost* is computed as

$$C_c = \text{Construction time (minutes)} \times \text{number of builders (persons)} \times 70,000 ($/person-minute) + (\text{Total time} - \text{Construction time}) \times 240,000 ($/minute) + \text{load test penalties ($).}$$

*"Load test penalties" are prescribed in 11.5.2. A penalty increment to the number of *builders* is prescribed in 10.4.1.*
6.2.6 Structural Efficiency

The bridge with the lowest structural cost ($C_s$) will win in the structural efficiency category. Structural cost is computed as

\[
C_s = \begin{cases} 
(Total \ weight - Measured \ weight) \times 5,000 \ ($/pound) \\
+ Aggregate \ deflection \ (inches) \times 3,150,000 \ ($/inch) \\
+ Load \ test \ penalties \ ($)
\end{cases}
\]

If measured weight does not exceed 175 pounds,

\[
C_s = \begin{cases} 
(Measured \ weight - 175) \times 8,000 \ ($/pound) \\
+ (Total \ weight - Measured \ weight) \times 5,000 \ ($/pound) \\
+ Aggregate \ deflection \ (inches) \times 3,150,000 \ ($/inch) \\
+ Load \ test \ penalties \ ($)
\end{cases}
\]

If measured weight exceeds 300 pounds,

\[
C_s = \begin{cases} 
(Measured \ weight - 237.5) \times 16,000 \ ($/pound) \\
+ (Total \ weight - Measured \ weight) \times 5,000 \ ($/pound) \\
+ Aggregate \ deflection \ (inches) \times 3,150,000 \ ($/inch) \\
+ Load \ test \ penalties \ ($)
\end{cases}
\]

Section 11.5.2 prescribes “load test penalties.”

6.2.7 Overall Performance

The overall performance rating of a bridge is the sum of construction cost $C_c$, structural cost $C_s$ and any fines incurred as a violation to a Team Contract (Student Steel Bridge Competition National Finals only). The bridge achieving the lowest value of this total wins the overall competition.

6.3 SPREADSHEET FOR SCORING

The scoring spreadsheet is available at www.aisc.org/ssbc. Questions and comments regarding the spreadsheet should be sent to ssbcscorekeeper@aisc.org. The spreadsheet also is useful for comparing alternatives when designing a bridge. Teams are encouraged to download, understand, and verify the spreadsheet before the competition.

6.4 SPECIAL AWARDS

In addition to the competition category awards, special awards are given to eligible participating teams. These awards do not factor into the category scores or overall performance rating of a bridge as defined in 6.2.7.

6.4.1 SSBC Team Engagement Award

The SSBC Team Engagement Award is presented to a team that demonstrates an outstanding commitment to building a diverse team, creating an inclusive environment,
and appreciating the value of remarkable individuals working together to succeed. The basis for this competition is a one- to two-page written narrative that details how the team benefited from its efforts toward equity and diversity during recruiting, training, and while working together to design and create the best bridge they can.

All teams that compete at a Regional Event are eligible for this award; participation is not mandatory. Additional information on this award and the submission form can be found at [www.aisc.org/ssbc](http://www.aisc.org/ssbc). Entries must be received before 5:00 PM Eastern Daylight-Saving Time, May 4, 2020 to be considered. The winner will be selected by the Rules Committee and announced at the National Finals.

6.4.2 Robert E. Shaw, Jr. Spirit of the Competition Award

The award is named for Robert E. Shaw, Jr. who founded the Student Steel Bridge Competition in the spring of 1987 as a means of challenging university and college students to use their engineering skills to design, fabricate, construct and test a scaled-version of a steel bridge in a friendly competition.

The Robert E. Shaw, Jr. Spirit of the Competition Award is presented to a team that demonstrates outstanding team comradery, professionalism, positive work ethic and respect for their competition peers.

All teams that compete at the National Finals are eligible for this award.

6.4.3 Frank J. Hatfield Ingenuity Award

The award is named for Frank J. Hatfield who was the Chair of the Student Steel Bridge Competition Rules Committee during its first three decades of existence. He was responsible for orchestrating the many evolutions of the rules since the first Student Steel Bridge Competition in 1992 and was involved in the competition from its inception.

The Frank J. Hatfield Ingenuity Award is presented to a team that shows the most engineering ingenuity in the design and/or construction of their bridge based on the requirements of the competition rules.

All teams that compete at the National Finals are eligible for this award.
Section 7
SCHEDULE OF COMPETITION

In the months before the competition, students design their bridges, fabricate members, test load, designate the competition team, and practice construction. The regional host school procures a venue, organizes equipment (Section 12), and recruits judges (Section 14). Judges are prepared by reviewing the current rules and all clarifications (Section 13). Clarifications, some of which may have been posted immediately prior to the competition, are found at www.aisc.org/ssbc.

7.1 RECOMMENDED SCHEDULE

(1) The official scoring spreadsheet is downloaded from www.aisc.org/ssbc, and data forms are generated from that spreadsheet.

(2) Using a random process, the head judge or host school determines the order in which teams will compete.

(3) The head judge conducts a meeting with the other judges to clarify any rules concerns and to inspect the construction and loading facilities.

(4) Bridges are erected for public viewing and are judged for aesthetics. After the start of aesthetics judging, bridges shall not be altered, modified, or enhanced in any way.

(5) Bridges are disassembled.

(6) In a meeting at which all captains are present, the head judge clarifies rules and conditions of the competition, and answers questions.

(7) Immediately before timed construction of the first bridge, the head judge rolls a die to determine the locations of decking units and where the lateral load will be applied. These designations will guide load tests as described in 11.4.1, 11.5.1, and the Lateral and Vertical Load Test Plan Diagrams. For each possible result of the roll (N), Table 7.1 gives the dimensions for positioning decking units and locations where the lateral and vertical load is applied and vertical deflection and sway are measured.

TABLE 7.1 Determination of $L_1$, $L_2$, and $S$

<table>
<thead>
<tr>
<th>N</th>
<th>$L_1$</th>
<th>$L_2$</th>
<th>$S$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>8'-0&quot;</td>
<td>3'-0&quot;</td>
<td>9'-0&quot;</td>
</tr>
<tr>
<td>2</td>
<td>10'-0&quot;</td>
<td>4'-0&quot;</td>
<td>9'-0&quot;</td>
</tr>
<tr>
<td>3</td>
<td>11'-0&quot;</td>
<td>7'-0&quot;</td>
<td>9'-0&quot;</td>
</tr>
<tr>
<td>4</td>
<td>12'-0&quot;</td>
<td>3'-6&quot;</td>
<td>9'-0&quot;</td>
</tr>
<tr>
<td>5</td>
<td>12'-6&quot;</td>
<td>6'-0&quot;</td>
<td>9'-0&quot;</td>
</tr>
<tr>
<td>6</td>
<td>13'-0&quot;</td>
<td>8'-5&quot;</td>
<td>9'-0&quot;</td>
</tr>
</tbody>
</table>
The same values of $L_1$, $L_2$ and $S$ will be used for all bridges in the same Regional Event. The east end is determined individually for each bridge after construction by a randomizing process (e.g., coin flip).

(8) Bridge members, tools, nuts, and bolts are staged for construction and inspected by the judges. See Section 8, “Material and Component Specifications,” and Sub-Sections 10.2.3, 10.2.4, 10.2.5, and 10.6 for details.

(9) Timed construction. See Section 10, “Construction Regulations,” for details.

(10) Judges inspect assembled bridges. For details, see Section 9, “Structural Specifications.” Between corrections described in Section 9.4 and the start of load testing, force shall not be applied to the bridge except as necessary to move it. For example, leaning or sitting on the bridge is not allowed.

(11) Bridges are weighed (if it is impractical to weigh the entire bridge, its individual parts may be weighed). All bridges shall be weighed, including those that fail as well as those which are withdrawn from competition and not eligible for all awards.

(12) Bridges are load tested. See Section 11, “Load Test Instructions,” for details.

(13) Data entry is conducted. After a team has completed all phases of the competition, data for the team is transcribed from the data forms into the official scoring spreadsheet and checked by the captain. After data entry has been completed, a copy of the team’s “Computation” worksheet from the scoring spreadsheet is given to the captain electronically or on paper.

(14) Scores and rankings are determined using the official scoring spreadsheet.

(15) Paper or electronic copies of the “Rankings” worksheet of the official scoring spreadsheet are distributed to captains of all teams at the awards ceremony.

(16) The host school submits scans of the individual team’s data forms and the completed official scoring spreadsheet file by emailing them to ssbcscorekeeper@aisc.org as soon as possible after completion of the competition.

(17) The host school retains data forms until a confirmation email has been received.

7.2 ALTERNATIVES

The order recommended above may be altered. However, it is essential that

(1) Bridges are not modified after the die is rolled.
(2) Bridges are not modified between aesthetics judging and timed construction.
(3) No components or tools are added to or removed from the construction site after staging for inspection.
(4) Modifications between timed construction and load testing are limited to connection corrections described in Sub-Section 9.4.
Section 8
MATERIAL AND COMPONENT SPECIFICATIONS

8.1 MATERIAL

Some grades of steel are not magnetically attractive. If any member, nut, or bolt is not strongly magnetic steel or incorporates parts that are not strongly magnetic steel, the bridge will not be eligible for awards listed in Section 6.2, except for aesthetics. The bridge may be constructed and load tested at the head judge’s discretion if that can be done safely within available time. See Section 8.2 for specifications on “members”, “loose bolts”, “nuts” and “holes in members”.

8.2 COMPONENTS

Violation of the specifications in this Sub-Section (8.2) will result in penalties being added to the weight of the bridge. The penalty is 25 pounds for each individual noncompliant nut and loose bolt, and 35 pounds for each individual non-compliant member. See 8.2.2, 8.2.3, and 8.2.4 for specifications on “members”, “loose bolts” and “nuts”.

8.2.1 Bridge

A bridge shall be constructed only of members, loose bolts, and nuts. Solder, brazing, and adhesives are not permitted. Exceptions: Purely decorative items such as coatings and decals are permitted, and bridge parts may be labeled.

8.2.2 Members

8.2.2.1 Parts of a member are welded together. Bolts and nuts that are welded¹ to a member are threaded parts that are considered part of that member and are not considered to be loose bolts and loose nuts. A member shall retain its shape, dimensions, and rigidity during timed construction and load testing. A member shall not have moving or flexible parts. Exception: Deformations caused by mechanical strain (e.g., bending, stretching) during construction and load testing are not violations.

¹ Health advisory: The bright silvery or colored coating on bolts, nuts, threaded rods, and other hardware contains zinc and cadmium. At welding temperature, both elements create hazardous fumes. Inhalation of zinc fumes causes symptoms resembling those of influenza. Cadmium gas can damage lungs and kidneys and is a potential carcinogen. Only plain (uncoated) hardware should be welded.
8.2.2.2 All members shall fit into a right rectangular prism (i.e., box) of dimensions of 3'-6" x 6" x 4".

8.2.2.3 Threads shall be continuous around the full circumference of an externally threaded part of a member if that part is necessary for compliance with Sub-Section 9.4.1.

8.2.3 Loose Bolts

8.2.3.1 Loose bolts shall not have parts that flex or move. Loose bolts shall be commercially available, have a head, and shall not be mechanically altered or modified in any way but may be painted.

8.2.3.2 Nominal length of loose bolts shall not exceed 3” measured from the bottom of the head to the end. Loose bolts shall have external threads that extend around the full circumference, but need not extend over its full length.

8.2.4 Nuts

8.2.4.1 Nuts, whether loose or welded, shall have the external shape of a hexagonal prism over its full length and not have parts that flex or move. Nuts shall be commercially available and shall not be mechanically altered or modified in any way but may be painted.

8.2.4.2 Nuts shall have internal threads that extend for the full circumference over its full length.

8.2.5 Holes in Members

Holes for loose bolts or externally threaded parts of members shall not be threaded. Exception: A nut that is welded to a member and conforms to the specifications of Sub-Section 8.2.4 is not a violation.
Section 9
STRUCTURAL SPECIFICATIONS

9.1 MEASUREMENT

Conformance with the specifications in this section (9) will be checked with the bridge in its as-built condition after termination of timed construction and before the bridge is moved from the construction site or load tested. The bridge shall not be modified or distorted from its as-built condition in order to conform to these specifications except as prescribed by Sub-Section 9.4. Dimensions will be checked without decking or applied load. Judges may touch the bridge but shall not turn nuts or bolts or alter the condition of the bridge in any other way.

9.2 FUNCTIONALITY

If any specification in this sub-section (9.2) is violated, the bridge will not be eligible for awards in any category, except for aesthetics. The bridge may be load tested at the head judge's discretion if that can be done safely within available time.

9.2.1 The bridge shall have exactly two stringers, each of which is contiguous. Stringers shall extend from inside each footing on the west end to inside each footing on the east end for the north and south sides of the bridge. Sections of the stringer may be part of members that serve other functions in the bridge. See the Bridge Elevation Diagram.

9.2.2 The bridge shall provide access for safely placing 3’-6” wide decking and load along any point between the interior most footings of the bridge.

9.2.3 The decking shall not be attached or anchored to the bridge. This prohibition includes but is not limited to protrusions, irregularities, and textures that inhibit movement of decking relative to stringers.

9.2.4 Decking shall not distort the bridge from its as-built condition when positioned for lateral and vertical load testing.

9.2.5 The bridge shall not be anchored or tied to the floor.

9.2.6 Teams shall accept and bridges shall accommodate conditions at the competition site.
9.3 USABILITY

Specifications in this sub-section (9.3) are illustrated by the Bridge Elevation and Bridge Plan Diagrams.

A weight penalty will be assessed for each specification in this sub-section (9.3) that is violated, rather than for every violation of that specification. If there are multiple violations of the same specification, the penalty will be based on the largest violation.

The penalty for violation of each of the specifications in this sub-section (9.3) will be an addition to the weight of the bridge determined as follows:

1. 20 pounds for a dimensional violation not exceeding 1/4”,
2. 100 pounds for a violation greater than 1/4” but not exceeding 1”,
3. 200 pounds for a violation greater than 1” but not exceeding 2”
4. 400 pounds for a violation greater than 2” but not exceeding 3”, and
5. if a violation exceeds 3”, the bridge will not be eligible for awards in any category, except aesthetics. The bridge may be load tested at the head judge’s discretion if that can be done safely within available time.

9.3.1 The bridge shall not touch the river or the ground outside the footings except when the exception in Sub-Section 10.4.2 is invoked.

9.3.2 The bridge shall not extend more than 5'-0” above the ground or river.

9.3.3 The bridge shall not be wider than 5'-0” at any location along the span.

9.3.4 Vertical clearance shall be provided at all points directly over the ground and river. The clearance shall be no less than 7.5”, measured from the surface of the ground or river. Parts of the bridge, including nuts and bolts, shall not extend below this limit. Exception 1: No clearance is required for the portion of the bridge for which the exception in Sub-Section 10.4.2 is invoked. Exception 2: No clearance is required over the footings except as necessary to accommodate restraint applied during the lateral load test described in Sub-Section 11.4.1.

9.3.5 The tops of the stringers shall be no more than 1'-11” and no less than 1'-7” above the surface of the river or ground at any location along the span.

9.3.6 Each stringer shall be at least twenty feet long, measured along the top.

9.3.7 At the ends of the bridge, parts of the bridge shall not extend away from the river beyond the vertical planes that pass through the bridge envelope boundary shown on the Bridge Plan Diagram.

9.3.8 The bridge shall provide a straight, clear passageway conforming to the Clearance Template detail on the Bridge Elevation Diagram. To verify compliance with
9.3.8.1 and 9.3.8.2, judges will slide the **template** along the tops of the **stringers** while holding it plumb and perpendicular to the span of the **bridge**. The top of only one **stringer** will be in contact with the top of only one rabbet from the point of termination of the **stringer** in the innermost footing to the point of termination of the **stringer** in the outermost footing on the opposite side at each end of the **bridge**. If the same obstruction causes a violation of both 9.3.8.1 and 9.3.8.2, the **judge** will record only the larger violation.

**9.3.8.1** At no location along the full length of the **stringers** shall part of the **bridge**, including **nuts** and **bolts**, obstruct passage of the **template**. The measurement for non-compliance with 9.3.8.1 is the distance an obstruction projects onto the **template**, measured perpendicularly from the obstructed edge.

**9.3.8.2** The tops of both **stringers** shall contact the tops of the two rabbets in the **template** at every location along the length of the **stringers** between the ends of the north and south side **stringers** within the innermost footings during the verification procedure described in 9.3.8. The measurement for non-compliance with 9.3.8.2 is the vertical distance between the top of a rabbet and the top of the corresponding **stringer**.

9.3.9 Tops of **stringers** shall be free of holes, splits, separations, protrusions, and abrupt changes in elevation or slope, except that between adjacent **members** that comprise a **stringer** there may be a horizontal separation not exceeding 1/4” and a change in elevation not exceeding 1/8”.

### 9.4 CONNECTION SAFETY

After termination of timed construction and inspection by **judges**, **builders** are required to attempt to correct violations of specifications 9.4.1, 9.4.2, and 9.4.3, and will be granted the option to correct violations of specification 9.4.4. Only **tools**, **loose nuts**, and **loose bolts** that were in the **staging yards** at the start of timed construction shall be used. Safe construction practices (10.2 and 10.3) are required, but **accidents** (10.4) will not be penalized. **Builders** will be allowed five minutes to correct only those connections in violation of the rules that are identified by the **judges**. If any connection identified by the judges still violates specification 9.4.1, 9.4.2, or 9.4.3 when that time limit is reached, the **bridge** will not be eligible for awards in any category, except **aesthetics**, and will not be **load** tested. **Judges** may touch the **bridge**, **bolts**, and **nuts**, but shall not turn **nuts** or **bolts**, or alter the condition of the **bridge** in any other way.

**9.4.1** Each individual **member** shall be connected to each **member** that it touches by at least one **loose bolt** or externally threaded part of a **member** secured by a **loose** or welded **nut** so that those connected **members** cannot be separated without first unscrewing and removing the **loose bolt** or externally threaded **member** that connects them, or without first unscrewing and removing the **loose nut** from that **loose bolt** or externally threaded **member**. The **loose bolt** or externally threaded part of a **member** shall pass through holes in all the **members** that it connects. A **loose bolt** or threaded part of a
member may connect more than two members. **Penalty is five minutes added to construction time for each individual violation.**

9.4.2 Each individual loose or welded nut shall at least fully engage the threads of the matching bolt or externally threaded part of a member. That is, the terminal threads of the bolt or externally threaded part of a member shall extend beyond or be flush with the outer face of the nut. The threads of the nut shall match the bolt or externally threaded part of the member so that installation and removal require relative rotation. **Penalty is five minutes added to construction time for each individual violation.**

9.4.3 Each individual hole in a member for a loose bolt or externally threaded part of another member shall be completely surrounded by the member. Furthermore, such holes in the outer plies of a connection shall be small enough that the nut or bolt head cannot pass through. **Penalty is five minutes added to construction time for each individual violation.**

9.4.4 Each individual loose nut and loose bolt shall be tightened sufficiently so that the nut and bolt head contact the outer ply of the connection. **Penalty is one minute added to construction time for each individual violation regardless of whether the violation is corrected.** However, if a fastening consists of a loose nut on a loose bolt, only one penalty will be applied for that fastening.

9.5 INSPECTABILITY

Each individual nut, head of a loose bolt, and threaded end of a bolt or member shall be visible in the completed bridge so that compliance with specifications in Sub-Section 9.4 can be verified. **If any individual threaded end, nut, or bolt head cannot be inspected, the bridge will not be eligible for awards in any category, except aesthetics, and will not be load tested.**
Section 10
CONSTRUCTION REGULATIONS

10.1  GENERAL CONSTRUCTION REGULATIONS

10.1.1 The team designates one builder to serve as captain for the entire competition.

10.1.2 All construction activities are conducted within the site boundary. The host school marks the site boundary and its enclosed features on the floor before the competition, as illustrated by the Site Plan Diagram.

10.1.3 Builders on the ground in the construction zones put members together to assemble the bridge.

10.1.4 Builders carry members, tools, nuts, and bolts across the transportation zones.

10.1.5 Builders shall wear hardhats that meet ANSI standard Z89.1 and protective eyewear or safety goggles that meet ANSI standard Z87.1 as personal protective equipment during all construction activities.

10.1.6 There may be multiple constructed portions. If a member that is part of the constructed portion is removed from contact with the constructed portion, it becomes an individual member again.

10.2  PRE-CONSTRUCTION CONDITIONS

Timed construction will not commence if any provision of this subsection (10.2) is violated.

10.2.1 Only builders and judges are permitted within the site boundary during timed construction. Other team members and associates of the team, coaches, faculty, advisers, and spectators shall remain in designated areas at a distance from the construction site that assures they are not at risk and cannot interfere with the competition.

10.2.2 There shall be no more than six builders.

10.2.3 Welding machines and tools requiring external power connections shall not be used during timed construction. Tools powered by batteries or other internal energy supplies are acceptable.
10.2.4  A tool must not weigh more than twenty pounds and shall fit within a right rectangular prism (i.e., box) of dimensions of 3'-6" x 6" x 4". During timed construction, multiple tools may be combined to form an assembled tool that does not need to meet the requirements of sub-section 10.2.4.

10.2.5  Containers of lubricant shall not be in the construction site at any time.

10.3  SAFE CONSTRUCTION PRACTICES

If any rule in this sub-section (10.3) is violated during timed construction, the judge will stop the clock and explain the violation. Before the clock is restarted, builders, tools, members, nuts, and bolts will be returned to the positions they occupied immediately before the violation. Builders will then be asked to resume construction using safe procedures. Builders will have the opportunity to construct their bridge safely. However, if they are not able to construct the bridge completely using safe procedures, construction will cease and the bridge will not be eligible for awards in any category, except for aesthetics.

10.3.1  Builders, judges, host personnel, and spectators shall not be exposed to risk of personal injury. Only builders and judges may be in the construction site.

10.3.2  At all times during timed construction every builder shall wear personal protective equipment in the proper manner.

10.3.3  A pouch or other article of clothing shall not be removed from a builder’s person or held in a builder’s hand(s).

10.3.4  Nuts, bolts, or tools shall not be held in the mouths of builders.

10.3.5  Throwing anything is prohibited.

10.3.6  A builder shall not cross from the ground on one bank of the river to the ground on the other bank.

10.3.7  A builder who is outside a staging yard shall not simultaneously support or touch, directly or with tools, more than one member that is not in a constructed portion.

10.3.8  A builder shall not use the bridge, a constructed portion of the bridge, a member, or a tool to support all or part of the builder’s body weight. However, a builder may be partially supported by a constructed portion if the builder is kneeling on the floor on both knees, kneeling on the floor on one knee with the other foot on the floor, or standing with the heels and toes of one or both feet on the floor.

10.3.9  A builder shall not depend on another builder or builders for support or balance.
10.3.10 Construction of the bridge shall commence by creating a constructed portion. Each constructed portion shall be started on the ground within a footing.

10.3.11 A builder who is outside a construction zone shall not touch (or touch with tools) a constructed portion, and shall not install a member, nut, or bolt on a constructed portion.

10.3.12 At no time shall a builder or builders support the entire weight of a constructed portion. However, a builder or builders may remove a single member from a footing or from a constructed portion.

10.3.13 No part of a constructed portion shall extend beyond the site boundary at any time.

10.3.14 A team shall construct its bridge safely using the site and floor surfaces provided by the host school. Bridges and participants shall accommodate local conditions.

10.4 ACCIDENTS

Accident types are described in Sections 10.4.1, 10.4.2, and 10.4.3. In general, the clock is not stopped when there is an accident.

A penalty is assessed for each separate accident. If an accident is continuous (for example, a builder stands in the river, or a dropped item is not retrieved promptly) it will be counted as multiple occurrences until corrected. Builders involved in accidents may continue to build. Items involved in accidents shall be recovered promptly and may be used.

Construction cannot depend on deliberately committing an accident. Therefore, the clock will be stopped if any work is accomplished by committing an accident. Before timed construction is resumed, builders, tools, members, nuts, and bolts will be returned to the positions they occupied immediately before the accident.

10.4.1 A builder, builder’s footwear, pouch, or article of clothing touches the river or the floor outside the site boundary. For each occurrence, the number of builders is increased by one when the spreadsheet computes construction cost \( C_c \), but the number of builders actually constructing the bridge does not change. Exception: There is no penalty for stepping out of bounds or entering the river to retrieve an object that has been dropped, such as a member, tool, nut, bolt, or personal protective equipment.

10.4.2 A member, constructed portion, tool, nut, bolt, or personal protective equipment touches the river, the ground outside the staging yard, or the floor outside the site boundary. Penalty is 1/4 minute (15 seconds) for each item during each occurrence. Exception: There is no penalty for a member or constructed portion.
touching the *ground* within a *footing*. However, construction may proceed if it is no longer possible to hold the bearing surfaces of a *constructed portion* within the *footings*. In this situation, the *captain* may request that the clock be stopped while the difficulty is demonstrated to the *head judge*. If the *head judge* is convinced, no additional *accidents* will be cited for a *constructed portion* touching the *ground* outside the *footings* (regulation 10.4.2), the clock will be restarted, construction will resume, and a 200-pound weight penalty will be assessed, even if the bearing surfaces of the *bridge* are within the *footings* when it is completed. All penalties applied associated with this rule prior to the exception being taken remain.

10.4.3 Outside the *staging yards*, a *member* that is not part of a *constructed portion* touches or is in contact with another *member* that is not part of a *constructed portion*. **Penalty is 1/4 minute (15 seconds) for each occurrence.** Exception: There is no penalty if a *member* that is on the *ground* within a *footing* touches another *member*.

10.5 **CONSTRUCTION SITE**

See the Site Plan Diagram for the *construction site* layout. The host *school* lays out the site before the competition. The *construction site* shall be laid out so that the tape that designates lines is wet or out of bounds. That is, the edges of tape, not the centerlines, designate the lines shown on the drawing.

10.6 **START**

10.6.1 Before construction begins, only the following are allowed in the *staging yards*: all *builders*, *members*, *loose nuts*, *loose bolts*, and *tools*. Every *member*, *loose nut*, *loose bolt*, and *tool* must be in contact with the *ground* and must fit entirely within the assigned area of a *staging yard* as designated on the *Staging Yard* detail on the Site Plan Diagram. *Loose nuts* may be installed on *loose bolts*. *Tools* or parts of *tools* cannot touch each other. *Builders* are wearing *personal protective equipment* as well as optional clothing such as *pouches*. At the start, *builders* cannot touch *members*, *tools*, *nuts*, or *bolts*, which may only be picked up and passed from one *builder* to another after timed construction begins. There shall be nothing within the *construction site* that is not in a *staging yard*.

10.6.2 *Judges* inspect *members*, *loose nuts*, *loose bolts*, and *tools* as they are placed in the *staging yard*. *Tools* that do not conform to regulation 10.2.3 and 10.2.4 shall be removed from the *staging yard* and shall not be used. After inspection and throughout timed construction, additional *members*, *tools*, *nuts*, *bolts*, or other items shall not be brought into the *construction site* nor shall anything be removed. Additional *builders* shall not enter the *construction site* after the beginning of timed construction.

10.6.3 Timing and construction begin when the *captain* signifies that the *team* is ready and the *judge* declares the start.
10.7 TIME

10.7.1 Time is kept from start to finish of construction. The clock will be stopped under the following conditions

(1) if a builder or judge sees a condition that could cause injury, or
(2) when a safety regulation has been violated (see 10.3), or
(3) when work has been accomplished by committing an accident. The clock is not stopped if the accident does not contribute to the construction process (see 10.4), or
(4) if a builder or judge is injured or incapacitated.

10.7.2 Construction ceases while the clock is stopped. After the situation has been corrected, builders, tools, and bridge components are returned to the positions they occupied immediately before the interruption, the clock is restarted, and construction resumes.

10.8 TIME LIMIT

10.8.1 If construction time not including penalties exceeds thirty minutes, the scoring spreadsheet will count construction time as 180 minutes. Accidents (10.4) that occur after thirty minutes will not be penalized but safety regulations (10.3) will still be enforced. Judges may inform the team when this time limit is approaching and shall inform them when it is reached.

10.8.2 If construction time not including penalties exceeds 45 minutes, judges will halt construction. If local conditions allow and the head judge approves, the team may move its bridge off site for continued, untimed construction if it can be done safely. The bridge will not be eligible for awards in any category, except for aesthetics, but it may be load tested at the discretion of the head judge if that can be done safely within available time.

10.9 FINISH

10.9.1 Construction is complete when

(1) the bridge has been completed by connecting all the members that were in the staging yards at the start of timed construction,
(2) all builders are in the staging yards,
(3) all tools are in contact with the ground in the tool section of the staging yard, and
(4) all extra nuts and bolts are held in the hands of builders, or are in clothing worn by builders, or are on the ground in the staging yards.

10.9.2 The clock is stopped when the captain informs the judge that construction is complete. If the requirements of Sub-Section 10.9.1 are not met when the clock is
stopped, *builders, tools, members, nuts,* and *bolts* will be returned to the positions they occupied immediately before the clock was stopped. The clock will then be restarted and *builders* will be required to complete construction as designated in Sub-Section 10.9.1 prior to the clock being stopped when the *captain* again informs the *judge* that construction is complete.

10.9.3 After construction is complete, *assembled tools* must be in a disassembled state such that all *tools* satisfy the requirements of Sub-Section 10.2.4 and are in contact with the *ground* in the *tool* section of the *staging yard*. A **one-time penalty of 5 minutes will be added to the construction time if any tool does not meet the specification.**

10.9.4 Installation of *decking* is not included in timed construction.

10.9.5 The *bridge* shall not be modified after construction, except for correction of connections as prescribed in Sub-Section 9.4.
Section 11
LOAD TEST INSTRUCTIONS

11.1 DAMAGE

A bridge with damage that would reduce its strength or stability (such as a fractured weld, missing or broken member, broken bolt, or missing nut) will not be approved for load testing and will not be eligible for awards, except for aesthetics. Repair and modifications are not permitted after timed construction except as prescribed in Sub-Section 9.4.

11.2 SAFETY PRECAUTIONS

It is the responsibility of judges, host personnel, and competitors to employ effectively all precautions, which are summarized in this sub-section (11.2). Competitors should follow the same precautions when proof testing bridges in preparation for competition.

11.2.1 General Precautions

11.2.1.1 An activity shall be halted if a judge considers it to be hazardous. If a team cannot load its bridge safely, loading will cease and the bridge will not be eligible for awards, except aesthetics.

11.2.1.2 Competitors who are not participating in loading, faculty, advisers, and other spectators shall observe from a safe area designated by the judges and host school.

11.2.1.3 While participating in load testing, competitors shall wear personal protective equipment consisting of hardhats meeting ANSI standard Z89.1, protective eyewear or safety goggles meeting ANSI standard Z87.1, work gloves, and leather construction boots. This safety equipment is provided by each team. Judges will not permit load testing by competitors who are not wearing the specified personal protective equipment or are wearing it improperly.

11.2.2 Lateral Load Test Precautions

11.2.2.1 There shall be no more than four students in the crew that participates in a lateral load test.

11.2.2.2 A bridge that sways in excess of one inch during lateral load testing shall not be loaded vertically and will not be eligible for awards, except for aesthetics.
11.2.3 Vertical Load Test Precautions

*Bridges* may collapse suddenly without warning, and a failure may involve only one side so that the *load* falls or slides sideways off the *bridge*. The intent of the provisions of this subsection (11.2.3) is to prevent personal injury if a *bridge* collapses.

11.2.3.1 The number of people near the *bridge* shall be minimized during vertical *load* tests. The loading crew is limited to four students, but substitutions may be made during the loading process.

11.2.3.2 *Safety supports* shall be provided by the host *school*, and shall be of adequate strength, height, and number to arrest falling *load* if a *bridge* collapses. The use of the AISC provided jack stands is highly recommended.

11.2.3.3 *Safety supports* shall be in place under the *decking* units before *load* is placed on the *bridge*.

11.2.3.4 The number and location of *safety supports* under a *decking* unit shall be sufficient to arrest the *load* even if only one side or one end of the *bridge* collapses. Therefore, *safety supports* are needed under the sides and ends of the *decking* units, not just in the middle. *Safety supports* should be directly under *decking* units rather than under *bridge* trusses or cross braces, if possible.

11.2.3.5 *Safety supports* shall be adjusted individually for each *bridge* so that *load* cannot drop more than approximately four inches. If the height of the *safety supports* is not adjustable in appropriate increments, they shall be augmented with pieces of wood or other suitable material provided by the host *school*.

11.2.3.6 No one shall reach, crawl, or step under a *bridge*, or stand inside a *bridge* while any portion of the vertical *load* is in place. If *safety supports* must be adjusted during loading, the *load* shall first be removed without disturbing the *bridge*, adjustments made, and the *load* replaced as it was before being removed.

11.2.3.7 *Bridges* that inhibit safely placing vertical *load* shall not be tested and will not be eligible for awards, except for *aesthetics*.

11.2.3.8 *Judges* shall continuously observe *sway* carefully during vertical *load* testing. If *sway* exceeds one inch, loading shall cease and *load* shall be removed carefully.

11.2.3.9 *Judges* shall continuously observe *deflections* carefully. If any *deflection* exceeds three inches downward, loading shall cease and *load* shall be removed carefully.

11.2.3.10 *Judges* shall continuously observe the behavior of the *bridge*. Loading shall cease and the *load* shall be removed carefully if, in the opinion of a *judge*, collapse is imminent.
11.3 PREPARATION

The captain shall observe the load tests and may handle load. A captain who does not handle load shall comply with 11.2.1.3 but does not count toward the four-person limit.

Teams shall accept imperfect field conditions such as bent decking, sloping floors, and unfavorable floor surfaces. Commencing the lateral load or vertical load test indicates acceptance of all starting conditions.

For each bridge, the judge will determine by a randomizing process (e.g., coin flip) which end is the east end of the bridge. The other is the west end.

Positions L1 and L2 of the decking units and position S for the decking unit for the lateral load are determined at the beginning of the competition as described by paragraph 7.1 (7) and illustrated by the Lateral Load Test Plan and Vertical Load Test Plan on the Load Test Plan Diagrams.

At their discretion, judges may impose a penalty for a bridge that incorporates parts having the primary function of interfering with placement of decking, load, or measuring devices. If the bridge cannot be loaded safely, or sway or deflection cannot be measured in accordance with the provisions of this section (11), the bridge shall not be load tested and will not be eligible for awards, except for aesthetics.

Typically, sway is determined by using a plumb bob attached to the bridge or decking at a specific point, but sway limits apply even if the plumb bob is displaced by contact with another part of the bridge.

11.4 LATERAL LOAD TEST

The provisions of this sub-section (11.4) are illustrated by the Lateral Load Test Plan on the Lateral Load Test Plan Diagram.

11.4.1 Set Up

Lateral load tests are conducted with one decking unit positioned at a distance S from the east end of the south side stringer and approximately 75 pounds of weight on that decking near the north side of the bridge. This load is intended to restrain the bearing surfaces of the bridge from lifting off the floor when lateral load is applied. No additional uplift restraint will be used, even if bearing surfaces lift.

Bearing surfaces are prevented from sliding by lateral restraint applied by the loading crew. This lateral restraint shall not restrain rotation or uplift. The restraint is applied as close to the floor as possible, at the locations shown on the Lateral Load Test Plan on the Lateral Load Test Plan Diagrams. Teams may provide and use optional devices to prevent
sliding. However, the device must prevent sliding only. Devices designed to prevent vertical uplift will not be permitted. The lateral load test is failed if the bridge is restrained in other than the lateral direction, or if the restraint is not applied close to the ground, or if the restraint is not effective.

11.4.2 Lateral Load Test

A fifty-pound lateral load is applied and sway is measured on the south side of the bridge, centered on the decking unit positioned at S. Lateral load is applied at the level of the decking or top of the stringer, which is the bottom of the decking. The sway measurement is made as close as possible to the location of the lateral load. The sway measurement device may be attached to the decking at the discretion of the judges.

The test is failed if sway exceeds one inch.

If the bridge fails the lateral load test, it will not be eligible for awards, except for aesthetics. Do not conduct the vertical load test. Check the appropriate box on the data form.

If the bridge passes the lateral load test, proceed with the vertical load test.

11.5 VERTICAL LOAD TEST SEQUENCE

The provisions of this section are illustrated by the Vertical Load Test Plan and Vertical Load Test Elevation on the Vertical Load Test Plan and Elevation Diagram.

11.5.1 Set Up

11.5.1.1 Decking units are 3’-0” long in the longitudinal (span) direction of the bridge so that the main bars of grating span laterally. Two decking units are used. Decking units are placed square with and centered on the stringers. Decking units shall not be attached to the bridge and shall not distort it (see 9.2.3 and 9.2.4).

Two decking units are placed at distances L1 and L2 from the east end of the top of the south side stringer.

A decking unit that does not contact the top of a stringer at a location where deflection will be measured will be clamped to the stringer at or near that location. The clamp will be removed when sufficient load is in place to hold the decking unit in contact with the top of the stringer.

11.5.1.2 Safety supports are placed under the decking units so that no portion of the load will drop more than approximately four inches if the bridge collapses.

11.5.1.3 Deflections are measured as close as possible to the tops of stringers, which are at the same level as the bottom of the decking. Deflection measurement
devices may be connected to the *decking*. Measurements are made at the following locations

- *D1* centered on the *south side* of the *decking* unit positioned at *L1*.
- *D2* centered on the *north side* of the *decking* unit positioned at *L2*.

*Sway* is observed on the *north side* of the *bridge*, at the center of the *decking* unit positioned at *L1*.

### 11.5.2 General Loading Procedure

*Load* is laterally centered on the *decking* unit and distributed over the length of the *decking* unit as uniformly as possible. *Load* is distributed and aligned as identically as possible for each *bridge*. It is highly recommended that angles provided by AISC be used as the load. Angles shall be placed perpendicular to the span of the bridge to maintain safety in the event of a failure or a collapse. *Load* shall be placed at a steady pace, without hesitation. Crews shall stand outside the *bridge* while placing *load*.

As *load* is being placed, continuously observe *deflection* and *sway*. Stop loading if

- (a) *sway* exceeds one inch, or
- (b) any measured *deflection* exceeds three inches downward, or
- (c) *decking* or any part of the *bridge*, other than the intended bearing surfaces, comes to bear on a *safety support* or the floor, or
- (d) a *decking* unit or some of the *load* falls off the *bridge*, or
- (e) the *bridge* collapses or a dangerous collapse is imminent in the opinion of the *judge*.

If loading is stopped for any of the situations a, b, c, d, or e, the *bridge* is not approved for further *load* testing and will not be eligible for awards, except *aesthetics*. **Do not continue load testing.** Ask the crew to remove the *load* carefully. Check the appropriate box on the *data form*.

*Deflections* measured while the vertical *load* is in place will be used by the *scoring spreadsheet* to compute *aggregate deflection* by adding the absolute values of *deflections* at *D1* and *D2*, and then rounding the sum to the nearest 0.01 inch. If any measured *deflection* exceeds two inches, the *scoring spreadsheet* will add penalties of $4,000,000 to the *Construction Economy* score and $10,000,000 to the *Structural Efficiency* score.

### 11.5.3 Vertical Load Test

1. The crew distributes 100 pounds of preload on the *decking* unit positioned at *L1* and 100 pounds of preload on the *decking* unit positioned at *L2*. The preload is distributed uniformly, centered laterally on the *decking* unit, and positioned identically for each *bridge*.
2. Initialize the *sway* measurement device.
(3) Initialize the two deflection measuring devices at \( D_1 \) and \( D_2 \) or record the initial readings.

(4) The crew places 1400 pounds of additional load on the decking unit at \( L_1 \).

(5) The crew places 900 pounds of additional load on the decking unit at \( L_2 \).

(6) Record the final readings for \( D_1 \) and \( D_2 \).

11.5.4 Loss of Data

If deflection data is lost or compromised, the judge will require the team to disassemble the bridge, repeat timed construction beginning with the initial conditions prescribed in 10.6, and redo lateral and vertical load tests. Compliance with all rules will be checked except those in Section 8 and Sub-Section 9.3, which will not be checked again. Scoring will be based on the run that results in the larger construction cost, \( C_c \) (not including load test penalties), but will not exceed 110% of \( C_c \) (not including load test penalties) for the initial run.

11.6 UNLOADING

Load on the decking unit at \( L_2 \) is removed before the load on the decking unit at \( L_1 \). If the bridge collapses during unloading (situation c, d, or e in 11.5.2), it is not eligible for awards, except for aesthetics.
Section 12
EQUIPMENT PROVIDED BY HOST

12.1 SOURCES OF INFORMATION

Equipment for hosting a competition is listed in this section and described in the Host Guide at www.aisc.org/ssbc. The equipment provided by AISC is preferred for conducting the competition. The Host Guide also includes competition procedures and illustrations of bridge details that demonstrate compliance and noncompliance with specifications and regulations. Host personnel, judges, and competitors are encouraged to review the site and guide.

Although the equipment described in this section (12) will be provided by the host school, competitors should acquire similar equipment for load testing before the competition.

All teams are required to accept/accommodate local conditions and equipment, including floor, decking, safety supports, load, templates, boxes, deflection measurement devices and scales.

12.2 DECKING

Preferred decking is steel bar grating identified as W-19-4 (1” x 1/8”). The dimensions of a unit of grating are approximately 3’-6” x 3’-0” x 1” and the weight is approximately fifty pounds. Grating has significant bending strength only in the direction of the main bars, which are 3’-6” long. The grating will be installed with the main bars perpendicular to the length of the bridge, creating a roadway that is 3’-6” wide. Therefore, support for the grating is needed for the edges that are parallel to the length of the bridge but not for the edges that are perpendicular to the length.

12.3 SAFETY SUPPORTS

Safety supports must be used during load tests and are intended to limit the consequences of a bridge collapsing. Safety supports shall be of sufficient height, strength, number, and extent so that none of the load will fall more than approximately four inches if the bridge collapses. Safety supports may be steel, nested stacks of plastic buckets, jack stands, timbers, sand bags, or masonry units. Jack stands with welded plates are the recommended safety supports because of their flexibility in height, ease of placement, and stability.
12.4 LOAD

A total load of 2500 pounds should be supplied in pieces of uniform size and weight that can be handled safely. When in place, the load should not provide significant stiffness in the longitudinal direction of the bridge. The recommended load consists of 25-pound lengths of 4” x 4” x 3/8” or 5” x 5” x 1/16” steel angle placed perpendicular to the length of the bridge. Alternatively, sacks of material, containers of liquid, concrete blocks, or jacking systems can be used. Decking is not included as part of the 2500-pound load. If a jacking system is used, loading forces may be concentrated nine inches in from each end of the decking units.

12.5 TEMPLATE

A template as dimensioned in the Clearance Template detail on the Bridge Elevation Diagram shall be used to check clearances. Plywood is recommended. Holes for handholds are helpful but optional.

12.6 BOX

A box with inner dimensions of 3’-6” x 6” x 4” should be supplied to ensure that members and tools meet dimensional requirements specified in 8.2.2.2 and 10.2.4. Wood or other non-deforming material is recommended.

12.7 SCALES

Four calibrated scales should be supplied to be used under the four bridge supports to determine the measured weight of the bridge. The scales should be checked prior to competition for measurement accuracy. If it is impractical to weigh the whole bridge at once, then each individual piece of the bridge can be weighed separately on a single scale and summed to determine the measured weight of the bridge.
The website **www.aisc.org/ssbc** lists clarifications of the rules. Students, *judges*, and host personnel may submit questions via a form on that website but should **first read the previously posted clarifications, reread this rules document carefully in its entirety, and review the Host and Participant Guides at www.aisc.org/ssbc**. Submitters’ names and affiliations must accompany clarification requests and will be posted with the questions and answers. Questions shall be limited to interpretation of rules; specific designs and procedures will not be validated. Deliberation by the SSBC Rules Committee typically requires one to two weeks but possibly longer. Questions must be submitted before 5:00 PM Eastern Daylight-Saving Time, May 4, 2020.
Section 14
JUDGING

The host school will recruit judges. Judges are empowered to halt any activity that they deem to be hazardous. The head judge has full authority over the conduct of the competition and interpretation of the rules. Decisions, scoring, and ranking are the sole responsibility of the judges and will be final. The host school will assure that the judges are fully informed of the rules and procedures, and fully equipped for their tasks. More information for the host school and judges is available at www.aisc.org/ssbc, where the official scoring spreadsheet may be downloaded and the Host Guide reviewed.
15.1 REGIONAL EVENTS

15.1.1 At the beginning of the competition, each team will identify its captain. The host school will identify the regional head judge (RHJ).

15.1.2 A penalty, decision, measurement, score, condition of competition, or interpretation of rules may be appealed only by the captain and only to the RHJ. The RHJ will not hear the appeal if he or she is approached by anyone other than the captain. The RHJ will refuse to hear protests regarding bridges other than the captain’s. The appeal must be made as soon as possible after the situation becomes apparent. The RHJ will hear the appeal as soon as possible and may interrupt the competition. If the captain does not consent to the decision of the RHJ, he or she shall write an explanation on the data form before signing it. Participants are reminded that civility and ethical behavior are expected during the competition and particularly concerning appeals.

15.1.3 After the Regional Event, the SSBC Rules Committee will consider only those appeals that allege errors in interpretation of rules, and only if those appeals were made to the RHJ during the Regional Event in conformance with 15.1.2. Appeals should be submitted by e-mail to Ms. Maria Mnookin mnookin@aisc.org and shall include

(1) name of the college or university making the appeal,
(2) captain’s name, e-mail address, and telephone number,
(3) faculty advisor’s name, e-mail address, and telephone number,
(4) brief description of the problem, including citation of pertinent rules,
(5) action taken at the competition to deal with the problem,
(6) action that the appealing team feels should have been taken, and
(7) data showing that the team should have qualified for national competition.

The SSBC Rules Committee may review the submitted data forms documenting the problem and may confer with the RHJ.

15.1.4 Appeals must be made by e-mail. An appeal will be considered only if the e-mail is received by 5:00 PM Eastern Daylight-Saving Time on the Wednesday immediately after the Regional Event. Ms. Mnookin will forward the appeal to the SSBC Rules Committee for their evaluation. The SSBC Rules Committee will not respond to an appeal until the official scoring spreadsheet file for that Regional Event has been submitted by the host school to ssbcscorekeeper@aisc.org. The only redress that may be made is an invitation to participate in the National Finals if the SSBC Rules Committee
is convinced that the appeal is valid and that the appealing team should have qualified for the National Finals. Decisions and rankings made by regional judges will not be overturned.

15.2 NATIONAL FINALS

15.2.1 Judges will refuse to hear protests from a team concerning any bridge other than their own.

15.2.2 A penalty, decision, measurement, score, condition of competition, or interpretation of rules may be appealed only by a captain and only to the station head judge (SHJ). The SHJ will not hear the appeal if he or she is approached by anyone other than the captain. The appeal must be made as soon as possible after the situation becomes apparent and before the conditions at issue are changed (e.g., by further construction, loading, or disassembly of the bridge). The SHJ will hear the appeal as soon as possible and will make a ruling. The conditions at issue will not be changed during deliberation. Teams are reminded that civility and ethical behavior are expected during the competition and particularly concerning appeals.

15.2.3 After hearing the SHJ’s ruling, the captain may request a five-minute recess to discuss the issue with the team. During the recess, the conditions at issue will not be changed. Immediately after that recess, if the team has justification to contest the SHJ’s ruling, the captain has the option to appeal that decision to the national head judge (NHJ). The NHJ will hear the appeal as soon as possible and will make a ruling. The NHJ may consult with the SSBC Rules Committee. The conditions at issue will not be changed during deliberation.

15.2.4 If the team has justification to contest the NHJ’s ruling, the captain has the option to appeal that decision directly to the SSBC Rules Committee within fifteen minutes after hearing the NHJ’s ruling. The Committee may request information from the NHJ and SHJ but those judges will not vote on the final ruling.

15.2.5 The decision of the SSBC Rules Committee is final; there are no further appeals. However, AISC welcome written suggestions for improving future competitions.
CONSTRUCTION SITE PLAN

STAGING YARD

TOOLS

MEMBERS

CONSTRUCTION ZONE

AND RIVER DETAIL

SITE PLAN

NOTES:
1. DRAWINGS ARE NOT TO SCALE
2. DIMENSION MAY BE REDUCED TO FIT LOCAL CONDITIONS.
3. DIMENSIONS AND LOCATIONS ARE IDENTICAL FOR STAGING YARDS AT BOTH ENDS.
4. ALL FOUR FOOTINGS ARE THE SAME SIZE.
5. LINE REPRESENTS PART OF THE BRIDGE ENVELOPE (9,3,7)
1. DRAWINGS ARE NOT TO SCALE.
2. NO PART OF THE BRIDGE SHALL EXTEND AWAY FROM THE RIVER BEYOND THE BRIDGE ENVELOPE (8.3.7).
3. TOPS OF STRINGERS SHALL BE AT LEAST 20 FT. LONG (9.3.6).
BRIDGE PLAN

NOTES:
1. DRAWINGS ARE NOT TO SCALE.
2. ALL FOUR FOOTINGS ARE THE SAME SIZE (1 FT. X 1 FT.)
3. NO PART OF THE BRIDGE MAY EXTEND AWAY FROM THE RIVER BEYOND THE BRIDGE ENVELOPE (9.3.7)
LATERAL LOAD TEST PLAN

NOTES:
1. DRAWING NOT TO SCALE
2. DECKING LOCATION "S" IS 9'-0" FOR ALL BRIDGES.
3. NORTH AND SOUTH SIDES ARE BASED ON THE RANDOM SELECTION OF THE EAST END FOR EACH BRIDGE.
4. LOCATIONS OF LATERAL PULL, LATERAL RESTRAINT, AND SWAY MEASUREMENTS ARE SPECIFIC TO EAST END OF THE SOUTH SIDE STRINGER (11'-4').
VERTICAL LOAD TEST PLAN AND ELEVATION

NOTES:
1. DRAWINGS ARE NOT TO SCALE.
2. DECKING LOCATIONS "L1" AND "L2" ARE RANDOMLY DETERMINED AND ARE THE SAME FOR ALL BRIDGES.
3. DECKING LOCATIONS "L1" AND "L2" ARE MEASURED FROM THE EAST END OF THE SOUTH SIDE STRINGER.
4. SAFETY SUPPORTS ARE REQUIRED UNDER BOTH DECKING UNITS AT ALL TIMES.
5. THE 100 LB PRELOAD IS PLACED FIRST, FOLLOWED BY INITIALIZATION OR INITIAL READINGS OF DEFORMATION AND SWAY MEASURING DEVICES.
6. THE PRELOAD REMAINS IN PLACE, AND 1400 LB OF LOAD IS PLACED ON THE DECKING UNIT LOCATED AT "L1", FOLLOWED BY 900 LB OF LOAD ON THE DECKING UNIT LOCATED AT "L2".
7. LOCATIONS OF DEFORMATION AND SWAY MEASUREMENTS ARE SPECIFIC TO THE NORTH AND SOUTH SIDES (11.5.1.3).
8. DEFORMATIONS D1, D2, AND SWAY ARE MONITORED CONTINUOUSLY.
9. STOP LOADING IF ANY DEFORMATION EXCEEDS 3 IN. OR SWAY EXCEEDS 1 IN.
10. DEFORMATIONS ARE Recorded AFTER ALL LOAD IS IN PLACE.