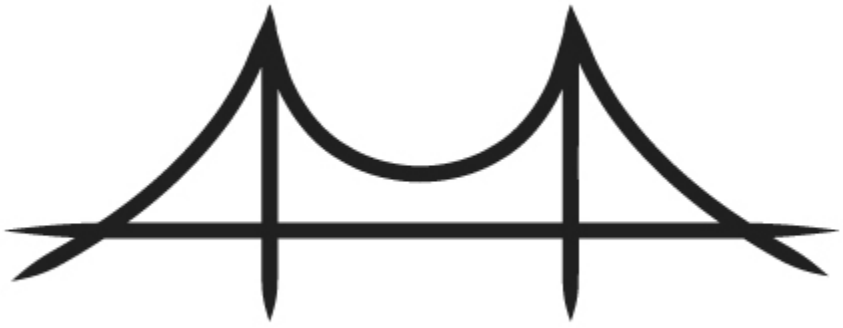
STUDENT STEEL BRIDGE COMPETITION

2014 RULES



MISSION

The mission of the Student Steel Bridge Competition (SSBC) is to supplement the education of civil engineering students with a comprehensive, student-driven project experience from conception and design through fabrication, erection, and testing, culminating in a steel structure that meets client specifications and optimizes performance and economy. The SSBC increases awareness of real-world engineering issues such as spatial constraints, material properties, strength, serviceability, fabrication and erection processes, safety, aesthetics, project management, and cost. Success in inter-collegiate competition requires application of engineering principles and theory, and effective teamwork. Future engineers are stimulated to innovate, practice professionalism, and use structural steel efficiently.

WELCOME

ASCE and AISC support and encourage the equitable opportunity for participation by all interested and eligible individuals in the Student Steel Bridge Competition without regard to race, ethnicity, religion, age, gender, sexual orientation, nationality, or physical challenges. Bridge teams should be inclusive and open and fair to all interested and eligible participants.

SPONSORS

Organizing sponsors of the Student Steel Bridge Competition are

- American Institute of Steel Construction (AISC)
- American Society of Civil Engineers (ASCE)

Co-sponsors are

- American Iron and Steel Institute (AISI)
- Bentley Systems, Inc.
- Canadian Institute of Steel Construction (CISC)
- DS SolidWorks Corp.
- James F. Lincoln Arc Welding Foundation
- National Steel Bridge Alliance (NSBA)
- Nucor Corporation
- Steel Structures Education Foundation (SSEF)

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Any revisions to the rules in this document are incorporated in clarifications that are published at the bridge competition web site, http://www.aisc.org/steelbridge. Revisions and clarifications do not appear in this document but are considered formal addenda to the Rules.

Section 1

INTRODUCTION

Students design and erect a steel bridge by themselves but may seek advice from faculty and student organization advisers. Students gain maximum benefit if they fabricate the entire bridge themselves. However, because appropriate shop facilities and supervision are not available at all universities, students may use the services of a commercial fabricator provided that they develop the work orders and shop drawings, and observe the operations. Students are encouraged to maximize their involvement in fabrication.

Safety is of primary importance. AISC and ASCE request that competitors, advisers, hosts, and judges take all necessary precautions to prevent injury to competitors, judges, host personnel, and spectators.

This document describes the competition and states the rules for competitions conducted during 2014 at both conference and national levels. It is available at http://www.aisc.org/steelbridge, together with revisions, clarifications, other information, and the form for submitting requests for clarifications. Information at this site takes priority over any other source except as noted herein.

The rules are changed every year to enhance the competition and ensure that competitors design and build new bridges. The rules are intended to be prescriptive but may require some 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 thoroughly from beginning to end and then review the Competition Guide at http://www.nssbc.info. That site also is the source of the official scoring spreadsheet which generates forms for recording data. Judges should be familiar with these forms prior to the competition.

Members of the Student Steel Bridge Rules Committee are

- Michael F. Engestrom, Technical Marketing Director, Nucor-Yamato Steel
- Nancy Gavlin, S.E., P.E., Director of Education, AISC
- Jennifer Greer-Steele, ASCE Committee on Student Activities Corresponding Member
- Frank J. Hatfield, P.E., Professor Emeritus, Michigan State University
- John M. Parucki, Structural Steel Consultant
- Craig E. Quadrato, P.E., Director, Civil Engineering Design Group, United States Military Academy
- Brian Raff, Marketing Director, NSBA
- Don Sepulveda, P.E., Executive Officer, Regional Rail, Los Angeles County Metropolitan Transportation Authority
- Ping Wei, Director of Educational Activities, ASCE

Section 2

EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication, and construction of a scaled steel bridge. Participating students apply engineering principles and theory, and gain practical experience in structural design, fabrication processes, construction planning, organization, project management, and teamwork.

The rules of the competition 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.

Standards for strength, durability, constructability, usability, functionality, and safety reflect the volumes of requirements that govern the design and construction of full-scale bridges. Criteria for excellence are represented by the award categories of stiffness, lightness, construction speed, display, efficiency, and economy. Competition judges and the Rules Committee take the role of the owner and have the authority to accept and reject entries.

The safety of competitors, judges, host personnel, and spectators is paramount. Risky procedures are prohibited. Load testing is stopped if sway or deflection exceeds specified limits, or if collapse is deemed imminent in the opinion of the judges. Bridges that cannot be constructed and loaded safely are withdrawn from competition. In addition, the rules identify and penalize construction errors that represent accidents in full-scale construction.

The rules of the competition accommodate a variety of designs and allow innovation. Designers must consider carefully the comparative advantages of various alternatives. For example, a truss bridge may be stiffer than a girder bridge but slower to construct. Successful teams analyze and compare alternative designs prior to fabrication using value analysis based on scoring criteria.

The Student Steel Bridge Competition provides design and construction planning experience, an opportunity to learn fabrication procedures, and the excitement of networking with and competing against students from other colleges and universities.

Section 3

PROBLEM STATEMENT

The eighty-year old timber trestle that carries a spur of the NE&SW railroad over the Spodumene River is essential for transporting ore from United Voltaic's lithium mine but has deteriorated beyond repair and must be replaced. A continuous supply of lithium is vital to production of batteries for hybrid electric vehicles. Disruption of ongoing railroad activities must be minimized, and bridge construction completed expeditiously within a limited time window. Therefore, the contract demands Accelerated Bridge Construction (ABC) methods.

NE&SW specifies steel because it supports fast erection and reduces mobility impacts, all of which are essential to ABC. Steel's durability and high level of recycled content also contribute to exceptional sustainability. The high strength to weight ratio of steel assures an efficient structure, and prefabricated elements and systems (PBES) help to reduce construction time and expedite ABC.

The state Department of Natural Resources will not approve permanent piers in the river and requires adequate clearance under the bridge to accommodate extreme high water. However, barges and a temporary pier will be permitted during construction.

Location and size of the staging area are restricted by topography, and dimensions and weight of equipment and transported material are limited by the narrow railroad cut.

The scope of the bridge contract does not include deck panels or removal of the timber trestle. The new bridge will rest on existing footings.

Your company's proposal is among those that NE&SW deems responsive, and winning the contract would establish your team as a leader in Accelerated Bridge Construction technologies. Each competing firm is requested to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and will be tested for stability, strength, and serviceability using standardized lateral and vertical loads. NE&SW engineers will judge the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy, and attractiveness. The contract will be awarded to the company whose model satisfies specified requirements and best achieves project objectives. 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 the model and terminating the company's eligibility.

Section 4

ELIGIBILITY

4.1 LEVELS OF COMPETITIONS

There are two levels of competition: conference and national. Conference competitions are held in conjunction with ASCE annual student conferences. Outstanding performance in conference competitions qualifies eligible teams for the national competition.

4.2 CONFERENCE COMPETITIONS

4.2.1 Only one bridge per college or university may compete in an ASCE student conference, and a college or university may compete in only one ASCE student conference.

4.2.2 The ASCE student organization that is hosting a conference may invite guest teams, which are teams from colleges or universities that do not have ASCE student organizations, or from official ASCE student organizations that are assigned to different conferences. Conference assignments are listed in the ASCE Official Register at http://www.ASCE.org/Official-Register/Official-Register/.

4.2.3 A team shall consist only of undergraduate and graduate students in good standing with their ASCE student organization during all or part of fall through spring of the current competition academic year. This requirement is waived for guest teams.

4.2.4 The official scoring spreadsheet shall be used, and all teams (including guest teams) shall be listed on that spreadsheet. The official scoring spreadsheet may be downloaded from http://www.nssbc.info.

4.2.5 The host student organization shall promptly submit the completed official scoring spreadsheet for a conference competition to ssbc.results@gmail.com. Teams from that conference will not be invited to the National Student Steel Bridge Competition (NSSBC) until the spreadsheet is received and eligibility is confirmed.

4.3. NATIONAL COMPETITION

4.3.1 A team is not eligible to be invited to compete in the NSSBC if it is

(1) a guest team as defined in 4.2.2, or
(2) from an organization that is not in good standing with ASCE, or
(3) from an organization that has not satisfied ASCE requirements regarding participation in its conference, or
(4) ruled to be ineligible to complete its conference competition.

ASCE requirements for good standing and for conference participation are reprinted in 4.4 but are subject to change.

4.3.2 The maximum number of eligible teams from a conference that will be invited to compete in the NSSBC is based on the number of teams at that conference that competed (that is, presented bridges and staged them for timed construction) but not including guest teams as defined in 4.2.2.

(1) Only the single best scoring eligible team will be invited from a conference in which two, three or four non-guest teams competed.
(2) The two top scoring eligible teams will be invited from a conference in which five to ten non-guest teams competed.
(3) The three top scoring eligible teams will be invited from a conference in which eleven to nineteen non-guest teams competed.
(4) The four top scoring eligible teams will be invited from a conference in which twenty or more non-guest teams competed.

4.3.3 Teams are not invited to compete in the NSSBC as guests.

4.3.4 Only one bridge per college or university may be entered in the NSSBC. Bridges may be modified in preparation for NSSBC.

4.3.5 A team shall consist only of ASCE national members of any grade who were students during all or part of the academic year leading up to the NSSBC.

4.4 ASCE NATIONAL COMPETITION ELIGIBILITY REQUIREMENTS

ASCE requirements for good standing and for conference participation, as they existed in July, 2013, are reprinted in this sub-section (4.4) but are subject to change. The current version is at http://www.asce.org/Audience/Students/Student-Competitions/National-Competition-Eligibility-Requirements/. ASCE has sole authority for determining and enforcing these requirements; questions should be sent by e-mail to student@asce.org.

"In order to facilitate broader participation by ASCE Student Organizations in Student Conference activities, the ASCE Committee on Student Members (CSM) stresses the importance of the conference as an event that is much more than a qualifying round for national competitions and highlights the required events at a conference. As such, the following qualifications are required of all ASCE Student Organizations in order to participate in an ASCE-sponsored National Competition.

An ASCE Student Organization must:

- Be in good standing with ASCE (annual report and annual dues submitted and received by ASCE prior to the start of the Student Conference).
- Attend and participate in their assigned Student Conference as shown through their school's:
  a) Good faith participation in the Student Conference Business Meeting (i.e. on time attendance by at least one student representative);
  b) Good faith participation in the Student Conference Paper Competition (i.e. submission and presentation by at least one member of the ASCE Student Organization); and
  c) Meeting any additional requirements of Student Conference participation set by the Student Conference at the previous year's business meeting or in their written and approved by-laws, standing rules, or constitution.
  Note: *The concrete canoe design paper/oral presentation does not count as an entry into the Student Conference Paper Competition."*

Section 5

SAFETY

Safety has the highest priority – risk of personal injury will not be tolerated. Sub-sections 8.3, 9.1, 10.2, 10.3, 11.1, and 11.3 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 appropriate boxes on the data entry forms. Judges also must comply with and enforce the safety regulations for load testing in sub-section 11.2. Sub-sections 11.4, 11.5, and 11.6 specify penalties for bridges that exhibit unsafe characteristics during load testing.

Judges are empowered to halt any activity that they deem to be hazardous. If a bridge cannot compete safely, it must be withdrawn from competition. If the problem is not anticipated by the sub-sections listed in the preceding paragraph, the judge should write a brief description of the problem on the data form.

Students are requested to practice safe fabrication procedures and receive appropriate instruction and supervision. Precautions listed in sub-section 11.2.3 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 judges' scoring forms printed from the official scoring spreadsheet downloaded from http://www.nssbc.info. Data from those forms are then entered in the spreadsheet. After all scoring information has been collected for a team, the scoring official reviews 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.

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

The completed official scoring spreadsheet for a conference competition shall be submitted to ssbc.results@gmail.com by the host student organization. Conference results are not final until the spreadsheet is submitted. Questions and comments regarding the spreadsheet should be sent to ssbc.results@gmail.com.

Judges' scoring forms shall be retained by the host student organization for two weeks after the competition.

6.2 CATEGORIES OF COMPETITION

Categories of competition are display, construction speed, lightness, stiffness, construction economy, and structural efficiency. In addition, overall performance is rated.

6.2.1 Display

An award is given for Display. The bridge is presented exactly as it will be erected during timed construction. Display is judged by the following criteria

6.2.1.1 Appearance of bridge, including balance, proportion, elegance, and finish. Quality of fabrication, including welding, shall not be considered because some bridges may be fabricated professionally rather than by students.

6.2.1.2 Permanent identification of the bridge consisting of the name of the college or university exactly as shown on the ASCE student web site, http://www.asce.org/Content.aspx?id=14843. 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 low display rating.

6.2.1.3 Poster describing design. The poster must

(1) be flat with maximum dimensions of two by three feet and must present all information on one side without attached pages that must be lifted or turned,
(2) identify the college or university with the same name that appears on the bridge,
(3) be illustrated with a scaled, dimensioned side view of the bridge,
(4) present a brief explanation of why the overall configuration of the bridge was selected,
(5) include a two-dimensional free-body diagram of the bridge for one of the vertical load conditions specified in section 7,

(6) present shear and moment diagrams corresponding to the free-body diagram, with peak magnitudes labeled,
(7) discuss provisions for Accelerated Bridge Construction (ABC), such as design features, construction sequencing, and procedures intended to minimize construction time,
(8) acknowledge university technicians, faculty, and others who helped fabricate the bridge or provided advice, and
(9) be in English.

Additional information may be included. Names of financial sponsors may be shown on the poster or on an optional second poster that could accommodate their logos. Electronic displays, decorated supports, lights, and sound are not permitted and will result in the worst possible rating for the poster. A very low rating will be imposed if there is no poster or if it is grossly inadequate. The poster is not part of the bridge but must be in place whenever the bridge is on display.

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.

6.2.1.4 Display is the tie breaker for all categories of competition. Judges shall not declare ties in display.

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 10.4 and 10.8.1, plus two minutes if repair time is commenced, plus double the repair time modified by construction penalties prescribed in 10.4 (see 10.10.1). There are upper limits on construction and repair time (see 10.8.2 and 10.10.2).

6.2.3 Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge (determined by scales provided by the host student organization) plus weight penalties prescribed in 8.4, 8.5, and 9.2. Decking, tools, temporary pier, lateral restraint devices, and posters are not included in 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 = Total time (minutes) x size of the build team (number of persons) x 50,000 ($/person-minute) + load test penalties ($).

Total time is defined in 6.2.2, and load test penalties are prescribed in 8.6, 11.4, and 11.5. "Build team" is defined in 10.1.4.

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

For a bridge that weighs 400 pounds or less,

C_s = Total weight (pounds) x 20,000 ($/pound)
+ Aggregate deflection (inches) x 1,000,000 ($/inch)
+ Load test penalties ($)

For a bridge that weighs more than 400 pounds,

C_s = [Total weight (pounds)]^2 x 50 ($/pound^2)
+ Aggregate deflection (inches) x 1,000,000 ($/inch)
+ Load test penalties ($)

Total weight is defined in 6.2.3, aggregate deflection is defined in 11.5, and load test penalties are prescribed in 11.4 and 11.5.

6.2.7 Overall Performance

The overall performance rating of a bridge is the sum of construction cost and structural cost, (C_c + C_s). The bridge achieving the lowest value of this total wins the overall competition.

6.3 SPREADSHEET FOR SCORING

The spreadsheet for scoring the competition is also useful for comparing alternatives when designing a bridge. Teams are encouraged to download, understand, and verify the spreadsheet before the competition. It is available in the Competition Guide at http://www.nssbc.info. Questions and comments regarding the spreadsheet should be sent to ssbc.results@gmail.com.

Section 7

SCHEDULE OF COMPETITION

In the months before the competition, students design their bridges, fabricate members, test load, practice construction, and select the build team for timed construction.

7.1 RECOMMENDED ORDER OF COMPETITION

The following events occur during the competition

(1) The official scoring spreadsheet is downloaded from http://www.nssbc.info/, and judges' scoring forms are generated from that spreadsheet.
(2) Bridges are erected for public viewing and are judged for display. After the start of display judging, bridges must not be altered, modified, or enhanced in any way except for disassembly, timed construction, repair as described in 10.10, and re-installation of fasteners as required by 8.6.
(3) Bridges are disassembled.
(4) In a meeting at which all team captains are present, the head judge clarifies rules and conditions of the competition and answers questions.
(5) The head judge selects the locations of decking units and magnitudes of loads. See 11.5 and the Vertical Loading Diagram. Selection is done in the presence of the team captains by rolling a die. For each possible result S of the roll, Table 7.1 gives the dimensions M1 and M2 for positioning the decking units, and the magnitudes L1 and L2 of corresponding loads.

TABLE 7.1 Determination of M1, M2, L1, and L2

S	M1	M2	L1 (lb)	L2 (lb)
1	6'-6"	~~3"-0"~~ 3'-0"	1400	1000
2	9' 1"	5'-11"	1200	1200
3	9'-1"	5'-11"	1400	1000
4	10'-0"	5'-6"	1200	1200
5	10'-6"	4'-6"	1400	1000
6	10'-6"	4'-6"	1200	1200

The same locations and loads will be used for all bridges in the same conference competition.
(6) Using a random process, the head judge determines the order in which teams will compete.

(7) Bridge members, fasteners, tools, and the temporary pier are staged for construction and inspected by the judges. See section 9, “Material and Component Specifications,” and sub-sections 8.5.3, 8.5.4, 8.5.5, 8.5.7, 10.2, and 10.6 for details.
(8) Timed construction and repair. See section 10, “Construction Regulations,” for details.
(9) Judges inspect assembled bridges. For details, see section 8, “Dimension and Support Specifications,” (including 8.5.4, and 8.5.5 as they apply to installation of fasteners) and 9.1.2.
(10) Bridges are weighed (if it is impractical to weigh the entire bridge, its parts may be weighed prior to construction). All bridges shall be weighed, including those that are withdrawn from competition.
(11) Load testing. See section 11, “Load Tests,” for details.
(12) After a team has completed all phases of the competition, data for the team is transcribed from the judges’ scoring forms into the official scoring spreadsheet and checked by the captain. The team’s “Computation” worksheet is printed from the scoring spreadsheet and given to the team captain after data entry has been completed.
(13) Scores and rankings are determined using the official scoring spreadsheet.
(14) Paper or electronic copies of the “Rankings” worksheet of the official scoring spreadsheet are distributed to captains of all teams at the awards ceremony.
(15) The host ASCE student organization submits the completed official scoring spreadsheet by e-mailing it to the address given on that spreadsheet.
(16) The host student organization retains judges’ scoring forms for two weeks.

7.2 ALTERNATIVES

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

(1) Bridges are not modified after selection of the load location.
(2) Bridges are not modified between display 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 fastener re-installation as required by 8.6 and repairs as described in 10.10. Between repairs and 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.

Section 8

DIMENSION AND SUPPORT SPECIFICATIONS

8.1 DEFINITIONS

8.1.1 A “contact surface” is either of a pair of surfaces of different members that are in contact. See 9.2.2 for definition of “member.” The intersection of surfaces of the same member (i.e., a corner) is not a surface; therefore it cannot function as a contact surface. A contact surface may be part of a larger surface.

8.1.2 Decking bears on “decking support surfaces” which are comprised of the top surfaces or edges of members. See 12.2 for a description of “decking.”

8.1.3 A “gap” is a hole or depression that penetrates only part way through a member.

8.2 MEASUREMENT

Dimensions and support will be checked with the bridge in its as-built condition after termination of timed construction and the repair period described in sub-section 10.10, and before the bridge is moved from the construction site or load tested. The bridge must not be modified or distorted from its as-built condition in order to satisfy dimension and support rules. Dimensions will be checked without decking or applied load on the bridge.

8.3 FUNCTIONALITY AND SAFETY

If any specification in this sub-section (8.3) is violated, the bridge will not be approved for load testing and will not be eligible for awards in any category.

8.3.1 The bridge shall span the river completely without touching it. The river is 17’-0” wide. See the Site Plan on the Site and Bridge Diagram.

8.3.2 The bridge shall have two decking support surfaces that are continuous in the span direction of the bridge. See the Elevation and Section on the Site and Bridge Diagram.

8.3.3 The bridge shall provide access for safely placing the decking and load.

8.3.4 The decking shall not be attached or anchored to the bridge, nor shall it be used to distort the bridge from its as-built condition.

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

8.3.6 It shall be possible to construct and load the bridge safely using the site, equipment, and floor surfaces provided by the host student organization. **Bridges and participants shall accommodate local conditions.**

8.4 USABILITY

A weight penalty will be assessed for each specification in this sub-section (8.4) 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 (8.4) will be an addition to the weight of the bridge determined as follows

(1) 50 pounds for a dimensional violation of ½" or less,
(2) 150 pounds for a violation greater than ½" but not exceeding 1",
(3) 300 pounds for a violation greater than 1" but not exceeding 2", and
(4) if a violation exceeds 2", the bridge will not be approved for load testing and will not be eligible for awards in any category.

8.4.1 The bridge shall not extend more than 5'-0" above the surface of the ground or river. See the Section on the Site and Bridge Diagram.

8.4.2 Parts of the bridge (including fasteners and parts that bear on the ground) shall not extend beyond the vertical plane defined by the ends of the decking support surfaces at each end of the bridge.

8.4.3 The length of each decking support surface shall not exceed 19'-0".

8.4.4 The decking support surfaces shall be smooth and free of discontinuities such as protrusions, holes, and depressions, except that at each connection there may be a gap that does not exceed ¼" measured in the span direction of the bridge.

8.4.5 The outer edges of the two decking support surfaces shall be no less than 2'-6" from one another, and the inner edges of the decking support surfaces shall be no more than 3'-2" apart. These dimensions are measured perpendicularly to the span of the bridge. See the Section on the Site and Bridge Diagram.

8.4.6 The decking support surfaces shall be no more than 2'-4" above the surface of the river or ground at any point. See the Section on the Site and Bridge Diagram.

8.4.7 A clearance envelope shall completely traverse the bridge from end to end. It must be at least 1'-6" high measured up from the decking support surfaces, and must be at least 3'-8" wide measured perpendicularly to the span of the bridge. No part of the bridge, including fasteners, shall extend into this clearance envelope. This specification (8.4.7) applies only to bridges with structure above the level of the decking support surfaces. See the Section on the Site and Bridge Diagram.

8.4.8 Vertical clearance shall be provided under the bridge at all points directly over the river. The clearance shall be at least 1'-7" high, measured from the surface of the river. No part of the bridge, including fasteners, shall extend below this limit. See the Elevation on the Site and Bridge Diagram.

8.5 MEMBER-TO-MEMBER CONNECTIONS

Violations of specifications in this sub-section (8.5) will result in penalties being added to the weight of the bridge. The penalty for each noncompliant contact or connection is 25 pounds.

8.5.1 Every connection shall incorporate one or more pairs of contact surfaces.

8.5.2 Members shall be in contact only at contact surfaces and at corners formed by the intersection of contact surfaces of the same member.

8.5.3 Every contact surface shall be continuous, planar, smooth, and free of protrusions. A contact surface may be bare steel or painted but shall be free of other materials such as tape.

8.5.4 The bolt for every fastener shall pass through a hole in one or more contact surfaces of every member that it connects. Dimension(s) of the hole shall be small enough so that neither the head of the bolt nor the nut can pass through the hole. The hole for a bolt shall be completely surrounded by the contact surface. See 9.2.3 for the definition of "fastener."

8.5.5 Every bolt shall be perpendicular to the contact surfaces that it penetrates.

8.5.6 The nut and bolt head of every fastener shall be in contact with members that are connected by that fastener.

8.5.7 The hole for a fastener shall not be threaded. It must be possible to install and remove the bolt without turning it. A nut welded to a member constitutes a threaded hole.

8.5.8 A fastener shall not be in contact with another fastener nor with a member that it does not connect.

8.6 MISSING AND INCORRECTLY INSTALLED FASTENERS

After termination of timed construction and the repair period described in sub-section 10.10, every contact surface shall be penetrated by one or more fasteners to form a connection. Bolts shall fully engage the threads of the nuts. That is, the terminal threads on a bolt shall extend beyond or be flush with the outer face of the nut.

A team shall install all missing fasteners and correct all fasteners for which the threads on nuts are not fully engaged. If this is not possible for any reason, including a contact surface that lacks a hole for a fastener, the bridge shall not be approved for load testing and is not eligible for awards in any category.

A penalty of $1,000,000 will be added to the Construction Economy score for every bolt and every nut that is successfully installed, replaced, or tightened after termination of timed construction and the repair period. The recorded construction time shall not be increased.

Section 9

MATERIAL AND COMPONENT SPECIFICATIONS

9.1 SAFETY

If any one of the rules in this sub-section (9.1) is violated, the bridge will not be approved for construction or load testing, and will not be eligible for awards in any category.

9.1.1 A member shall not weigh more than twenty pounds. See 9.2.2 for definition of “member.”

9.1.2 A bridge shall not incorporate an electric, electronic, fluidic, or other non-mechanical sensor or control system; a non-mechanical energy transmission device such as a wire, duct, or tube; an energy conversion or storage device such as an electromagnet, electric cell, motor, hydraulic or pneumatic piston, turbine, chemical reactor, pressure vessel, pre-loaded spring, or triggering device.

9.2 DURABILITY AND CONSTRUCTABILITY

Violation of the specifications in this sub-section (9.2) will result in penalties being added to the weight of the bridge. The penalty is 25 pounds for every non-compliant fastener and 25 pounds for every non-compliant member plus the weight of that member.

9.2.1 Bridge

A bridge shall be constructed only of steel members and steel fasteners. For the purposes of this competition, steel is defined as an iron alloy that is strongly attracted to the magnet provided by the host organization. Solder, brazing, and adhesives are not permitted. Exceptions: Purely decorative items such as coatings and decals are permitted, and bridge parts may be labeled.

9.2.2 Members

9.2.2.1 A member is a rigid component comprised of steel parts welded together. A member shall retain its shape, dimensions, and rigidity during timed construction and load testing. Hinged, jointed, articulated, and telescoping members are prohibited, as are those with parts that move. This prohibition includes members with parts that are intended to slide, rotate, deflect, or bend relative to the member such as cams, latches, sliding pins, springs, and snap-lock devices. Also prohibited are members incorporating hinges or other devices that do not restrain rigid-body rotation or translation of one part of the member relative to another part. Exception: Deformations caused by mechanical strain (e.g., bending, stretching) during construction and load testing are not violations.

9.2.2.2 A member must not exceed overall dimensions of 3'-0” x 6” x 4”. That is, it must fit into a right rectangular prism (i.e., box) of those dimensions.

9.2.3 Fasteners

9.2.3.1 A fastener is a bolt that is not part of a member, with one nut that is not part of a member. Grade is not restricted. Custom fabricated bolts and nuts are prohibited. A bolt or nut that is welded to a member does not qualify as part of a fastener.

9.2.3.2 The bolt in a fastener shall be solid, with a minimum diameter of $^{3}/_{8}$”, and no more than 1½” nominal length (bottom of head to end). The head shall be hexagonal in shape. Bolts shall be commercially available and shall not be mechanically altered or modified in any way but may be painted.

9.2.3.3 The nut for a fastener shall match the bolt. That is, the nominal size (inside diameter) must be the same as that of the bolt and permit the nut to be turned onto the bolt. Nuts shall be solid and hexagonal in shape, and shall be available commercially. Only one bolt and nothing else shall be threaded into a nut. Nuts shall not be mechanically altered or modified in any way but may be painted.

Section 10

CONSTRUCTION REGULATIONS

10.1 DEFINITIONS

10.1.1 "River, "staging yard," "footings," and "construction site boundary" are delineated by the Site Plan on the Site and Bridge Diagram.

10.1.2 "Ground" is the floor inside the construction site boundary, except for the river.

10.1.3 "Builders" and "supervisor" are undergraduate or graduate student members of a competing student organization. See section 4, "Eligibility."

10.1.4 The "build team" from a competing organization includes the supervisor and all builders who are within the construction site boundary during timed construction.

10.1.5 Some builders may be "barges." Barges operate only in the river; all other builders operate only on the ground.

10.1.6 The build team may include a "supervisor" who offers guidance to builders but shall not enter the construction site nor physically assist construction. The use of a supervisor is optional but increases construction cost.

10.1.7 The build team designates one of its members to serve as "captain" for the entire competition. The captain signifies that the build team is ready to start timed construction, declares the finish, and signs scoring forms.

10.1.8 "Personal protective equipment" consists of a hardhat meeting ANSI standard Z89.1 and protective eyewear or safety goggles meeting ANSI standard Z87.1. A team provides its own personal protective equipment.

10.1.9 A "pouch" is an optional article of clothing that may be used to carry fasteners and tools. This definition encompasses tool belts, magnets, and other accessories worn by builders and having the same function.

10.1.10 A "tool" is a device that is used to construct the bridge and is not part of the completed bridge. A team provides its own tools. Tools may be assembled during timed construction and may be powered by batteries.

10.1.11 The "constructed portion" is comprised of members and fasteners, and is created during timed construction. The constructed portion is not required to be contiguous.

10.1.12 A “temporary pier” is an optional device that is used to support the constructed portion of the bridge during timed construction. It has no other purpose, is not a tool, and is not part of the completed bridge. A team provides its own temporary pier, which may be made of any material.

10.1.13 “Member-to-member connection” is defined in 8.5. “Member” and “fastener” are defined in 9.2.2 and 9.2.3, respectively.

10.1.14 To “fasten” means making a member-to-member connection by installing a fastener to attach a member to the constructed portion or to attach two non-contiguous parts of the constructed portion.

10.2 GENERAL SAFETY CONDITIONS

Timed construction or repair will not commence or will be stopped if any provision of this sub-section (10.2) is violated.

10.2.1 The build team, judges, host personnel, and spectators must not be exposed to risk of personal injury.

10.2.2 Only builders and judges are permitted within the construction site boundary during timed construction and repair. The supervisor observes and directs construction from outside the construction site and shall not interfere with judges. Spectators, including coaches, faculty, advisers, and other associates of the team, must remain in designated areas at a distance from the construction site that assures they are not at risk and cannot interfere with the competition.

10.2.3 The build team shall include no more than six persons.

10.2.4 At all times during timed construction and repair every member of the build team shall wear personal protective equipment in the proper manner (e.g., hardhat with peak in front).

10.2.5 A tool or unassembled part of a tool shall not weigh more than twenty pounds, and not exceed overall dimensions of 3'-0” x 6” x 4”. That is, it shall fit into a right rectangular prism (i.e., box) of those dimensions. Welding machines and tools requiring external power connections shall not be used during timed construction or repair.

10.2.6 There shall be no more than one temporary pier. It must retain its original dimensions, not weigh more than twenty pounds, and not exceed 1’-6” in any horizontal dimension. That is, it should fit inside a vertical cylinder with diameter of 1’-6”.

10.2.7 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 or repair, the judge will stop the clock and explain the violation. Before the clock is restarted, the build team, tools, parts of tools, members, fasteners, and the temporary pier will be returned to the positions they occupied before the violation. Then the build team will be asked to resume construction using safe procedures. A build team will have the opportunity to construct its bridge safely. However, if the build team is not able to construct its bridge completely using safe procedures, construction will cease and the bridge will not be approved for load testing and will not be eligible for awards in any category.

10.3.1 Construction of every non-contiguous part of the constructed portion shall commence by placing a member on the ground within a footing. That member becomes part of the constructed portion. When a member is in contact with the constructed portion it becomes part of the constructed portion.

10.3.2 Surfaces of the constructed portion that bear on the ground shall be the same surfaces that will bear on the ground in the completed bridge.

10.3.3 The temporary pier shall not support tools or fasteners.

10.3.4 A member that is not part of the constructed portion shall not be supported by the temporary pier unless it is simultaneously supported by a builder.

10.3.5 The temporary pier shall not be moved while it is supporting the constructed portion, nor shall a builder simultaneously touch (or touch with tools) the temporary pier and the constructed portion.

10.3.6 Throwing anything is prohibited.

10.3.7 A builder shall not cross from the ground on one side of the river to the ground on the other side.

10.3.8 Outside the staging yard, a builder shall not simultaneously touch (or touch with tools) more than one member that is not part of the constructed portion.

10.3.9 A pouch or other article of clothing shall not be removed from a builder's person nor held in a builder's hand(s).

10.3.10 Nuts, bolts, and tools shall not be held in the mouths of builders.

10.3.11 A builder shall not use the bridge, a constructed portion of the bridge, a member, the temporary pier, or a tool to support the builder's body weight. For example, lying, standing, sitting, or kneeling on those objects is prohibited. However, a builder may lean on the 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.

10.3.12 A builder must not depend on another builder or builders for support or balance.

10.3.13 The supervisor shall not step into the construction site nor touch a builder, the bridge, a member, fastener, tool, or the temporary pier.

10.4 ACCIDENTS

In general, the clock is not stopped when there is an “accident,” i.e., an infraction of one of the provisions of this sub-section (10.4).

A time penalty is assessed for every 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, the build team, tools, members, temporary pier, and fasteners will be returned to the positions they occupied before the accident.

10.4.1 A builder who is not a barge or that builder’s clothing touches the river or the floor outside the construction site boundary. Penalty is 1/2 minute (30 seconds) for every occurrence. 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 barge or a barge’s clothing touches the ground or the floor outside the construction site boundary. Penalty is 1/2 minute (30 seconds) for every occurrence. Exception: There is no penalty for stepping out of bounds or on the ground to retrieve an object that has been dropped, such as a member, tool, nut, bolt, or personal protective equipment.

10.4.3 The temporary pier falls over or collapses while in use. Penalty is 1/2 minute (30 seconds) for every occurrence.

10.4.4 A member, constructed portion, tool, nut, bolt, or personal protective equipment touches the floor outside the construction site, the river, or the ground outside the staging yard. Penalty is 1/4 minute (15 seconds) for every item during every occurrence. Exception: The part of the constructed portion that is intended to bear on the ground may touch the ground within the footing without penalty.

10.4.5 Outside the staging yard, a member that is not part of the constructed portion touches another member that is not part of the constructed portion. Penalty is 1/4 minute (15 seconds) for every occurrence.

10.5 CONSTRUCTION SITE

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

10.6 START

10.6.1 Before construction begins, only the following items are in the staging yard: the temporary pier, all members, fasteners, tools, and unassembled parts of tools. The temporary pier and every member, tool, and fastener must be in contact with the ground within assigned areas of the staging yard as designated on the Site Plan on the Site and Bridge Diagram. Builders are within the construction site, and the supervisor is outside the boundary of the construction site. The build team is wearing personal protective equipment as well as optional clothing such as pouches. Builders start without tools and fasteners, which may be passed from one builder to another after timed construction begins. Similarly, the temporary pier is passed from builder to builder.

10.6.2 Judges inspect members, fasteners, tools, and the temporary pier as they are placed in the staging yard. Tools and temporary piers that do not conform to rules 10.2.5 and 10.2.6, respectively, shall not be used and shall be removed from the staging yard. After inspection and throughout timed construction and repair, additional members, tools, parts of tools, fasteners, temporary piers, 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, supervisor, or judge sees a condition that could cause injury, or
(2) when a safety rule has been violated (see 10.2 and 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, supervisor, or judge is injured.

10.7.2 Construction ceases while the clock is stopped. After the situation has been corrected, the build team, tools, temporary pier, and bridge components are returned to the positions they occupied before the interruption, and the clock is restarted.

10.8 TIME LIMIT

10.8.1 If construction time, not including penalties and repair time, 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 rules (10.2 and 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 and repair time, exceeds 45 minutes, judges shall 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 but may be load tested at the discretion of the head judge.

10.9 FINISH

10.9.1 Construction ends and the clock is stopped when

(1) the bridge has been completed by connecting all the members that were in the staging yard at the start of timed construction,
(2) the temporary pier is in the area of the staging yard designated on the Site and Bridge Diagram,
(3) every tool and extra fastener is held in the hands of a builder, or is in clothing worn by a builder, or is on the ground in the area of the staging yard designated on the Site and Bridge Diagram, and
(4) the captain informs the judge that construction is complete.

10.9.2 Installation of decking is not included in timed construction.

10.9.3 After construction is finished the bridge shall not be modified except for repair as permitted by 10.10 and re-installation of fasteners as required by 8.6.

10.10 REPAIR

10.10.1 Before the judges inspect and measure the bridge, and before the bridge is moved from the construction site, two members of the build team will be given one opportunity to inspect the bridge and plan any needed repairs. They will be given five minutes to accomplish this. They shall not modify the bridge, and they shall not touch the bridge except as necessary to use measuring devices. Following this inspection, builders will be permitted, but not required, to repair construction errors found by their inspectors. Repairs are made with the clock restarted and begin with the build team in the same locations they occupied at the start of construction, and with necessary items arranged in the staging yard as prescribed by 10.6.1. Safety precautions (10.2 and 10.3) are enforced and accidents (10.4) are counted. The repair period ends when the conditions listed in 10.9.1 are fulfilled and shall not be resumed. Judges will not inspect the bridge prior to the end of the repair period.

If builders commence repairs, the scoring spreadsheet will increase construction time by the sum of two minutes plus double the time required to make repairs, including any time penalties assessed during the repair period.

If, after termination of this repair period, any fastener is missing or the threads of any nut are not fully engaged, the bridge will be penalized or not approved for load testing, as specified in 8.6.

It is not necessary to inspect, measure, or repair a bridge that exceeded the 45-minute time limit prescribed in 10.8.2.

10.10.2 If the repair time, not including penalties, exceeds five minutes, judges shall halt construction. If local conditions allow, and the head judge approves, the build 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 but may be load tested at the discretion of the head judge.

Section 11

LOAD TEST INSTRUCTIONS

11.1 DAMAGE

A bridge will not be tested in a condition that compromises its strength or stability.

Specification 8.6 prescribes a penalty for fasteners that are missing or improperly installed.

A bridge with damage that would reduce its strength or stability (such as a fractured weld, missing or broken member, broken fastener, or fastener that cannot be installed correctly) shall not be approved for load testing and is not eligible for awards in any category. Repair and modifications are not permitted after the end of timed construction and repair except as required by 8.6.

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 the judge considers it to be hazardous. If competitors cannot load their bridge safely, loading will cease and the bridge will not be eligible for awards in any category.

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 student organization.

11.2.1.3 While participating in load testing, competitors shall wear 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 the competitors. Judges will not permit load testing by competitors who are not wearing the specified safety equipment or are wearing it improperly.

11.2.1.4 Damaged bridges (e.g., broken weld, missing or broken fastener, missing or broken member) shall not be tested.

11.2.2 Lateral Load Test Precautions

11.2.2.1 No more than three competitors shall be in the testing area during lateral load tests.

11.2.2.2 Bridges that sway in excess of 1” during lateral load testing must not be loaded vertically.

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 tips sideways. The intent of the provisions of this sub-section (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. No more than three competitors shall be in the testing area during a vertical load test**.**

11.2.3.2 Safety supports shall be provided by the host student organization, and shall be of adequate strength, height, and number to arrest falling load if a bridge collapses.

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 5”. 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 student organization.

11.2.3.6 No one shall reach, crawl, or step under a bridge while any portion of vertical load is in place. Safety supports must be in place before any load is on the bridge. 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.

11.2.3.8 Load on the decking shall not exceed 400 psf nor 500 pounds concentrated.

11.2.3.9 Judges shall observe sway carefully during vertical load testing. If sway exceeds 1", loading shall cease and load shall be removed carefully.

11.2.3.10 Judges shall observe vertical deflections carefully. If deflection at any target exceeds 3", loading shall cease and load shall be removed carefully.

11.2.3.11 Judges must observe the behavior of the bridge. Loading shall cease and the load shall be removed carefully if, in the opinion of a judge, a collapse is imminent.

11.3 PREPARATION

The captain must observe the load tests.

The temporary pier is not used during load tests.

The judge designates the "A" side of the bridge by a random process. The "B" side is opposite the "A" side. "Left" and "right" ends are determined by facing the "A" side.

Teams must accept imperfect field conditions such as bent decking, sloping floors, and unfavorable floor surfaces.

At their discretion, judges may impose a penalty for a bridge that incorporates parts having the primary function of interfering with placement of targets, 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 is not eligible for awards in any category.

"Sway" is translation in any horizontal direction. Typically, sway is determined by using a plumb bob attached to the bridge at a specified target. A sway requirement is failed if any part of the bridge causes the displacement of the plumb bob at floor level to exceed the specified limit, even if the plumb bob is not attached to that part.

11.4 LATERAL LOAD TEST

The provisions of this sub-section (11.4) are illustrated by the Lateral Load Test detail on the Loading Diagrams drawing.

The lateral load test is conducted with one decking unit placed at the center of the bridge and approximately 75 pounds of weight on the decking near the “B” 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 competitors. This lateral restraint does not restrain rotation or uplift. The restraint is applied as close to the floor as possible, at the locations shown on the Lateral Loading Diagram. Competitors may provide and use optional devices to prevent sliding. 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.

A sway target is established for measurement on the “A” side of the bridge, 9’-0” from the right end of the decking support surface. The sway target is located at the level of the decking or at the top of the decking support surface, which is the bottom of the decking.

Apply a 50-pound lateral pull and measure the sway. The pulling force is located as close as possible to the decking support surface and not more than 4” from the sway target. To pass the lateral load test, the sway must not exceed 1”.

If the bridge does not pass the lateral load test it is not approved for further testing. **Do not conduct any other load test**. Check the appropriate box on the judges’ scoring form. The spreadsheet will add penalties of $20,000,000 to the Construction Economy score and $40,000,000 to the Structural Efficiency score when the judging data is entered.

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

11.5 VERTICAL LOAD TEST

The provisions of this section are illustrated by the Vertical Load Test details on the Loading Diagrams drawing. “Deflection” is translation in a vertical direction.

Safety supports are placed under the decking so that no portion of the load will drop more than approximately 5” if the bridge collapses.

Decking units are 3’-0” long in the longitudinal (span) direction of the bridge. Two decking units are used for the vertical load test. Place the decking units at distances M1 and M2 from the right end of the decking support surfaces. M1 and M2 are determined at the beginning of the competition as described by Table 7.1 in section 7, “Schedule of Competition.” Decking units are placed square with the bridge and centered laterally with the main bars spanning laterally over the decking support surfaces. Decking units shall not be attached to the bridge and shall not distort it (see 8.3.4).

Three vertical deflection targets are located as close as possible to the decking support surface, which is at the same level as the bottom of the decking. The targets are at the following locations

- A side of the bridge, centered on the M1 decking unit.
- B side of the bridge, centered on the M1 decking unit.
- A side of the bridge, centered on the M2 decking unit.

A decking unit that does not contact the decking support surface at a vertical deflection target will be clamped to the decking support surface at that location, and the clamp will remain in place during vertical load testing.

Position measuring devices on the three vertical deflection targets.

Uniformly distribute 100 pounds of preload on the M1 decking unit. The preload is laterally centered on the decking unit. The preload is distributed and aligned identically for every bridge.

If a competitor disturbs a measuring device after it has been initialized and before loading is completed and all measurements have been recorded, the judge will require the team to disassemble the bridge and repeat timed construction beginning with the initial conditions prescribed in 10.6. 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 125% of C_c (not including load test penalties) for the initial run.

Vertical loading produces three measurements

(1) D1A = absolute value of vertical deflection at the target on the “A” side of decking unit M1.
(2) D1B = absolute value of vertical deflection at the target on the “B” side of decking unit M1.
(3) D2A = absolute value of vertical deflection at the target on the “A” side of decking unit M2.

The scoring spreadsheet computes aggregate deflection as the sum of those three measurements.

Load the bridge and measure the deflections, using the following procedure

(1) The preload remains in place.
(2) Initialize the sway measurement device.
(3) Initialize the three vertical deflection measuring devices or record the initial readings.
(4) Competitors place L1 pounds of additional load on decking unit M1, and then place L2 pounds of load on decking unit M2. L1 and L2 are determined at the beginning of the competition as described by Table 7.1 in section 7, “Schedule of Competition.” Load is laterally centered on the decking unit and is distributed over the length of the decking unit as uniformly as possible at all times during loading. Load is distributed and aligned identically for every bridge. Load shall be placed at a steady pace, without hesitation.
(5) As the load is being placed, observe the deflection and sway targets. Stop loading if
    (a) sway exceeds 1”, or
    (b) deflection at any deflection target exceeds 3” 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 is not eligible for awards in any category. Remove the load and **do not continue load testing**. Check the appropriate box on the judge’s scoring form.

If the bridge passes, record the final readings for D1A, D1B, and D2A. If any of those values exceeds 2”, the scoring spreadsheet will add penalties of $8,000,000 to the Construction Economy score and $20,000,000 to the Structural Efficiency score.

11.6 Unloading

If the bridge collapses during unloading (situation c, d, or e), it is not eligible for awards in any category.

Section 12

EQUIPMENT PROVIDED BY HOST

12.1 SOURCES OF INFORMATION

Equipment for hosting a competition is listed and described by the Competition Guide at http://www.nssbc.info. This site also includes competition procedures and illustrations of bridge details that demonstrate compliance and non-compliance with specifications and regulations. Host personnel, judges, and competitors are encouraged to review the site.

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

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 50 pounds. However, the host may provide a different type of decking with approximately the same dimensions. 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 5" if the bridge collapses. Safety supports may be steel, nested stacks of plastic buckets, timbers, sand bags, or masonry units.

12.4 LOAD

A total load of 2500 pounds should be supplied in uniform pieces of 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 5" x 5" x $^{5}/_{16}$" steel angle placed perpendicular to the length of the bridge. Sacks of material, containers of liquid, concrete blocks, or jacking systems could be used. Decking is not included as part of the 2500 pound load.

Section 13

INTERPRETATION OF RULES

The web site http://www.aisc.org/steelbridge lists clarifications of the rules. Competitors, judges, and host personnel may submit questions via a form on that web site but should **first read the previously posted clarifications, reread this Rules document carefully in its entirety, and review the Competition Guide at** http://www.nssbc.info. Submitters' names and affiliations must accompany clarification requests and will be posted with the questions and answers. Internet 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 5, 2014.

Section 14

JUDGING

The host student organization will recruit judges. Judges are empowered to halt any activity that they deem to be hazardous. Judges have full authority over 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 student organization will assure that the judges are fully informed of the Rules and procedures, and fully equipped for their tasks. More information for host organizations and judges is available at http://www.aisc.org/steelbridge and at http://www.nssbc.info, where the official scoring spreadsheet may be downloaded and the Competition Guide reviewed.

Section 15

APPEALS

15.1 CONFERENCE COMPETITIONS

15.1.1 At the beginning of the competition each team will identify its captain. The host organization will identify the conference head judge (CHJ).

15.1.2 A penalty, decision, measurement, score, or condition of competition may be appealed only by the team captain and only to the CHJ. The CHJ will not hear the appeal if he or she is approached by students other than the team captain. The CHJ 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 CHJ will hear the appeal as soon as possible and may interrupt the competition. If the captain does not consent to the decision of the CHJ, he or she shall write an explanation on the judge's scoring sheet 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 conference competition, the team captain has the option to appeal the decision of the CHJ by e-mail to Ms. Maria Mnookin <mnookin@aisc.org> or by letter to Ms. Mnookin (AISC, Suite 700, One E. Wacker Dr., Chicago, IL 60601-2001). The e-mail message or letter shall include

(1) name of the college or university making the appeal,
(2) captain's name, e-mail address, postal address, and telephone number,
(3) faculty adviser's name, e-mail address, postal 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,
(7) data showing that the team should have qualified for national competition, and
(8) captain's signature (letter only).

The SSBC Rules Committee may ask the host student organization to provide judges' scoring forms documenting the problem and may confer with the CHJ.

15.1.4 Appeals must be made by e-mail or letter. An appeal will be considered only if the e-mail is received or the letter is postmarked by 5:00 PM Eastern Daylight Saving Time on the Wednesday immediately after the conference competition. Ms. Mnookin will forward the appeal to the SSBC Rules Committee for their evaluation. The Committee will not respond to an appeal until the official scoring spreadsheet for that conference has been submitted by the host organization to ssbc.results@gmail.com. The only redress that may be made is an invitation to participate in the national competition if the Committee is convinced that the appeal is valid and that the appealing team should have qualified for the national competition. Decisions and rankings made by conference judges will not be overturned.

15.2 NATIONAL COMPETITION

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, or condition of competition may be appealed only by a team captain and only to the station head judge (SHJ). The SHJ will not hear the appeal if he or she is approached by students other than the team 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. Participants 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 team 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 team 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 and ASCE welcome written suggestions for improving future competitions.

Section 16

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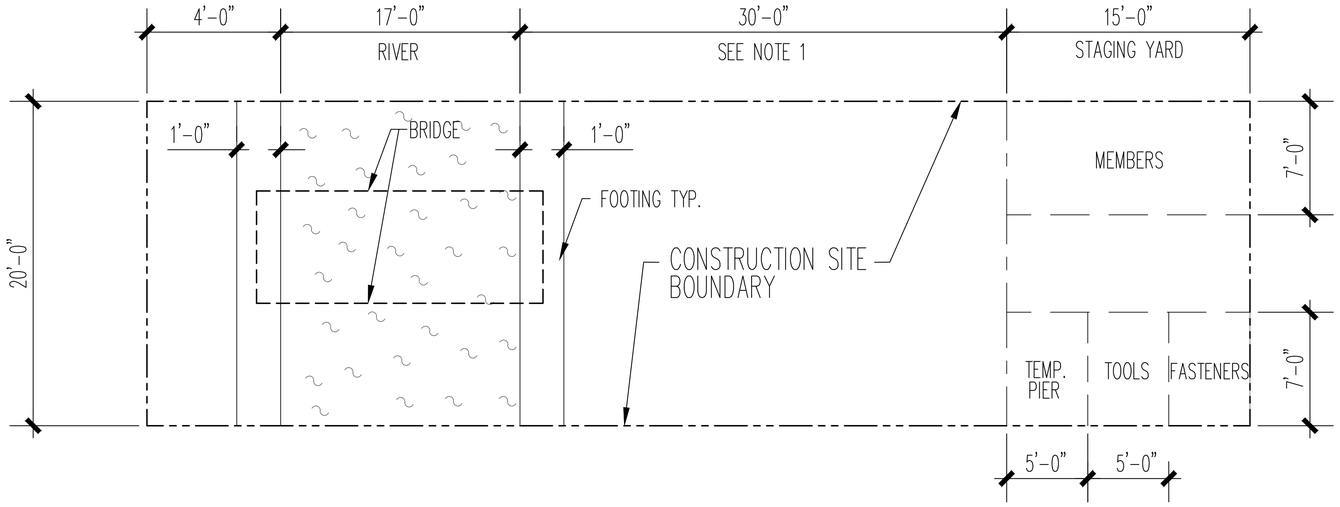
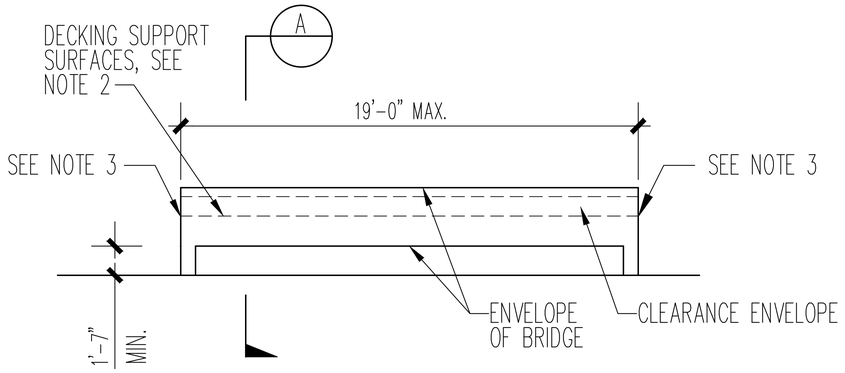


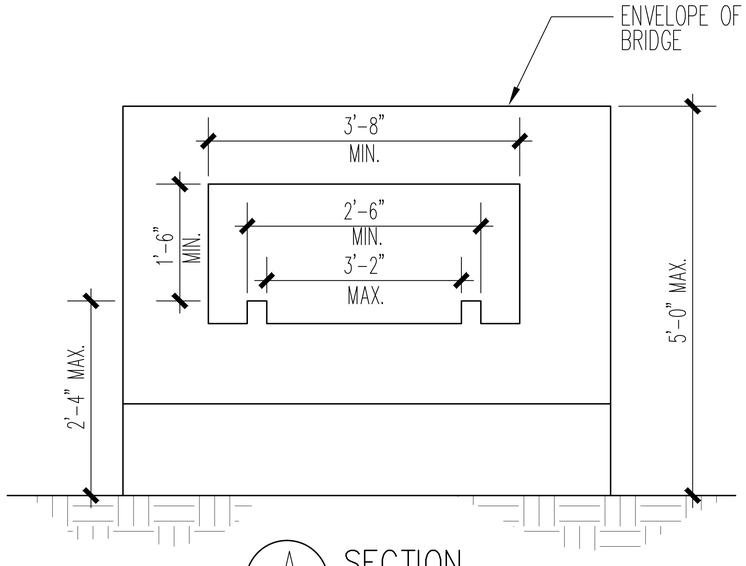
NOTES:

1. LENGTH CAN BE ADJUSTED TO FIT SITE CONDITIONS.
2. BRIDGE SHALL ACCOMODATE DECKING THROUGHOUT OVERALL LENGTH OF THE BRIDGE.
3. NO PART OF THE BRIDGE SHALL EXTEND BEYOND DECKING SUPPORT SURFACES (AT BOTH ENDS).

SITE PLAN – REFER TO CHAPTERS 8 & 10



ELEVATION – REFER TO CHAPTER 8



A SECTION

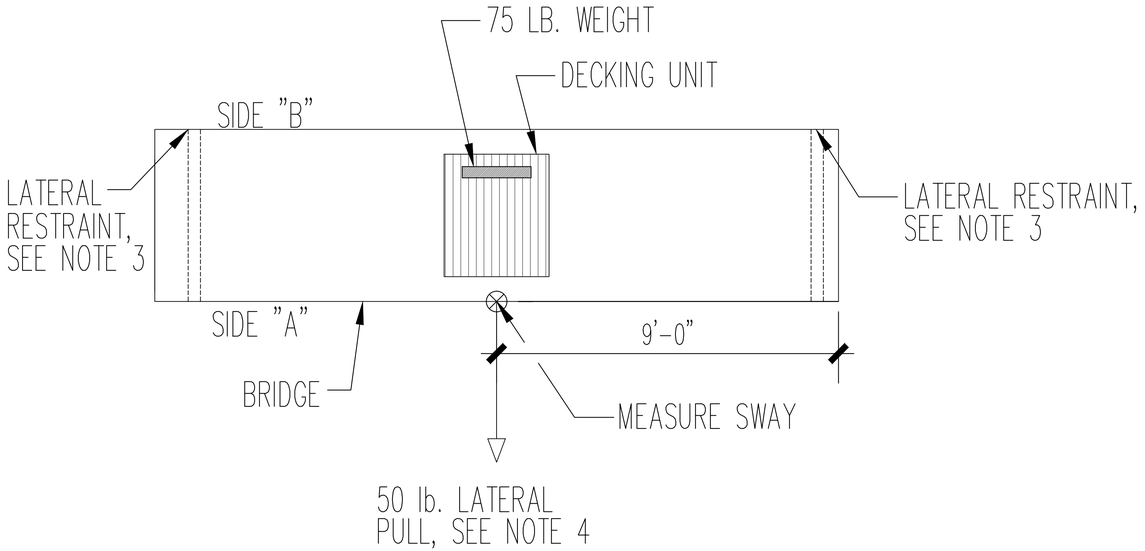
REV.	BY	DATE	APP	REC NO.	EXPIRES	SEAL HOLDER	DESCRIPTION
							2013 SSBC RULES

DESIGNED BY F. HATFIELD
DRAWN BY D. SEPULVEDA
CHECKED BY RULES COMM.
N CHARGE N. GAVLIN
DATE 08-20-2013

ASCE-AISC
STUDENT STEEL BRIDGE CONTEST
SUBMITTED
APPROVED

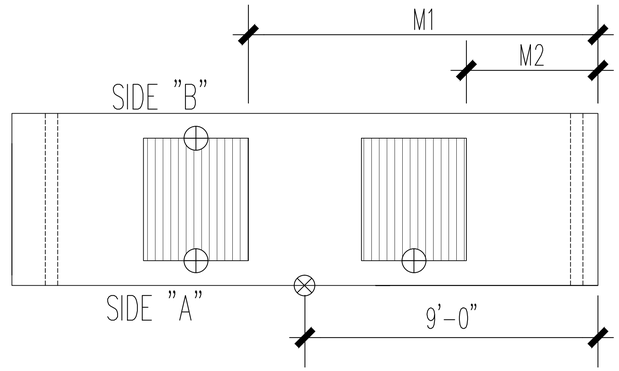
SITE AND BRIDGE DIAGRAM

CONTACT NUMBER
DRAWING NO. DWG 1
SCALE NTS
SHEET NO.



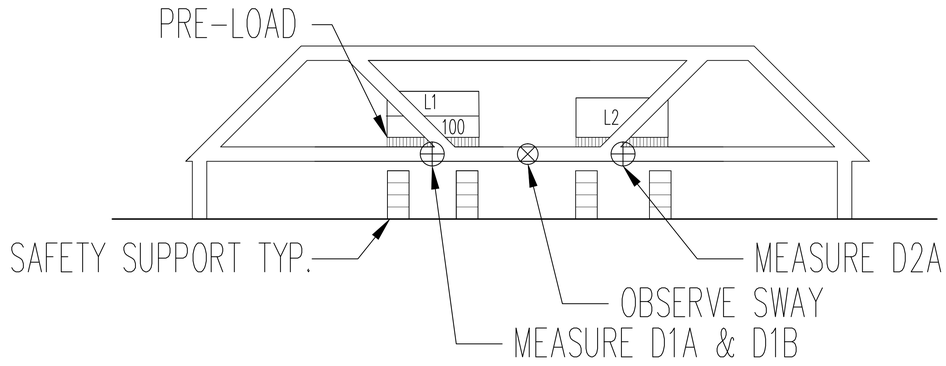
LATERAL LOAD TEST

REFER TO 11.4



LOCATION OF DECKING AND TARGETS FOR VERTICAL LOAD TEST

REFER TO 11.5



VERTICAL LOAD TEST

REFER TO 11.5

NOTES:

1. SAFETY SUPPORTS TO BE IN PLACE UNDER THE LOAD AND TO REMAIN AT ALL TIMES DURING LOADING.
2. ALL LOADING SAFETY PROCEDURES TO BE FOLLOWED.
3. LATERAL RESTRAINT MUST BE APPLIED CLOSE TO THE GROUND AND MUST NOT RESTRAIN ROTATION, UPLIFT, OR TRANSLATION IN OTHER THAN THE LATERAL DIRECTION.
4. LOCATION OF 50 lb. PULL SHALL NOT EXCEED 4" FROM SWAY TARGET.
5. SWAY TARGET IS TO REMAIN IN PLACE THROUGHOUT LOADING PROCESS.
6. LOADS ARE CENTERED LATERALLY AND DISTRIBUTED OVER THE DECKING UNIT AS UNIFORMLY AS POSSIBLE DURING LOADING.
7. OBSERVE SWAY AND TERMINATE LOADING IF SWAY EXCEEDS 1 INCH.

REV.	BY	DATE	APP	REC NO.	EXPIRES	SEAL HOLDER	DESCRIPTION
							2013 SSBC RULES

DESIGNED BY F. HATFIELD
DRAWN BY D. SEPULVEDA
CHECKED BY RULES COMM.
N CHARGE N. GAVLIN
DATE 08-20-2013

ASCE-AISC
STUDENT STEEL BRIDGE CONTEST
SUBMITTED
APPROVED

LOADING DIAGRAMS

CONTACT NUMBER
DRAWING NO. DWG 2
SCALE NTS
SHEET NO.