



## STUDENT STEEL BRIDGE COMPETITION

# 2018 RULES

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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 Galvanizers Association (AGA)
- 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 Tube Institute (STI)

This document, which is available at [www.aisc.org/nssbc](http://www.aisc.org/nssbc), describes the Student Steel Bridge Competition and states the 2018 rules for both conference and national levels. **Clarifications, which include any revisions to the rules, are published at that web site and do not appear in this document although they are formal addenda to the rules.** The web site includes the form for requesting clarifications and other information. Information at the web site takes priority over any other source except as herein noted.

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## WELCOME

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

## Section 1

### MISSION AND 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, culminating 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 and erection processes, safety, esthetics, 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 universities, 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 and ASCE request 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. 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 colleges and universities.

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.

## 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, display, efficiency, and economy are listed in “Scoring.” Competition judges and the 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 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 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 from beginning to end and then review the Competition Guide at [www.nssbc.info](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 those forms prior to the competition.

Results of the previous year’s national competition are posted at [www.nssbc.info](http://www.nssbc.info).

Members of the Student Steel Bridge Rules Committee are

- Nancy Gavlin, S.E., P.E., Director of Education, AISC
- Jennifer Greer-Steele, Committee on Student Members Corresponding Member, ASCE
- Frank J. Hatfield, P.E., Professor Emeritus, Michigan State University
- Lawrence F. Kruth, P.E., Vice President of Engineering and Research, AISC
- Tony Palmer, P.E., Project Manager, Hargrove Engineers + Constructors
- John M. Parucki, Structural Steel Consultant
- Leslie Payne, Director, Student and Younger Member Programs, ASCE
- Don Sepulveda, P.E.
- Matthew Shergalis, P.E., Northeast Regional Director, National Steel Bridge Alliance

### **Section 3**

## **PROBLEM STATEMENT**

Portland's Bridge of the People, opened in 2015, is the first major bridge in the U.S. to carry mass transit, bicycles, pedestrians, and emergency vehicles while prohibiting private motor vehicles. The intent is to serve growing populations without overwhelming antiquated road infrastructure in the formerly industrial districts on both banks of the Willamette River.

Confronted with similar problems, the Burgeon County Transportation Commission (BCTC) is conducting a feasibility study that includes a competition to identify the best design for a limited access, short span bridge. Your company is invited to compete by submitting 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. Construction cost and duration, and esthetics are important considerations. Virtual costs are assigned to critical features, including a sliding scale for material that promotes robustness without wastefulness. BCTC engineers will judge the competition and will award the design/build contract to the company whose model satisfies specified requirements and best achieves project objectives.

Steel is specified for ease of prefabrication, rapid erection, superior strength to weight ratio, durability, and high level of recycled content. Designs with permanent or temporary piers in the river will not be considered. Existing infrastructure on the banks also precludes permanent and temporary piers, as well as restricting the size of work zones, requiring remote staging of material and equipment, and limiting the size and number of members to be transported. Models will not include deck, foundations, and approaches.

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 LEVELS OF COMPETITIONS

There are two levels of competition: United States of America (USA) conference and national. USA conference competitions are held in conjunction with ASCE annual student conferences in the USA. Outstanding performance in USA conference competitions, and only in those 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 USA student conference, and a college or university may compete in only one ASCE USA student conference.

**4.2.2** ASCE student chapters hosting conferences may invite guest teams, which are teams from colleges or universities that do not have ASCE student chapters or from official ASCE student chapters that are assigned to different conferences. Conference assignments are listed in the ASCE Official Register at [www.asce.org/offreg](http://www.asce.org/offreg), and conference host chapters are listed at [www.asce.org/studentconferences](http://www.asce.org/studentconferences).

**4.2.3** A team shall consist only of undergraduate and graduate students in good standing with their ASCE student chapter 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 [www.nssbc.info](http://www.nssbc.info).

**4.2.5** The host student chapter shall promptly submit the completed official scoring spreadsheet for a conference competition to [ssbc.results@gmail.com](mailto: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

- (1) was a guest team as defined in sub-section 4.2.2, or
- (2) was a non-guest team in a conference competition outside the USA, or
- (3) is from a chapter that is not in good standing with ASCE, or
- (4) is from a chapter that has not satisfied ASCE requirements regarding participation in its conference, or
- (5) was not ranked for awards at its conference competition.

ASCE requirements for good standing and for conference participation are listed at [http://ektronstaging.asce.org/eligibility\\_for\\_national\\_competitions](http://ektronstaging.asce.org/eligibility_for_national_competitions).

**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 sub-section 4.2.2.

- (1) The single eligible team with the best overall performance rating will be invited from a conference in which two, three, or four non-guest teams competed.
- (2) The top two eligible teams in overall performance will be invited from a conference in which five to thirteen non-guest teams competed.
- (3) The top three eligible teams in overall performance will be invited from a conference in which fourteen to twenty-one non-guest teams competed.
- (4) The top four eligible teams in overall performance will be invited from a conference in which twenty-two or more non-guest teams competed.

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

**4.3.4** A team shall consist only of undergraduate and graduate students who were in good standing with their ASCE student chapter during all or part of the academic year leading up to the NSSBC.

**4.3.5** Bridges may be modified in preparation for NSSBC.

## 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, 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 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 judges' data forms printed from the official scoring spreadsheet downloaded from [www.nssbc.info](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.

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.

The completed official scoring spreadsheet for a conference competition shall be submitted to [ssbc.results@gmail.com](mailto:ssbc.results@gmail.com) by the host student chapter as soon as possible after the competition. **Conference results are not final until the spreadsheet is submitted.** Questions and comments regarding the spreadsheet should be sent to [ssbc.results@gmail.com](mailto:ssbc.results@gmail.com).

Judges' data forms shall be retained by the host student chapter 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, and all parts of the assembled bridge must be visible during display judging. 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, [www.asce.org/find-a-chapter](http://www.asce.org/find-a-chapter). 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 display rating.

**6.2.1.3** Poster describing design. The poster shall present the following

- (1) identification of the college or university, using the same name that appears on the bridge,
- (2) brief explanation of why the overall configuration of the bridge was selected,
- (3) scaled, dimensioned side view of the bridge,
- (4) free-body diagram of a single beam that represents the entire bridge, with the same end-to-end length, supports at ends only, loads for one of the cases specified in sub-sections 7.1(6) and 11.5, and reaction forces,
- (5) shear and moment diagrams of the beam corresponding to that free-body diagram, showing peak magnitudes,
- (6) provisions for Accelerated Bridge Construction (ABC), such as design features, construction sequencing, and procedures intended to minimize construction time, and
- (7) acknowledgement of university technicians, faculty, and others who helped fabricate the bridge or provided advice.

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.

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.

The display rating will be very poor if there is no poster or if it is grossly inadequate. Electronic displays, decorated supports, lights, and sound are not permitted and will result in a poor rating. 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 9.4, 10.4, and 10.8.1. 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, 9.5, and 10.4.2. Measured weight is the weight of the bridge as determined by scales provided by the host student chapter. 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

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

“Total time” is defined in 6.2.2, “builder” is defined in 10.1.1, and “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

If measured weight does not exceed 120 pounds,

rev 1. 
$$C_s = (\text{Total weight} - \text{measured weight}) (\text{pounds}) \times 5000 (\$/\text{pound}) \\ + \text{Aggregate deflection} (\text{inches}) \times 3,000,000 (\$/\text{inch}) \\ + \text{Load test penalties} (\$).$$

If measured weight exceeds 120 pounds but does not exceed 200 pounds,

$$C_s = (\text{Total weight} - 120) (\text{pounds}) \times 5000 (\$/\text{pound}) \\ + \text{Aggregate deflection} (\text{inches}) \times 3,000,000 (\$/\text{inch}) \\ + \text{Load test penalties} (\$).$$

If measured weight exceeds 200 pounds,

$$C_s = (\text{Total weight} - 184) (\text{pounds}) \times 25,000 (\$/\text{pound}) \\ + \text{Aggregate deflection} (\text{inches}) \times 3,000,000 (\$/\text{inch}) \\ + \text{Load test penalties} (\$).$$

“Measured weight” and “total weight” are defined in 6.2.3, and “aggregate deflection” is defined in 11.5.2, which also prescribes “load test penalties.”

### 6.2.7 Overall Performance

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

## 6.3 SPREADSHEET FOR SCORING

The scoring spreadsheet is available in the Competition Guide at [www.nssbc.info](http://www.nssbc.info). Questions and comments regarding the spreadsheet should be sent to [ssbc.results@gmail.com](mailto:ssbc.results@gmail.com). 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.

## Section 7

### SCHEDULE OF COMPETITION

In the months before the competition, students design their bridges, fabricate members, test load, practice construction, and designate the competition team. The host student chapter procures a venue, organizes equipment (section 12), and recruits judges (section 14). Judges are prepared by reviewing current year 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/nssbc](http://www.aisc.org/nssbc).

#### 7.1 RECOMMENDED SCHEDULE

- (1) The official scoring spreadsheet is downloaded from [www.nssbc.info](http://www.nssbc.info), and judges' data forms are generated from that spreadsheet.
- (2) Using a randomizing process, the head judge or host student chapter determines the order in which teams will compete.
- (3) Bridges are erected for public viewing and are judged for display. After the start of display judging, bridges shall not be altered, modified, or enhanced in any way.
- (4) Bridges are disassembled.
- (5) In a meeting at which all team captains are present, the head judge clarifies rules and conditions of the competition, and answers questions.
- (6) Immediately before timed construction of the first bridge, the head judge rolls a die to determine the locations of decking units. These designations will guide load tests as described in 11.4.1, 11.5.1, and the Load Test Diagrams. For each possible result S of the roll, Table 7.1 gives the dimensions for positioning decking units.

**TABLE 7.1 Determination of L1 and L2**

S	L1	L2
1	6'-8"	1'-0"
2	7'-0"	3'-6"
3	8'-4"	3'-0"
4	9'-0"	5'-5"
5	9'-7"	3'-4"
6	10'-0"	4'-7"

The same values of L1 and L2 will be used for all bridges in the same conference competition. East and west ends are determined individually for each bridge after construction by a randomizing process (e.g., coin flip). Left and right sides are relative to travel from west to east.

- (7) 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 10.1.12, 10.2.3, and 10.6 for details.
- (8) Timed construction. See section 10, "Construction Regulations," for details.

- (9) Judges inspect assembled bridges. For details, see section 9, “Structural Specifications.” Between corrections described in 9.4 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.
- (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 and not ranked for awards.**
- (11) Load testing. See section 11, “Load Test Instructions,” for details.
- (12) After a team has completed all phases of the competition, data for the team is transcribed from the judges’ data forms into the official scoring spreadsheet and checked by the team 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.
- (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 chapter submits the completed official scoring spreadsheet by e-mailing it to the address given on that spreadsheet as soon as possible after completion of the competition.
- (16) The host student chapter retains judges’ data 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 the die is rolled.
- (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 connection corrections described in sub-section 9.4.

## Section 8

### MATERIAL AND COMPONENT SPECIFICATIONS

#### 8.1 MATERIAL

For the purposes of this competition, steel is defined as an iron alloy that is strongly attracted to the magnet provided by the host chapter. **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 ranked for awards in any category. The bridge may be constructed and load tested at the head judge's discretion if that can be done safely within available time. See 8.2 for definitions of "member," "nut," and "bolt."

#### 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 non-compliant 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 definitions of "member," "loose," "bolt," and "nut."

##### 8.2.1 Bridge

A bridge shall be constructed only of members, loose bolts, and loose 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** A member is a rigid component of the finished bridge. Parts of a member are welded\* together. Bolts and nuts that are welded\* to a member are parts of that member and are not considered to be loose. 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.

**8.2.2.2** A member shall 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.

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\* **Health advisory:** The bright silvery or colored coating on bolts, nuts, threaded rod, 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.**

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

### **8.2.4 Loose and Welded Nuts**

**8.2.4.1** Nuts shall have the external shape of a hexagonal prism 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 and thickness.

### **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, 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 ranked for awards in any category. 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 straight stringers, each of which is contiguous over its full length so that decking could be placed on the tops of the stringers anywhere along the span. See Section 1 on the Bridge Diagram.

**9.2.2** The bridge shall provide access for safely placing 3'-6" wide decking and load.

**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.

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

**9.2.6** Teams shall accept and accommodate conditions at the competition site.

## 9.3 USABILITY

Specifications in this sub-section (9.3) are illustrated by the Bridge Diagram.

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", and
- (4) if a violation exceeds 2", the bridge will not be ranked for awards in any category. 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. Refer to 10.1.8 for definition of "footings."

**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 under the bridge 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: 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 seventeen 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 construction zone boundaries.

**9.3.8** The bridge shall provide a straight, clear passageway conforming to the Clearance Template detail on the Bridge Diagram. To verify compliance with 9.3.8 and 9.3.9, judges will slide the template along the tops of the stringers while holding it plumb and perpendicular to the span of the bridge. 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 penalty for non-compliance with 9.3.8 is based on the projection of an obstruction onto the template, measured perpendicularly from the obstructed edge.

**9.3.9** The tops of both stringers shall contact the tops of the two rabbets in the template at every location along the full length of the stringers during the verification procedure described in 9.3.8. The penalty for non-compliance with 9.3.9 is based on the vertical distance down from the top of a rabet to the top of the corresponding stringer. If the same obstruction causes a violation of both 9.3.8 and 9.3.9, the judge will record only the larger violation.

**9.3.10** 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 all connections. If any connection still violates specification 9.4.1, 9.4.2, or 9.4.3 when that time limit is reached, the bridge will not be ranked for awards in any category and will not be load tested.

**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 bolt or 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 bolt or externally threaded member shall be secured with a nut, and each individual nut shall fully engage the threads of the matching bolt or member. That is, the terminal threads of the bolt or 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 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 or loose bolt shall be tightened sufficiently so that the nut or bolt head contacts the outer ply of the connection. Penalty is one minute added to construction time for each individual violation. 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. A penalty of 25 pounds will be added to the weight of the bridge for each individual threaded end, nut, and bolt head that cannot be inspected.

## Section 10

### CONSTRUCTION REGULATIONS

#### 10.1 DEFINITIONS

**10.1.1** “Builders” are undergraduate or graduate students who construct the bridge and are part of a team. See section 4, “Eligibility.”

**10.1.2** The team designates one builder to serve as “captain” for the entire competition. The captain signifies that the builders are ready to start timed construction, declares the finish, and signs data forms.

**10.1.3** The “site boundary” encloses the “construction site,” which is comprised of “river,” “construction zones,” “transportation zones,” and “staging yards.” All construction activities are conducted within the site boundary. The host student chapter marks the site boundary and its enclosed features on the floor before the competition, as illustrated by the Site Diagram.

**10.1.4** The “river” represents a restricted natural feature.

**10.1.5** Builders on the ground in the “construction zones” put members together to create the bridge.

**10.1.6** Builders carry members, tools, nuts, and bolts across the “transportation zones.”

**10.1.7** “Staging yards” are occupied by builders and objects at the start and finish of timed construction.

**10.1.8** “Footings” are areas marked on the floor within the construction zones.

**10.1.9** “Ground” is the floor inside the site boundary, including footings, construction zones, transportation zones, and staging yards, but excluding the river.

**10.1.10** “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.

**10.1.11** A “pouch” is an optional article of clothing that is used to carry nuts, bolts, and tools. This definition encompasses tool belts, magnets, lanyards, and other accessories worn by builders and having the same function.

**10.1.12** A “tool” is a device that is used to construct the bridge but is not part of the completed bridge. A team provides its own tools.

**10.1.13** “Member,” “loose bolt” and “loose nut” are defined in sub-section 8.2.

**10.1.14** A “constructed portion” is comprised of two or more members in contact with one another, with or without loose nuts and loose bolts, and is created during timed construction by builders on the ground in the construction zones. There may be multiple constructed portions.

## **10.2 PRE-CONSTRUCTION CONDITIONS**

Timed construction will not commence if any provision of this sub-section (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** A tool shall not weigh more than fifteen pounds. 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** 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. Then builders will 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 ranked for awards in any category.

**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 student chapter. **Bridges and participants shall accommodate local conditions.**

## 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 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 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, loose nut, loose 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.

**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 Diagram for layout of the construction site. The host student chapter 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 drawing.

## 10.6 START

**10.6.1** Before construction begins, only the following are in 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 Diagram. Loose nuts may be installed on loose bolts. Builders are wearing personal protective equipment as well as optional clothing such as pouches. Builders start without members, tools, nuts, and bolts, which may 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 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 10.2 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 or judge is injured.

**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, and the clock is restarted.

## **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 (10.2 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 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, 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 ends and the clock is stopped 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 and 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, 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** 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 ranked for awards in any category. 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 the judge considers it to be hazardous. If a team cannot load its bridge safely, loading will cease and the bridge will not be ranked 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 chapter.

**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 three 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 ranked for awards in any categories.

### **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 sideways off the bridge. 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. The loading crew is limited to three students, but substitutions may be made during the loading process.

**11.2.3.2** Safety supports shall be provided by the host chapter, 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 six 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 student chapter.

**11.2.3.6** No one shall reach, crawl, or step under a bridge, or stand inside a bridge while any portion of 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 ranked for awards in any category.

**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 three-person limit.

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

For each bridge, the judge will determine by a randomizing process (e.g., coin flip) which end is the east end. The other end is the west end. Left and right sides are relative to travel from west to east.

Positions L1 and L2 of decking units and lateral load are determined at the beginning of the competition as described by paragraph 7.1 (6) and illustrated by the Lateral Load Test Plan and Vertical Load Test Plan on the Load Test 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 ranked 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 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 Load Test Diagrams.

### 11.4.1 Set Up

Lateral load tests are conducted with one decking unit positioned at a distance L1 from the east end of the stringers and approximately 75 pounds of weight on that decking near the left 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 Load Test Diagrams. Teams 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.

### 11.4.2 Lateral Load Test

A fifty-pound lateral load is applied and sway is measured on the right side of the bridge, centered on the decking unit positioned at L1. 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 test is failed if sway exceeds one inch.

**If the bridge fails the lateral load test it will not be ranked for awards in any category. Do not conduct the vertical load test.** Check the appropriate box on the judges' data form.

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 Plan and Vertical Load Test on the Load Test Diagrams.

### 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 tops of the stringers.

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 six inches if the bridge collapses.

**11.5.1.3** "Deflection" is vertical translation. Deflections are measured as close as possible to the tops of stringers, which are at the same level as the bottom of the decking. Measurements are made at the following locations

- D1 centered on the left side of the decking unit positioned at L1.
- D2 centered on the left side of the decking unit positioned at L2.

Sway is observed on the right 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 identically for each bridge. 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 ranked for awards in any category. **Do not continue load testing.** Ask the crew to remove the load carefully. Check the appropriate box on the judge's 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. 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 D1 and D2, or record the initial readings.
- (4) The crew places 1400 pounds of additional load on the decking unit at L1.
- (5) The crew places 1000 pounds of additional load on the decking unit at L2.
- (6) Record the final readings for D1 and D2.

#### **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 specifications in section 8 and sub-section 9.3 will not be checked again, but compliance with specifications in 9.4 and 9.5 will be verified. 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 L2 decking unit is removed before the load on L1. If the bridge collapses during unloading (situation c, d, or e in 11.5.2), 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 in the Competition Guide at [www.nssbc.info](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 student chapter, 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 fifty pounds. However, the host may provide a different type of decking with approximately the same length and width. 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 six inches if the bridge collapses. Safety supports may be steel, nested stacks of plastic buckets, jack stands, timbers, sand bags, or masonry units.

### 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 5" x 5" x  $\frac{5}{16}$ " steel angle placed perpendicular to the length of the bridge. Alternatively, 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. 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 Diagram. Plywood is recommended. Holes for handholds are helpful but optional.

## Section 13

### INTERPRETATION OF RULES

The web site [www.aisc.org/nssbc](http://www.aisc.org/nssbc) lists clarifications of the rules. Students, 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 [www.nssbc.info](http://www.nssbc.info)**. 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 7, 2018.

## Section 14

### JUDGING

The host student chapter 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 chapter will assure that the judges are fully informed of the rules and procedures, and fully equipped for their tasks. More information for host chapters and judges is available at [www.aisc.org/nssbc](http://www.aisc.org/nssbc) and at [www.nssbc.info](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 chapter will identify the conference head judge (CHJ).

**15.1.2** A penalty, decision, measurement, score, condition of competition, or interpretation of rules 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 anyone 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 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 conference competition, the Rules Committee will consider only those appeals that allege errors in interpretation of rules, and only if those appeals were made to the CHJ during the conference competition in conformance with 15.1.2. Appeals should be submitted by e-mail to Ms. Maria Mnookin [mnookin@aisc.org](mailto: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 adviser'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 ask the host student chapter to provide judges' data forms documenting the problem and may confer with the CHJ.

**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 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 chapter to [ssbc.results@gmail.com](mailto: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, condition of competition, or interpretation of rules 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 anyone 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. 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 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.

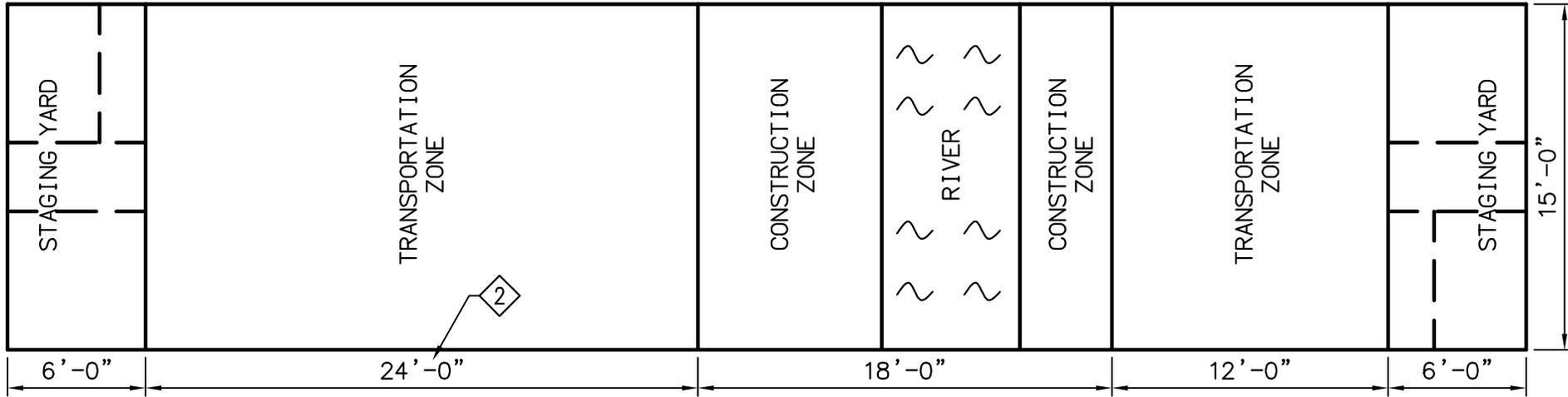
**15.2.4** If the team has justification to contest the NHJ's ruling, the team captain has the option to appeal that decision directly to the SSBC Rules Committee within fifteen minutes after hearing the NHJ's ruling. The Committee may request information from the NHJ and SHJ but those judges will not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

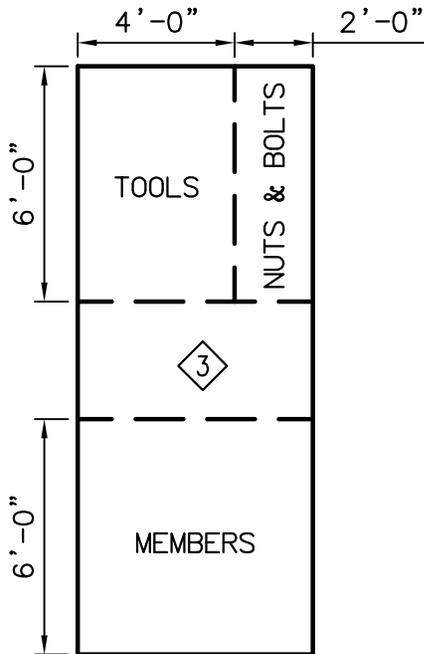
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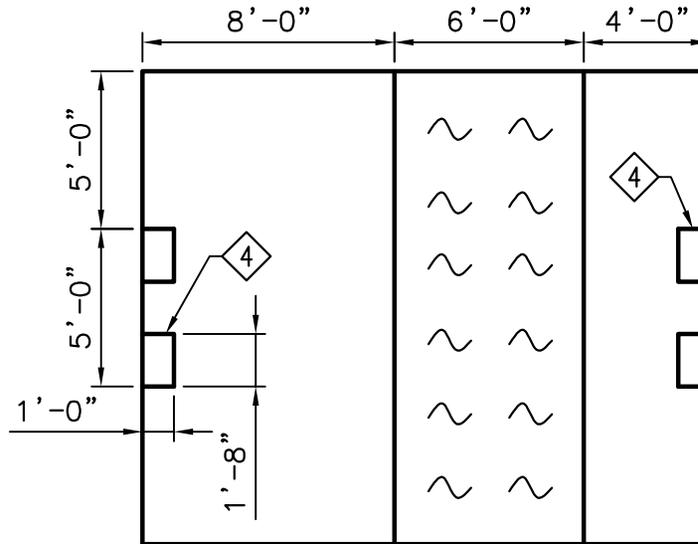
**SITE PLAN**

SCALE: NTS



**STAGING YARD DETAIL**

SCALE: NTS



**CONSTRUCTION ZONE AND RIVER DETAIL**

SCALE: NTS

**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, and locations are identical on both sides.

REV	BY	DATE	APP	REC NO.	EXPIRES	SEAL HOLDER	DESCRIPTION
							2017 SSSC RULES

DESIGNED BY  
F. HATFIELD  
DRAWN BY  
D. SEPULVEDA  
CHECKED BY  
RULES COMM.  
CHANGE  
N. GAVLIN  
DATE  
08-10-2017

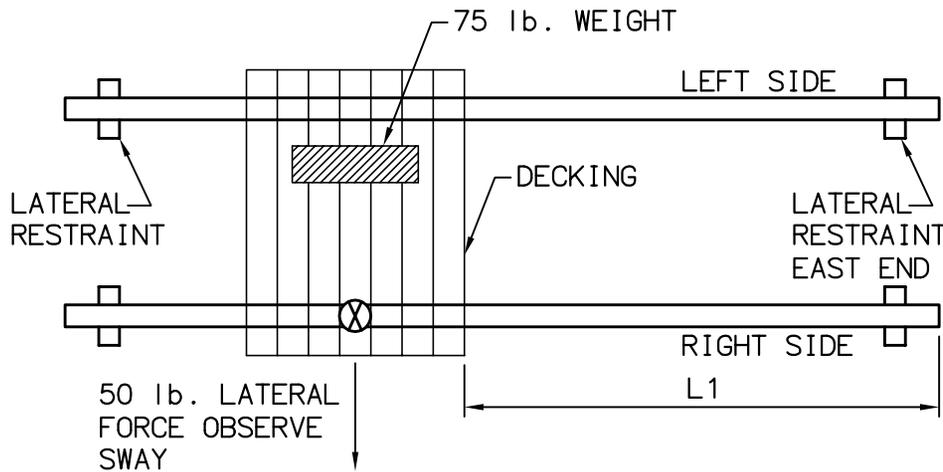


ASCE-AISC  
STUDENT STEEL BRIDGE CONTEST  
ASCE  
AMERICAN SOCIETY OF CIVIL ENGINEERS  
SUBMITTED \_\_\_\_\_  
APPROVED \_\_\_\_\_

**SITE DIAGRAM**  
REFER TO SECTION 10

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

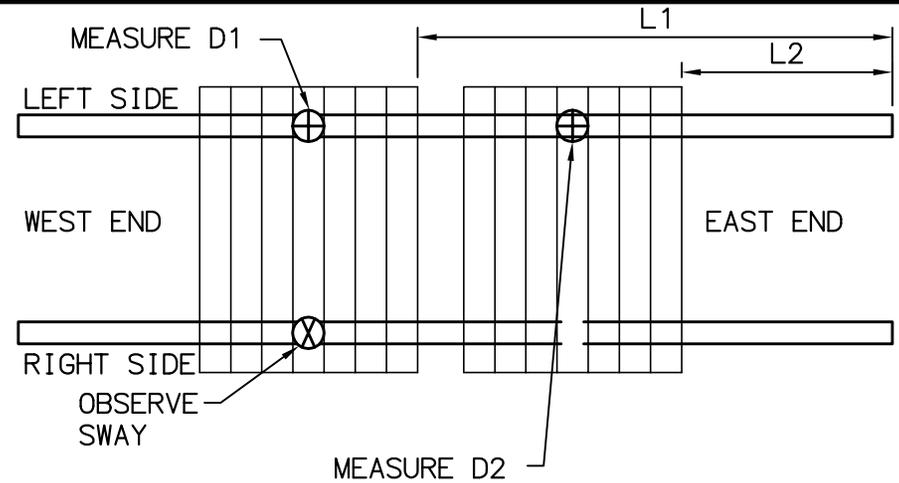




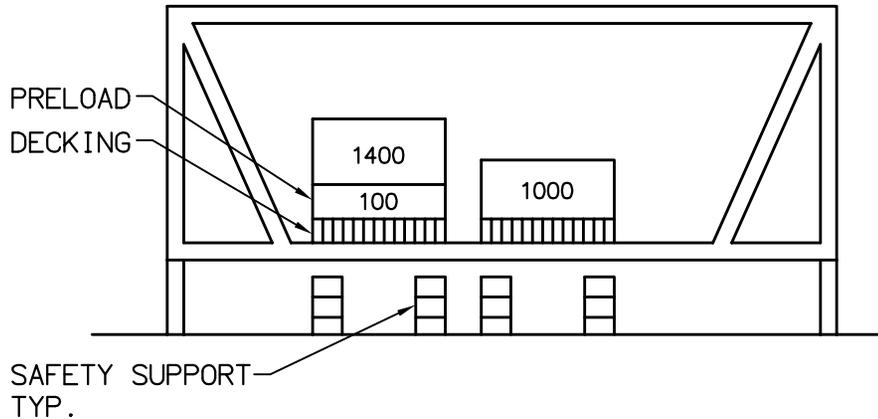
### LATERAL LOAD TEST PLAN

#### LATERAL LOAD TEST NOTES:

1. Lateral restraint is provided by each crew and is applied at the bases of abutments (11.4.1)
2. If sway exceeds one inch, do not proceed with vertical load test.



### VERTICAL LOAD TEST PLAN



### VERTICAL LOAD TEST

SCALE: NTS

#### GENERAL NOTES:

1. Drawings are not to scale.
2. Decking units are three feet long in the span direction of the bridge.
3. Decking locations L1 and L2 are randomly determined and are the same for all bridges. East and west ends are randomly determined separately for each individual bridge. Right and left sides are relative to travel from west to east (7.1(6)).
4. Decking locations L1 and L2 are measured from the east end.
5. Locations of lateral pull, lateral restraints, and deflection and sway measurements are specific to left and right sides (11.4, 11.5.1.3)

#### VERTICAL LOAD TEST NOTES:

1. Safety supports are required under both decking units at all times.
2. The 100-pound preload is placed first, followed by initialization or initial readings of deflection and sway measuring devices.
3. The preload remains in place, and 1400 pounds of load is placed on the decking unit located at L1, followed by 1000 pounds of load on the decking unit located at L2.
4. Deflections D1, D2 and sway are monitored continuously.
5. Stop loading if any deflection exceeds three inches or sway exceeds one inch.
6. Deflections are recorded after all load is in place.

							DESIGNED BY F. HATFIELD		<b>ASCE-AISC</b> STUDENT STEEL BRIDGE CONTEST		<b>LOAD TEST DIAGRAMS</b> REFER TO SECTION 11		CONTRACT NUMBER
							DRAWN BY D. SEPULVEDA						DRAWING NO. DWG 3
							CHECKED BY RULES COMM.			SUBMITTED _____ APPROVED _____		SCALE NTS	
							CHANGE N. GAVLIN					DATE 08-10-2017	SHEET NO.
REV	BY	DATE	APP	REC NO.	EXPIRES	SEAL HOLDER	2017 SSSC RULES DESCRIPTION						