STUDENT STEEL BRIDGE COMPETITION

2016 RULES

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)
- 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

This document, which is available at http://www.aisc.org/nssbc, describes the Student Steel Bridge Competition and states the 2016 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. Bridge teams should be inclusive, open, and fair to all interested and eligible participants.

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.

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 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 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 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, Douglas Steel Fabricating Corporation
- 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., Executive Officer, Regional Rail, Los Angeles County Metropolitan Transportation Authority

Section 3

PROBLEM STATEMENT

The sale of Impecunia State University to a for-profit enterprise provides funds to repave the state's highways and replace numerous bridges rendered deficient by age, increased traffic demand, overloading, and inadequate maintenance. ImpDOT determined that design costs can be minimized for most bridges by using a generic superstructure needing only minor adaptations for each site.

This strategy is viable only if the design accommodates the more challenging site conditions. Therefore, there are restrictions on transportation, site layout, temporary support, and access over water. Serviceability, construction cost and duration, material cost, and esthetics are critical considerations. Steel is specified for ease of prefabrication, rapid erection, superior strength to weight ratio, and high level of recycled content.

The company chosen to provide the standardized design will also design site-specific modifications and is likely to become ImpDOT's preferred firm for all other bridge work.

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. ImpDOT 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 chapter that is hosting a conference 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, and conference host chapters are listed at 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 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. 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 sub-section 4.2.2, or
(2) from a chapter that is not in good standing with ASCE, or
(3) from a chapter 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 listed at www.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 twelve non-guest teams competed.
(3) The top three eligible teams in overall performance will be invited from a conference in which thirteen 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 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 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.

Section 5

SAFETY

Safety has the highest priority; risk of personal injury will not be tolerated. Sub-sections 9.2.6, 9.4, 10.2, 10.3, 11.1, 11.2, and 11.5 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.

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 seek appropriate instruction and supervision. The sub-section 8.2 footnote warns of a welding hazard, and precautions listed in sub-section 11.2 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' 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 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.

Judges' scoring 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. 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. 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 shall present the following information

(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 the bridge for one of the load cases specified in section 7,
(5) shear and moment diagrams for the bridge considered as a single spanning beam. The diagrams shall correspond to the free-body diagram, and peak magnitudes shall be shown.
(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. 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 9.4, 10.4.2, 10.4.3, 10.4.4, 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 the weight of the bridge (determined by scales provided by the host student chapter) plus weight penalties prescribed in 8.2, 9.3, and 9.5. Temporary pier, decking, tools, 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 number of builders (persons)
x 50,000 ($/person-minute)
+ $30,000 if a temporary pier is staged for construction
+ load test penalties ($)

“Total time” is defined in 6.2.2, “builder” is defined in 10.1.3, and “load test penalties” are prescribed in 11.5. 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

For a bridge that weighs 400 pounds or less,

C_s = Total weight (pounds) x 10,000 ($/pound)
+ Aggregate deflection (inches) x 1,000,000 ($/inch)
+ Load test penalties ($)

For a bridge that weighs more than 400 pounds,

C_s = [Total weight (pounds)]^2 x 25 ($/pound^2)
+ Aggregate deflection (inches) x 1,000,000 ($/inch)
+ Load test penalties ($)

"Total weight" is defined in 6.2.3, and "aggregate deflection" is defined in 11.5, which also prescribes "load test penalties."

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 builders 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 shall not be altered, modified, or enhanced in any way except for corrections prescribed by sub-section 9.4.
(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) Immediately before timed construction of the first bridge, the head judge rolls a die to determine the locations of vertical deflection targets and loads. Team captains may observe the roll. The same locations will be used for all bridges. See 11.5 and the Loading Diagrams. For each possible result S of the roll, Table 7.1 gives the dimension D for positioning the off-center decking unit.

TABLE 7.1 Determination of D

S	D
1	4'-3"
2	4'-9"
3	5'-3"
4	12'-0"
5	12'-6"
6	13'-0"

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, temporary pier, and tools are staged for construction and inspected by the judges. See section 8, "Material and Component Specifications," and sub-sections 10.1.7, 10.1.8, 10.1.9, 10.2.3, 10.2.4, 10.2.5, 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."

(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 Test Instructions," 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. After data entry has been completed, a copy of the team's "Computation" worksheet from the scoring spreadsheet is given to the team 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' 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 load and target locations.
(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. Between corrections 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

MATERIAL AND COMPONENT SPECIFICATIONS

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.

8.1 MATERIAL

If any member is not steel or incorporates parts that are not steel, the bridge will not be approved for construction or load testing, and will not be eligible for awards in any category. See 8.2.2 for definition of "member."

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 every non-compliant loose bolt and loose nut, and 25 pounds for every non-compliant member plus the weight of that 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 comprised of parts welded* together. Bolts and nuts that are welded* to members are parts of members and are not considered to be loose. A member shall retain its shape, dimensions, and rigidity during timed construction and load testing. Members with moving and flexible parts are prohibited. 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.

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

Loose bolts shall not have parts that flex, move, or are not steel. Nominal length shall not exceed 3” measured from the bottom of the head to the end. Loose bolts shall be commercially available and shall not be mechanically altered or modified in any way but may be painted.

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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. **Participants are advised to weld only plain (uncoated) hardware.**

8.2.4 Loose and Welded Nuts

8.2.4.1 Nuts shall be hexagonal in shape and not have parts that flex, move, or are not steel. 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 height. The threads of a nut shall match the bolt or externally threaded member so that installation and removal require relative rotation.

8.2.5 Holes in Members

8.2.5.1 The 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.

8.2.5.2 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.

9.2 FUNCTIONALITY AND SAFETY

If any specification in this sub-section (9.2) is violated, the bridge will not be approved for load testing and will not be eligible for awards in any category.

9.2.1 The bridge shall have exactly two decking support surfaces that are continuous over the full length of the bridge so that decking could be placed to bear on them anywhere along the span. Decking support surfaces are tops of members. See the Elevation and Section on the Site and 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 of the decking support surfaces that enhance strength or stability of the bridge.

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 construct and load the bridge safely using the site, equipment, and floor surfaces provided by the host student chapter. **Bridges and participants shall accommodate local conditions.**

9.3 USABILITY

Specifications in this sub-section (9.3) are illustrated by the Site and 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 of 1/4” or less,
(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 approved for load testing and will not be eligible for awards in any category.

9.3.1 The bridge shall not touch the river or the ground outside the footings. The river is 6’6” wide and the footings are 6’6” from the river banks.

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 at least 1’6” high, measured from the surface of the ground or river. No part of the bridge, including nuts and bolts, shall extend below this limit. Exception: No clearance is required over footings except as necessary to apply restraint during the lateral load test described in sub-section 11.4.

9.3.5 The bridge shall provide exactly two decking support surfaces that are continuous along the full length of the bridge and a straight rectangular vehicle passageway such that the template illustrated by the Vehicle Clearance Template detail on the Site and Bridge Diagram will pass without obstruction along the decking support surfaces for the full length of the bridge.

9.3.6 The decking support surfaces shall be no more than 2’7” above the surface of the river or ground at any point.

9.3.7 Parts of the bridge (including nuts, bolts, 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.

9.3.8 Decking support surfaces at each end of the bridge shall not extend beyond the vertical plane defined by the footing edge farthest from the river.

9.3.9 Decking support surfaces shall be free of holes, splits, separations, and abrupt changes in elevation, except that between segments of decking support surfaces that are surfaces of adjacent members there may be a horizontal separation not exceeding 1/4” and a change in elevation not exceeding 1/8”. Decking support surfaces may be checked by sliding a unit of decking or equivalent template both ways over the full length. Obstruction or “catching” may indicate possible violation of 9.2.3 or 9.3.9. Compliance at the juncture of adjacent members will be verified by measurement.

9.4 CONNECTION SAFETY

Five minutes will be added to construction time for every violation of specifications in this sub-section (9.4) even if they can be corrected.

After termination of timed construction and inspection by the judge, the team is required to attempt to correct every violation of specification 9.4.1 and 9.4.2, and will be granted the option to correct violations of specifications 9.4.3 and 9.4.4. Only tools that were in the staging yard at the start of timed construction shall be used. Accidents will not be penalized. A team will be allowed five minutes to correct all connections. If any connection still violates specification 9.4.1 or 9.4.2 when that time limit is reached, the bridge will not be approved for load testing and is not eligible for awards in any category.

9.4.1 Every member shall be connected to every other member that it touches by at least one loose bolt or externally threaded part of a member so that those connected members cannot be separated without first unscrewing and removing a loose bolt or externally threaded member that connects them, or without first unscrewing and removing a 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.

9.4.2 Every 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.

9.4.3 Every loose nut shall be tightened sufficiently to contact the member it connects.

9.4.4 Every loose bolt shall be tightened sufficiently so that the head of the bolt contacts the member it connects.

9.5 INSPECTABILITY

All nuts, heads of loose bolts, and threaded ends of bolts and members 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 every threaded end, nut, and bolt head that cannot be inspected.

Section 10

CONSTRUCTION REGULATIONS

10.1 DEFINITIONS

10.1.1 “River,” “staging yards,” “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, including the footings but excluding the river.

10.1.3 “Builders” are undergraduate or graduate student members of a team who are within the construction site at the start of timed construction. See section 4, “Eligibility.”

10.1.4 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 scoring forms.

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

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

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

10.1.8 The “temporary pier” is an optional device that is used to support the constructed portion, tools, nuts, and bolts during timed construction. It has no other purpose, is not a tool, and is not part of the completed bridge. The temporary pier is provided by the team, may be made of any material, and may bear on the river or ground anywhere within the construction site. Construction cost is increased if a temporary pier is staged for construction.

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

10.1.10 An “assembly” consists of two members that are joined together in a staging yard during timed construction with a connection that complies with 9.4 and 9.5

10.1.11 The “constructed portion” is comprised of members, assemblies, loose nuts, and loose bolts, and is created during timed construction. The constructed portion is not required to be contiguous.

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 construction site boundary during timed construction. Team members who are not builders, coaches, faculty, advisers, other associates of the team, 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, batteries, or other internal energy supplies shall not be used during timed construction.

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

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

10.3 SAFE CONSTRUCTION PRACTICES

If any rule in this sub-section (10.3) is violated during timed construction, the judge will stop the clock and explain the violation. Before the clock is restarted, builders, temporary pier, tools, members, assemblies, nuts, and bolts will be returned to the positions they occupied 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 approved for load testing and will not be eligible 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, and 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 side of the river to the ground on the other side.

10.3.7 An assembly shall not consist of more than two members.

10.3.8 Outside the staging yards, an assembly shall not be supported by fewer than two builders holding the assembly with their hands or with tools held in their hands.

10.3.9 Outside the staging yards, a builder shall not simultaneously touch (or touch with tools) more than one member or assembly that is not in the constructed portion.

10.3.10 Outside the staging yards, members and assemblies shall not be modified nor shall assemblies be created.

10.3.11 The temporary pier shall not be moved while it is supporting the constructed portion or a non-contiguous part of the constructed portion.

10.3.12 A builder shall not use the bridge, a constructed portion of the bridge, the temporary pier, a member, assembly, or tool to support the builder's body weight. However, a builder may be partially supported by 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.

10.3.13 Construction of every non-contiguous part of the constructed portion shall commence by placing a member or assembly on the ground within a footing or on the temporary pier. That member or assembly becomes the constructed portion or a non-contiguous part of the constructed portion. When a member, assembly, loose nut, or loose bolt is in contact with the constructed portion it becomes part of the constructed portion.

10.3.14 At no time shall a builder or builders support the entire weight of the constructed portion or of a non-contiguous part of the constructed portion.

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 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, builders, temporary pier, tools, members, assemblies, nuts, and bolts will be returned to the positions they occupied before the accident.

10.4.1 A builder, builder's footwear or clothing touches the river or the floor outside the construction site boundary. For each occurrence, the number of builders is increased by one when the spreadsheet computes construction cost, C_c (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, assembly, tool, nut, bolt, or personal protective equipment.

10.4.2 A member, assembly, 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 construction site. Penalty is 1/4 minute (15 seconds) for every item during every occurrence. Exception: A constructed portion may touch the ground within a footing without penalty.

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

10.4.4 The temporary pier falls over or collapses while in use. Penalty is 1/2 minute (30 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 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 Site Plan.

10.6 START

10.6.1 Before construction begins, only the following are in a staging yard: all builders, members, loose nuts, loose bolts, the temporary pier, and tools. The temporary pier, 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 Site Plan on the Site and Bridge Diagram. Builders are wearing personal protective equipment as well as optional clothing such as pouches. Builders start without tools, nuts, and bolts, which may be passed from one builder to another after timed construction begins. Similarly, the temporary pier may be passed from builder to builder. 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, the temporary pier, and tools as they are placed in the staging yard. Tools and temporary piers that do not conform to regulations 10.2.3 and 10.2.4 shall be removed from the staging yard and shall not be used. After inspection and throughout timed construction, additional members, temporary piers, 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, the temporary pier, tools, 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 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 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, at the discretion of the head judge, it may be load tested after all eligible bridges.

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,
(4) the temporary pier is on the ground in a staging yard, and
(5) 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 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 is not eligible 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 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 chapter.

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 nut, broken bolt, 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 participate in lateral load tests.

11.2.2.2 Bridges that sway in excess of 1” during lateral load testing shall 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 participate in the vertical load test**.**

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 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 chapter.

11.2.3.6 No one shall reach, crawl, or step under 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.

11.2.3.8 Load on the decking shall not exceed 400 psf or 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 shall 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.

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 from the outside of the bridge.

Teams shall 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 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 detail. 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, 10’3” 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 fifty-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 and is not eligible for awards in any category. Do not conduct any other load test. Check the appropriate box on the judges’ scoring 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 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 8'9" and D from the right end of the decking support surfaces to the right ends of the decking units. D is determined before construction as described by paragraph 7.1 (5). Decking units are placed square with the bridge and centered on the decking support surfaces. Grating is placed with the main bars spanning laterally. Decking units shall not be attached to the bridge and shall not distort it (see 9.2.3 and 9.2.4).

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 at a distance D + 3'0" from the right end of the decking support surface.
- B side at a distance D + 1'6" from the right end of the decking support surface.
- B side at a distance 10'3" from the right end of the decking support surface.

Position measuring devices on the three vertical deflection targets.

Uniformly distribute fifty pounds of preload on each of the two decking units. The preloads are laterally centered on the decking unit. The preloads are located and aligned identically for every bridge.

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 or near that location until the preload has been placed and the vertical deflection measuring devices have been initialized. The clamp will be removed before additional load is placed.

If deflection data is lost (for example, by malfunction or displacement of a measuring device), 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) DA = absolute value of vertical deflection at the target on the “A” side.
(2) D1B = absolute value of vertical deflection at the off-center target on the “B” side.
(3) D2B = absolute value of vertical deflection at the center target on the “B” side.

The scoring spreadsheet computes aggregate deflection as the sum of those three measurements, rounded to the nearest 0.01”.

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 1000 pounds of additional load on the off-center decking unit, and then place 1400 pounds of additional load on the center decking unit. 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 DA, D1B, and D2B. 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 in 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 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 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 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 $^{5}/_{16}$" 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.

12.5 TEMPLATE

A template as dimensioned in the Vehicle Clearance Template detail on the Site and Bridge Diagram is needed. Plywood is recommended. Holes for handholds are helpful but optional.

Section 13

INTERPRETATION OF RULES

The web site http://www.aisc.org/nssbc 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. Questions shall be limited to interpretation of rules; specific designs 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 9, 2016.

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 http://www.aisc.org/nssbc 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 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 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 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> 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 chapter 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 chapter 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, 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. Participants are reminded that civility and ethical behavior are expected during the competition and particularly concerning appeals.

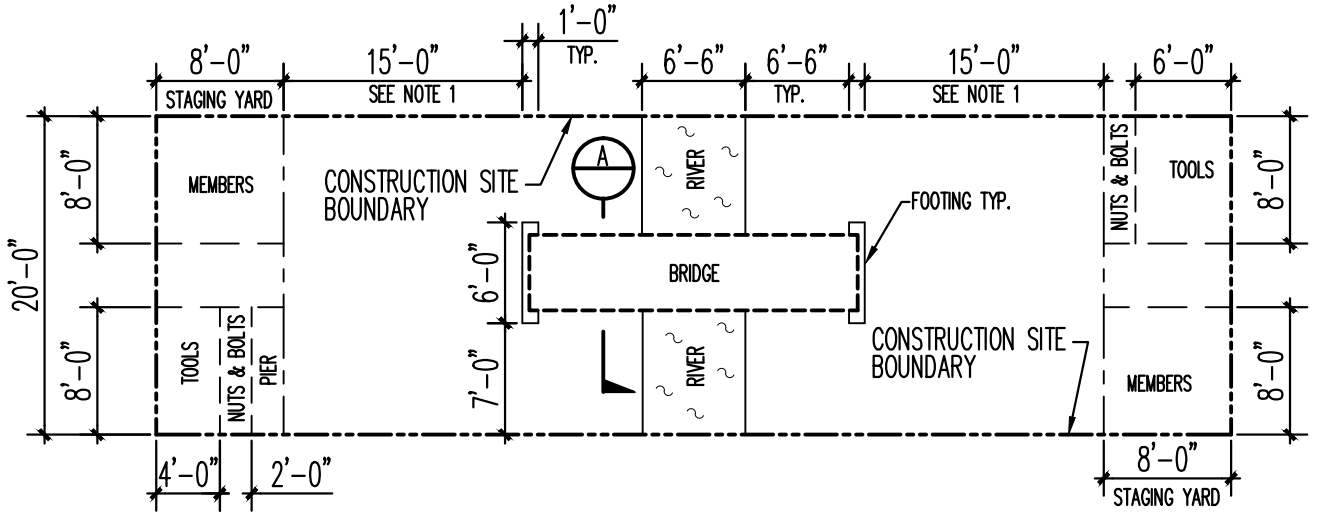
15.2.3 After hearing the SHJ's ruling, the team captain may request a five-minute recess to discuss the issue with the team. During the recess, the conditions at issue will not be changed. Immediately after that recess, if the team has justification to contest the SHJ's ruling, the captain has the option 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

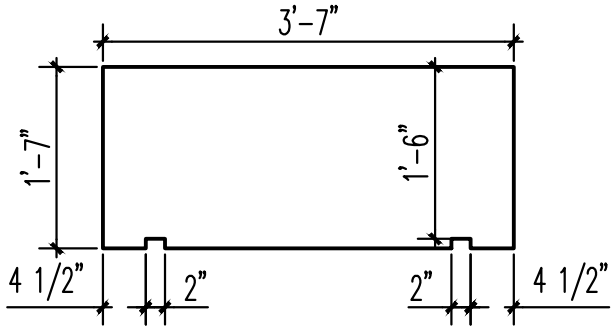
INDEX OF DEFINITIONS



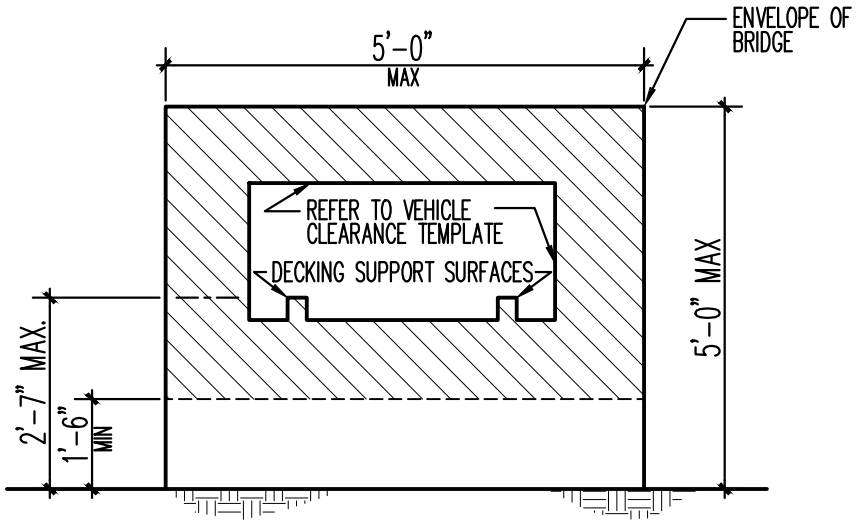
NOTES:

1. LENGTH MAY BE SHORTENED EQUALLY TO FIT SITE CONDITIONS.
2. BRIDGE SHALL ACCOMMODATE DECKING THROUGHOUT OVERALL LENGTH OF THE BRIDGE.
3. NO PART OF THE BRIDGE SHALL EXTEND BEYOND DECKING SUPPORT SURFACES (AT BOTH ENDS).
4. DECKING SUPPORT SURFACES SHALL NOT EXTEND BEYOND THE EDGE OF THE FOOTING (AT BOTH ENDS).
5. "GROUND" IS THE AREA WITHIN THE CONSTRUCTION SITE BOUNDARY INCLUDING THE FOOTINGS BUT EXCLUDING THE RIVER.

SITE PLAN – REFER TO CHAPTERS 9 & 10



VEHICLE CLEARANCE TEMPLATE



A SECTION

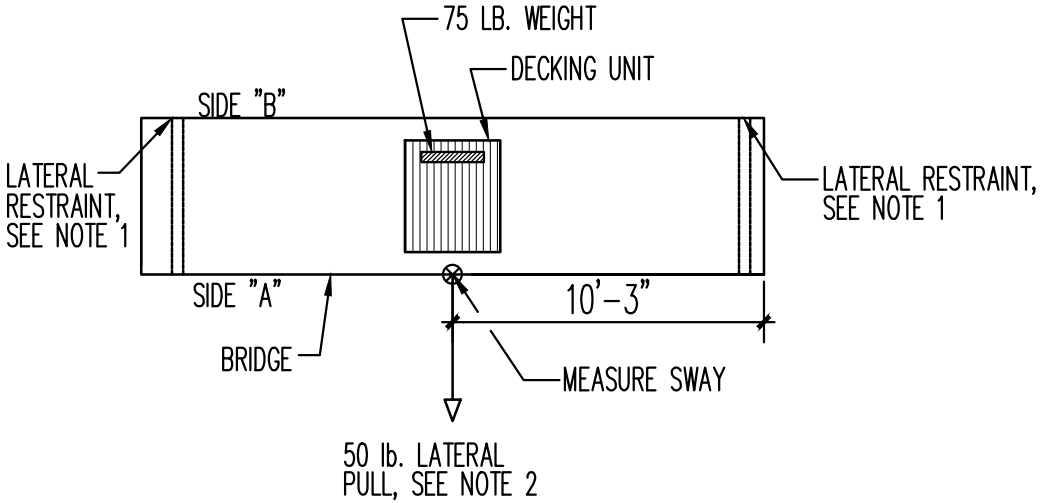
REV.	BY	DATE	APP	REC NO.	EXPIRES	SEAL HOLDER	2013 SSBC RULES DESCRIPTION		

DESIGNED BY F. HATFIELD
DRAWN BY D. SEPULVEDA
CHECKED BY RULES COMM.
IN CHARGE N. GAVLIN
DATE 08-20-2015

ASCE-AISC
STUDENT STEEL BRIDGE CONTEST
SUBMITTED
APPROVED

SITE AND BRIDGE DIAGRAM

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

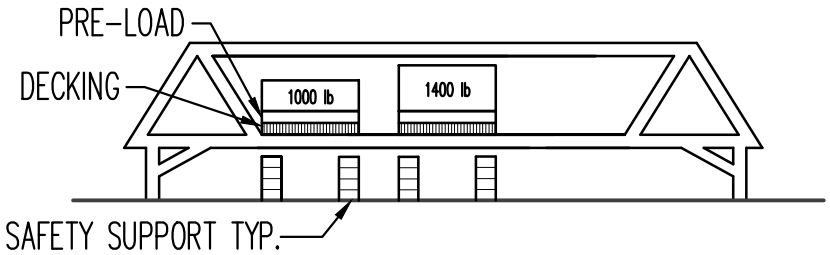


LATERAL LOAD TEST

REFER TO 11.4

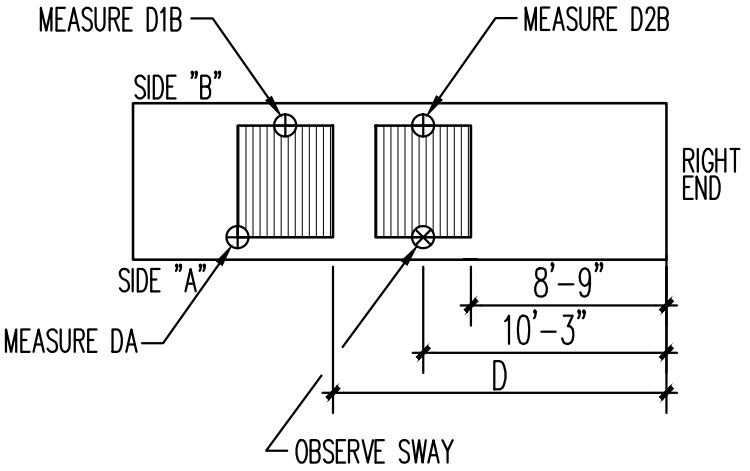
NOTES:

1. LATERAL RESTRAINT MUST BE APPLIED CLOSE TO THE GROUND AND MUST NOT RESTRAIN ROTATION, UPLIFT, OR TRANSLATION IN OTHER THAN THE LATERAL DIRECTION.
2. LOCATION OF 50 lb. PULL SHALL NOT EXCEED 4" FROM SWAY TARGET.



VERTICAL LOAD TEST

REFER TO 11.5



⊕ TARGET FOR MEASURING VERTICAL DEFLECTION

⊗ TARGET FOR MEASURING SWAY

LOCATION OF DECKING AND TARGETS FOR 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. SWAY TARGET IS TO REMAIN IN PLACE THROUGHOUT LOADING PROCESS.
4. LOADING SEQUENCE: PRELOAD, 1000 LB OFF-CENTER, 1400 LB CENTERED.
5. LOADS ARE CENTERED LATERALLY AND DISTRIBUTED OVER THE DECKING UNIT AS UNIFORMLY AS POSSIBLE DURING LOADING.
6. OBSERVE SWAY AND TERMINATE LOADING IF SWAY EXCEEDS 1 INCH.

REV.	BY	DATE	APP.	REC NO.	EXPIRES	SEAL HOLDER	2015 SSBC RULES DESCRIPTION

DESIGNED BY F. HATFIELD
DRAWN BY D. SEPULVEDA
CHECKED BY RULES COMM.
IN CHARGE N. GAVLIN
DATE 08-20-2015

ASCE-AISC
STUDENT STEEL BRIDGE CONTEST
SUBMITTED
APPROVED

LOADING DIAGRAMS

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

STUDENT STEEL BRIDGE COMPETITION

2015 RULES

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)
- 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)

This document, which is available at http://www.aisc.org/nssbc, describes the Student Steel Bridge Competition and states the 2015 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 other information and the form for requesting clarifications. Information at this web site takes priority over any other source except as noted herein.

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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. Bridge teams should be inclusive, open, and fair to all interested and eligible participants.

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, aesthetics, project management, and cost. Success in competition requires application of engineering principles and theory, and effective teamwork. Future engineers are stimulated to innovate, practice professionalism, and use structural steel efficiently.

Students design and erect a steel bridge by themselves but may consult with faculty and other advisors. Students gain maximum benefit if they fabricate the entire bridge themselves. However, because appropriate shop facilities and supervision are not available at all 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.

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 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 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 those 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, Committee on Student Members Corresponding Member, ASCE
- Frank J. Hatfield, P.E., Professor Emeritus, Michigan State University
- Lawrence F. Kruth, P.E., Vice President, Douglas Steel Fabricating Corporation
- John M. Parucki, Structural Steel Consultant
- Leslie Payne, Director, Student and Younger Member Programs, ASCE
- Craig E. Quadrato, P.E., Director, Civil Engineering Design Group, United States Military Academy
- Don Sepulveda, P.E., Executive Officer, Regional Rail, Los Angeles County Metropolitan Transportation Authority

Section 3

PROBLEM STATEMENT

When asked what would most effectively relieve poverty, the President of Kupicra requested a bridge over the Nogo River which bisects his tropical country, inhibiting commerce between farming villages and H'sogo, the capital city.

Transportation and scheduling will be challenges! The proposed site is accessible only by trails which are impassable during the rainy season. Materials must be transported in loads small enough for ox carts. Accelerated Bridge Construction (ABC) is essential to completing the project during a single dry season.

Consultants to the Sonarpin Foundation, which will fund the project, recommend a steel bridge to minimize the weight of material to be transported and erected, and to facilitate prefabrication, which reduces the duration of on-site construction. Durability and ease of maintenance also favor steel.

Piers in the river and surrounding floodplain would be uneconomic due to a deep layer of organic soil. The Nogo is navigable for a few weeks after the rainy season, so the bridge must provide clearance over the river. Low water levels during the dry season preclude the use of barges but allow construction of a temporary causeway crossing from bank to bank.

The scope of the bridge contract does not include footings, deck panels, or causeway, which will be constructed by local crews.

Your company's proposal is among those that the Sonarpin Foundation deems responsive, and winning the contract would establish your team as a leader in implementing Accelerated Bridge Construction technologies in a challenging environment. 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. Sonarpin consultants and village elders 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 sub-section 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 listed at http://www.asce.org/Audience/Students/Student-Competitions/National-Competition-Eligibility-Requirements/.

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) 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.

Section 5

SAFETY

Safety has the highest priority – risk of personal injury will not be tolerated. Sub-sections 8.1, 9.2, 9.4, 10.2, 10.3, 11.1, 11.2, 11.5, and 11.6 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.

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 seek appropriate instruction and supervision. The sub-section 8.2 footnote warns of a welding hazard, and 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 shall present the following information

(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 the bridge for one of the load cases specified in section 7,
(5) shear and moment diagrams for the bridge considered as a single spanning beam. The diagrams shall correspond to the free-body diagram, and peak magnitudes shall be shown.
(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. 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 9.4, 10.4.2, 10.4.3, 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 the weight of the bridge (determined by scales provided by the host student organization) plus weight penalties prescribed in 8.2, 9.3, and 9.5. Decking, tools, 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 number of builders (persons)
x 50,000 ($/person-minute) + load test penalties ($).

"Total time" is defined in 6.2.2, "builder" is defined in 10.1.3, and "load test penalties" are prescribed in 11.5. 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

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 11.5.

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 builders 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 repairs prescribed by sub-section 9.4.
(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 vertical deflection targets and magnitudes of loads. See 11.5 and the Loading Diagrams. 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 T1 and T2 for positioning the deflection targets, and the magnitudes L1 and L2 of loads.

TABLE 7.1 Determination of T1, T2, L1, and L2

S	T1	T2	L1 (lb)	L2 (lb)
1	9'9"	12'3"	1000	1400
2	7'9"	9'9"	1400	1000
3	7'9"	12'3"	1200	1200
4	7'3"	10'9"	1200	1200
5	7'3"	11'9"	1000	1400
6	9'3"	11'9"	1400	1000

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, and tools are staged for construction and inspected by the judges. See section 8, "Material and Component Specifications," and sub-sections 10.1.7, 10.2.5, 10.2.6, 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."

(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 Test Instructions," 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. After data entry has been completed, a copy of the team's "Computation" worksheet from the scoring spreadsheet is given to the team 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 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 connection repairs described in sub-section 9.4. 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

MATERIAL AND COMPONENT SPECIFICATIONS

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.

8.1 SAFETY

If any member is not steel, incorporates parts that are not steel, or weighs more than fifteen pounds, the bridge will not be approved for construction or load testing, and will not be eligible for awards in any category. See 8.2.2 for definition of "member."

8.2 DURABILITY AND CONSTRUCTABILITY

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 every non-compliant loose bolt and loose nut, and 25 pounds for every non-compliant member plus the weight of that 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 comprised of parts welded* together. Bolts and nuts that are welded* to members are parts of members and are not considered to be loose. A member shall retain its shape, dimensions, and rigidity during timed construction and load testing. Members with moving and flexible parts are prohibited. 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.

8.2.3 Loose Bolts

Loose bolts shall not have parts that flex, move, or are not steel. Nominal length shall not exceed 3” measured from the bottom of the head to the end. Loose bolts shall be commercially available and shall not be mechanically altered or modified in any way but may be painted.

8.2.4 Loose and Welded* Nuts

8.2.4.1 Nuts shall be hexagonal in shape and not have parts that flex, move, or are not steel. Nuts shall be commercially available and shall not be mechanically altered or modified in any way but may be painted.

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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. **Participants are advised to weld only plain (uncoated) hardware.**

8.2.4.2 Nuts shall have internal threads that extend for the full circumference and length. The threads of a nut shall match the bolt or externally threaded member so that installation and removal require relative rotation.

8.2.5 Holes in Members

8.2.5.1 The hole in a member for a loose bolt or externally threaded part of another member shall be completely surrounded by the member and small enough that the nut or bolt head cannot pass through.

8.2.5.2 Holes in 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.

9.2 FUNCTIONALITY AND SAFETY

If any specification in this sub-section (9.2) is violated, the bridge will not be approved for load testing and will not be eligible for awards in any category.

9.2.1 The bridge shall have two decking support surfaces that are continuous over the full length of the bridge so that decking could be placed anywhere along the span. Decking support surfaces are tops of members. See the Elevation and Section on the Site and 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 of the decking support surfaces that enhance strength or stability of the bridge.

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 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.**

9.3 USABILITY

Specifications in this sub-section (9.3) are illustrated by the Site and 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) 50 pounds for a dimensional violation of ½" or less,
(2) 100 pounds for a violation greater than ½" 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 approved for load testing and will not be eligible for awards in any category.

9.3.1 The bridge shall not touch the river or the ground outside the footings. The river is 6'6" wide and the footings are 6'0" from the river banks.

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 The bridge shall provide a straight rectangular vehicle passageway at least 3'7" wide that completely traverses the bridge from end to end. No part of the bridge, including nuts and bolts, shall be within that minimum width unless it is below the level of the decking support surfaces or at least 1'6" above the level of the decking support surfaces.

9.3.5 Vertical clearance shall be provided under the bridge at all points directly over the river. The clearance shall be at least 1'6" high, measured from the surface of the river. No part of the bridge, including nuts and bolts, shall extend below this limit.

9.3.6 Vertical clearance shall be provided under the bridge at all points directly over the ground. The clearance shall be at least 3 ½" high, measured from the ground. No part of the bridge, including nuts and bolts, shall extend below this limit. Exception: No clearance is required over the footings.

9.3.7 The decking support surfaces shall be no more than 2'7" above the surface of the river or ground at any point.

9.3.8 Parts of the bridge (including nuts, bolts, 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.

9.3.9 Decking support surfaces at each end of the bridge shall not extend beyond the vertical plane defined by the footing edge farthest from the river.

9.3.10 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. Surfaces outside of the 3’7” limit of specification 9.3.4 are not considered to be decking support surfaces.

9.3.11 Decking support surfaces shall be free of separations and abrupt changes in elevation, except that between segments of decking support surfaces that are surfaces of adjacent members there may be a separation not exceeding ¼”.

9.4 CONNECTION SAFETY

Three minutes will be added to construction time for every connection that violates any specification in this sub-section (9.4) even if it can be corrected.

After termination of timed construction and inspection by the judge, the team is required to attempt to correct every connection that violates specification 9.4.1 or 9.4.2, and will be granted the option to correct connections that violate specifications 9.4.3 or 9.4.4. Only tools that were in the staging yard at the start of timed construction shall be used. A team will be allowed five minutes to correct all connections. If any connection still violates specification 9.4.1 or 9.4.2 when that time limit is reached, the bridge will not be approved for load testing and is not eligible for awards in any category.

9.4.1 Every member shall be connected to every other member that it touches so that they cannot be separated without unscrewing and removing a loose nut or loose bolt, or unscrewing one member from the other.

9.4.2 Every 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.

9.4.3 Every loose nut shall be tightened sufficiently to contact the member it connects.

9.4.4 Every loose bolt shall be tightened sufficiently so that the head of the bolt contacts the member it connects.

9.5 INSPECTABILITY

All nuts, heads of loose bolts, and threaded ends of bolts and members 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 every threaded end, nut, and bolt head that cannot be inspected.

Section 10

CONSTRUCTION REGULATIONS

10.1 DEFINITIONS

10.1.1 "River," "staging yard," "footings," causeway," 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, excluding the river but including the causeway and footings.

10.1.3 "Builders" are undergraduate or graduate student members of a team who are within the construction site at the start of timed construction. See section 4, "Eligibility."

10.1.4 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 scoring forms.

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

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

10.1.7 A "tool" is a device that is used to construct the bridge but is not part of the completed bridge. A competing organization provides its own tools.

10.1.8 The "constructed portion" is comprised of members, loose nuts, and loose bolts, and is created during timed construction. The constructed portion is not required to be contiguous.

10.1.9 "Member," "loose bolt," and "loose nut" are defined in sub-section 8.2.

10.2 GENERAL SAFETY CONDITIONS

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

10.2.1 Builders, judges, host personnel, and spectators shall 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. Team members who are not builders, coaches, faculty, advisers, other associates of the team, 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.

10.2.3 There shall be no more than six builders.

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

10.2.5 A tool shall not weigh more than fifteen pounds. Welding machines and tools requiring external power connections, batteries, or other internal energy supplies shall not be used during timed construction.

10.2.6 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 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 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 the constructed portion. When a member, loose nut, or loose bolt is in contact with the constructed portion it becomes part of the constructed portion.

10.3.2 At no time shall a builder or builders support the entire weight of the constructed portion or of a non-contiguous part of the constructed portion.

10.3.3 Throwing anything is prohibited.

10.3.4 A builder shall not cross from the ground on one side of the river to the ground on the other side except via the causeway.

10.3.5 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.

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

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

10.3.8 A builder shall not use the bridge, a constructed portion of the bridge, a member, or a tool to support the builder's body weight. However, a builder may be partially supported by 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.

10.4 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 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, builders, tools, members, nuts, and bolts will be returned to the positions they occupied before the accident.

10.4.1 A builder or builder's clothing touches the river or the floor outside the construction site boundary. For each occurrence, the number of builders is increased by one when the spreadsheet computes construction cost, C_c (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 construction site. Penalty is 1/4 minute (15 seconds) for every item during every occurrence. Exception: A constructed portion may touch the ground within a footing without penalty.

10.4.3 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 are in the staging yard: 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 assigned area of the staging yard as designated on the Site Plan on the Site and Bridge Diagram. Builders are wearing personal protective equipment as well as optional clothing such as pouches. Builders start without tools, nuts, and bolts, which may be passed from one builder to another after timed construction begins.

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 10.2.5 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 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 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 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, at the discretion of the head judge, it may be load tested after all eligible bridges.

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) all builders are in the staging yard,
(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 yard, 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 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 is not eligible for awards in any category. Repair and modifications are not permitted after timed construction except as prescribed by 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 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 nut, broken bolt, 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 shall 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 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. 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 or 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 shall 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.

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 from the outside of the bridge.

Teams shall 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 Load Test detail. 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, 9’9” 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 fifty-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 and is not eligible for awards in any category. Do not conduct any other load test. Check the appropriate box on the judges’ scoring 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 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 so that they abut one another with the abutting edges 9'9" from the right end of the decking support surfaces.

Decking units are placed square with the bridge and centered on the decking support surfaces. If grating is used for decking, it is placed with the main bars spanning laterally. Decking units shall not be attached to the bridge and shall not distort it (see 9.2.4).

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 at a distance T1 from the right end of the decking support surface.
- A side at a distance T2 from the right end of the decking support surface.
- B side 9'9" from the right end of the decking support surface.

T1 and T2 are determined at the beginning of the competition as described by Table 7.1 in section 7, "Schedule of Competition."

Position measuring devices on the three vertical deflection targets.

Uniformly distribute fifty pounds of preload on each of the two decking units. The preloads are laterally centered on the decking unit. The preloads are located and aligned identically for every bridge.

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 or near that location until the preload has been placed and the vertical deflection measuring devices have been initialized. The clamp will be removed before additional load is placed.

If deflection data is lost (for example, by malfunction or displacement of a measuring device), 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 at T1.
(2) D2A = absolute value of vertical deflection at the target on the “A” side at T2.
(3) DB = absolute value of vertical deflection at the target on the “B” side.

The scoring spreadsheet computes aggregate deflection as the sum of those three measurements, rounded to the nearest 0.01”.

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 the right decking unit, and then place L2 pounds of load on the left decking unit. 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, D2A, and DB. 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/nssbc 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 4, 2015.

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/nssbc 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.

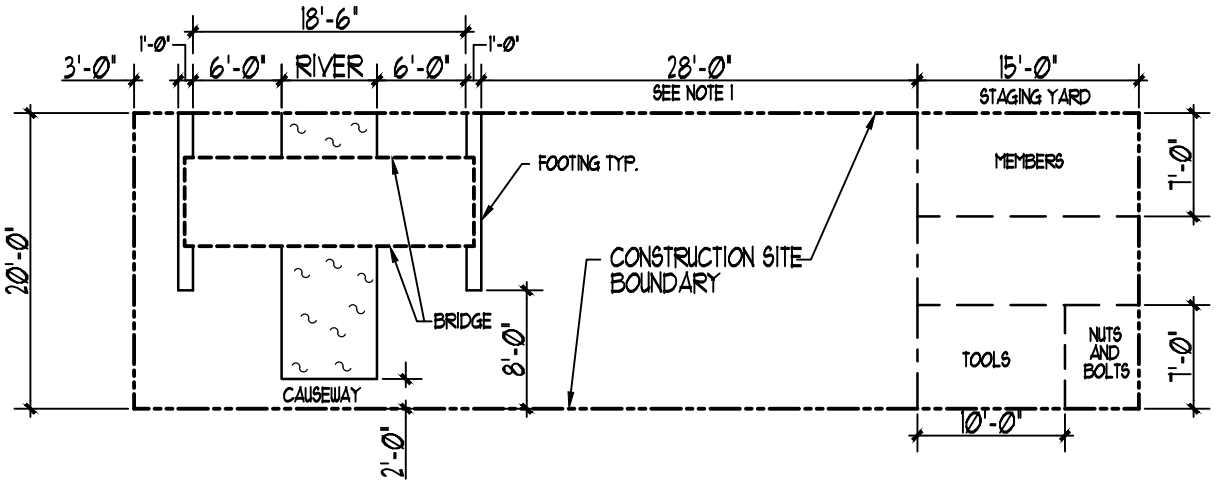
15.2.3 After hearing the SHJ's ruling, the team captain may request a five-minute recess to discuss the issue with the team. During the recess, the conditions at issue will not be changed. Immediately after that recess, if the team has justification to contest the SHJ's ruling, the captain has the option 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

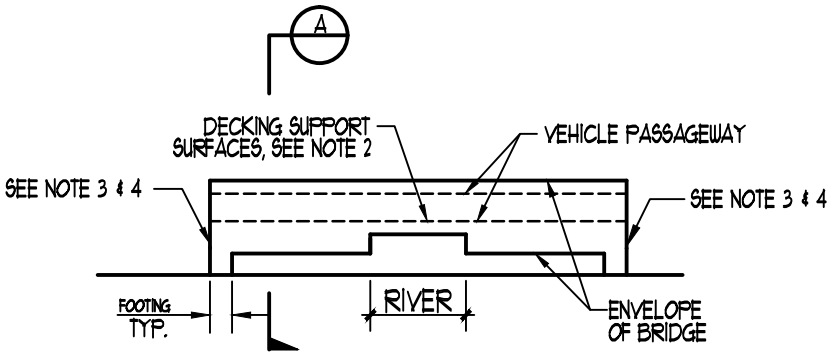
INDEX OF DEFINITIONS



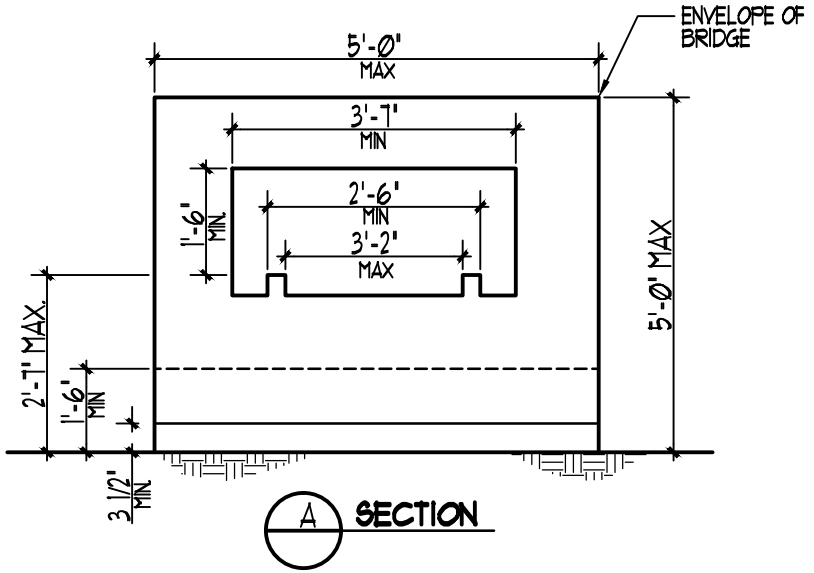
NOTES:

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).
4. DECKING SUPPORT SURFACES SHALL NOT EXTEND BEYOND THE EDGE OF THE FOOTING (AT BOTH ENDS).
5. "GROUND" IS THE AREA WITHIN THE CONSTRUCTION SITE BOUNDARY INCLUDING THE FOOTINGS AND CAUSEWAY BUT EXCLUDING THE RIVER.

SITE PLAN - REFER TO CHAPTERS 9 & 10



ELEVATION - REFER TO CHAPTER 9



REV.	BY	DATE	APP	REC NO.	EXPIRES	SEAL HOLDER	DESCRIPTION
							2015 SSBC RULES

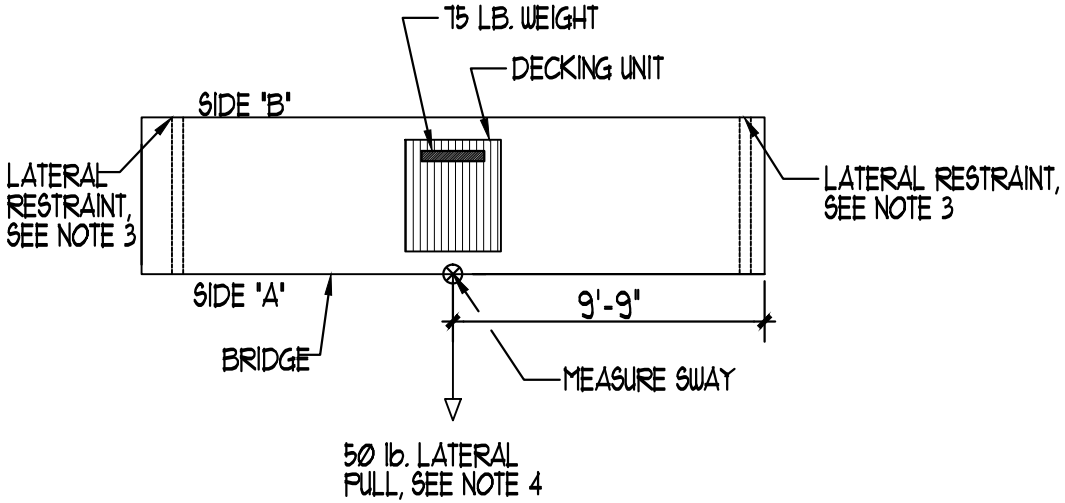
DESIGNED BY	F. HATFIELD
DRAWN BY	D. SEPULVEDA
CHECKED BY	RULES COMM.
IN CHARGE	N. GAVLIN
DATE	08-20-2014

ASCE-AISC
STUDENT STEEL BRIDGE CONTEST

SUBMITTED _____
APPROVED _____

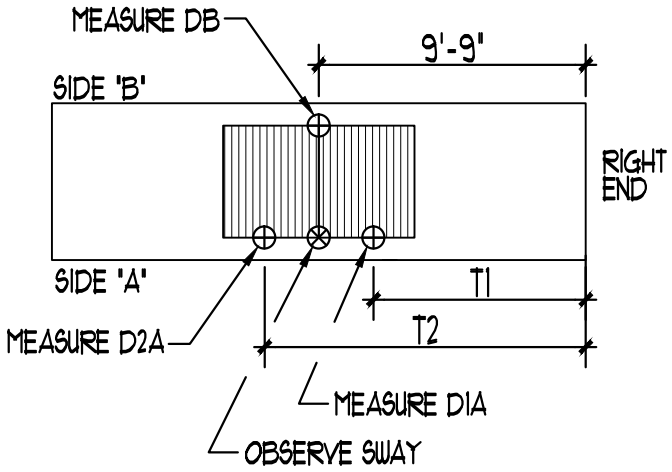
SITE AND BRIDGE DIAGRAM

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



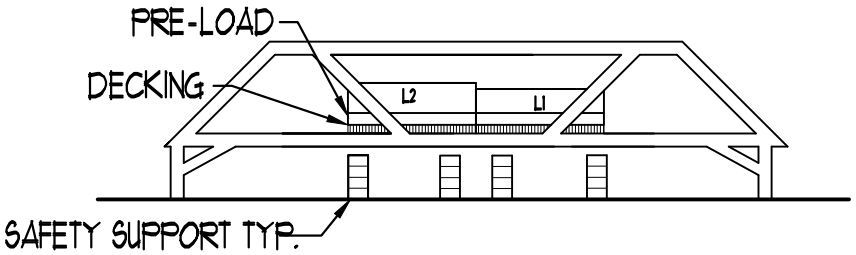
LATERAL LOAD TEST

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 SBBC RULES

DESIGNED BY: F. HATFIELD
DRAWN BY: D. SEPULVEDA
CHECKED BY: RULES COMM.
IN CHARGE: N. GAVLIN
DATE: 08-20-2014

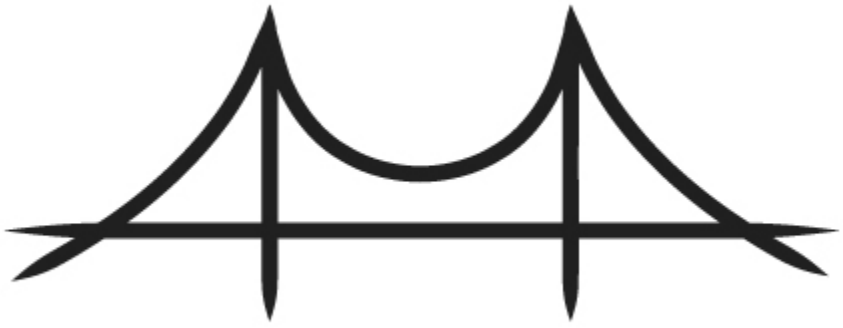
ASCE-AISC
STUDENT STEEL BRIDGE CONTEST
SUBMITTED
APPROVED

LOADING DIAGRAMS

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

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)

TABLE OF CONTENTS

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.

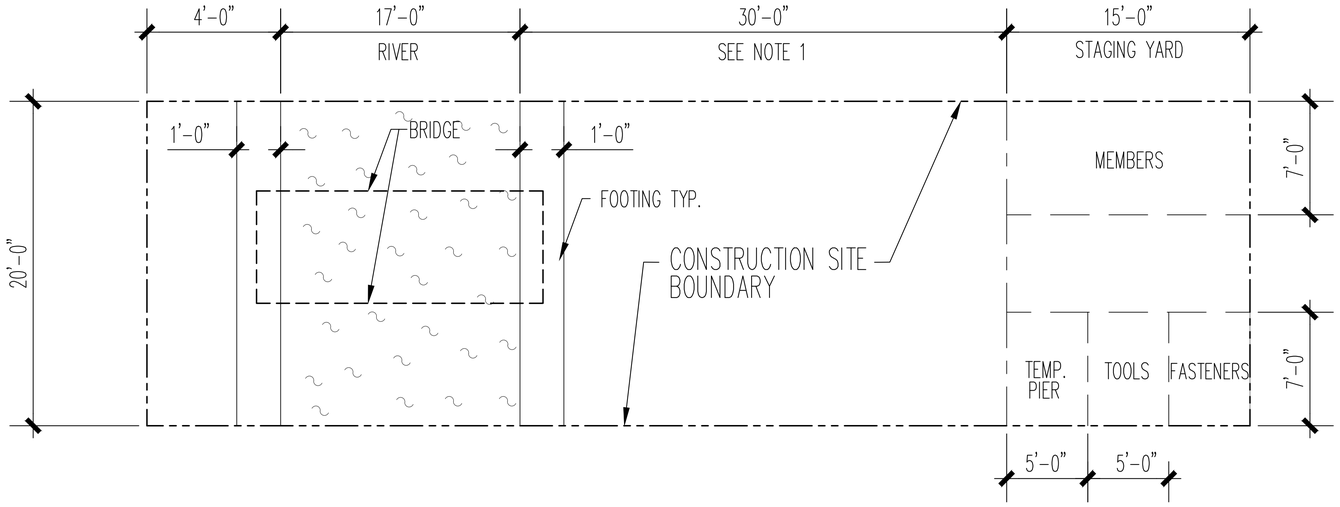
15.2.3 After hearing the SHJ's ruling, the team captain may request a five-minute recess to discuss the issue with the team. During the recess, the conditions at issue will not be changed. Immediately after that recess, if the team has justification to contest the SHJ's ruling, the captain has the option 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

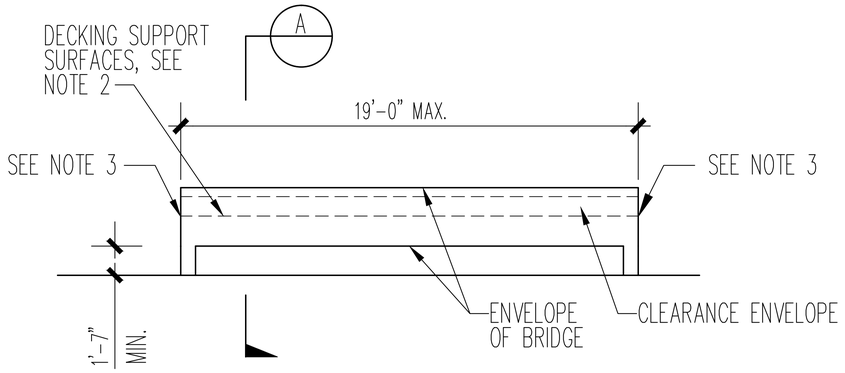
INDEX OF DEFINITIONS



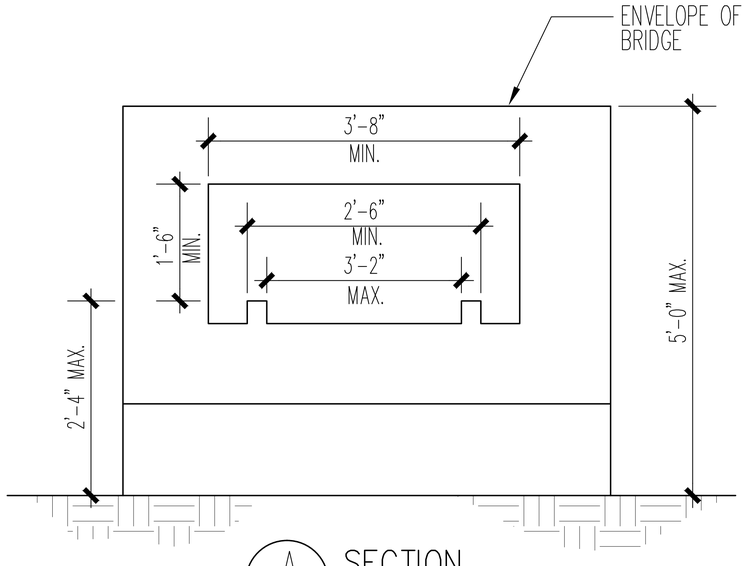
NOTES:

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

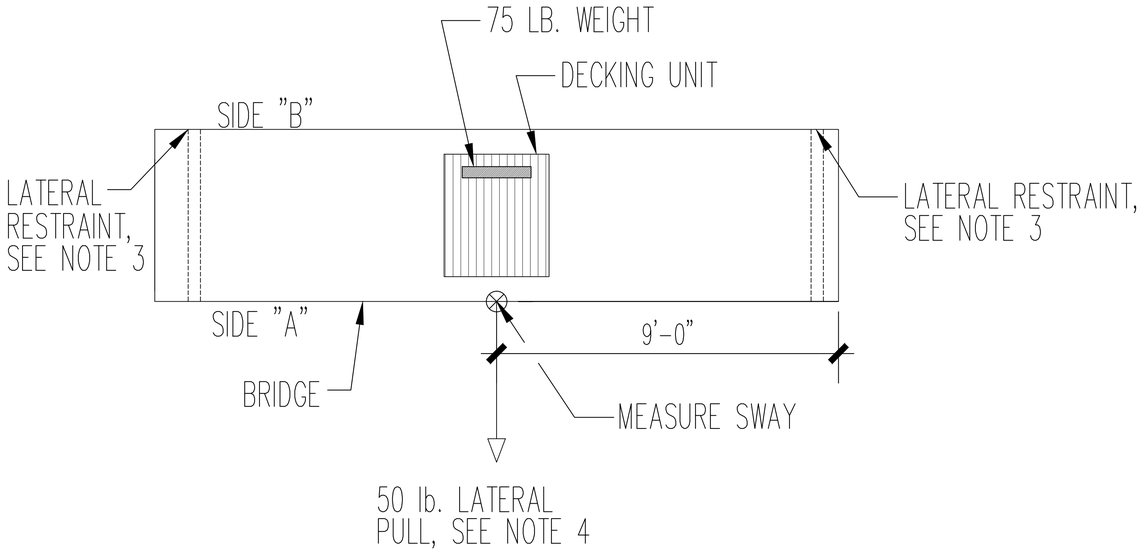
REV.	BY	DATE	APP	REC NO.	EXPIRES	SEAL HOLDER	DESCRIPTION
							2013 SSBC RULES

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

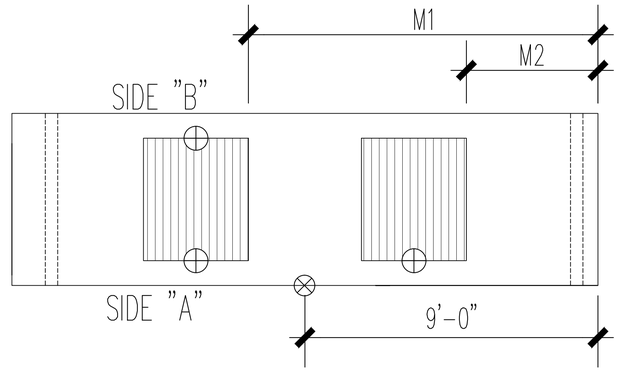
SITE AND BRIDGE DIAGRAM

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



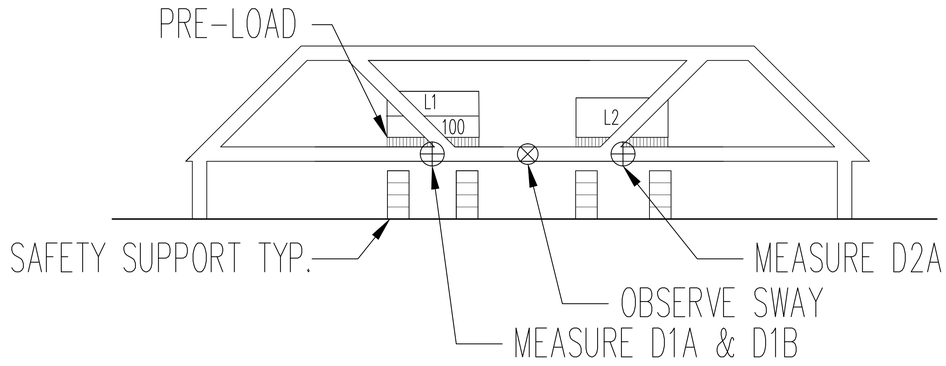
LATERAL LOAD TEST

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

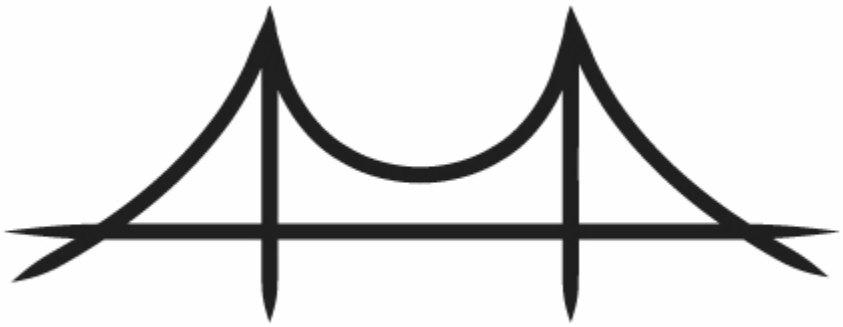
ASCE-AISC
STUDENT STEEL BRIDGE CONTEST
SUBMITTED
APPROVED

LOADING DIAGRAMS

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

STUDENT STEEL BRIDGE COMPETITION

2013 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)
- Nelson Stud Welding
- Nucor Corporation
- Steel Structures Education Foundation (SSEF)

TABLE OF CONTENTS

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 2013 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 14, “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
- 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
- James C. Williams, P.E., Professor, University of Texas at Arlington

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 new Hill Music Hall and Marian Paroo Memorial Library sparked revitalization of the River City waterfront, with restaurants, theaters, and luxury condominiums scrambling for space in the old brick warehouses. The resulting vehicle traffic now exceeds the capacity of city streets. Therefore, the River City Development Corporation (RCDC) is requesting design/build proposals for a bridge to provide direct access from suburbs across the river.

Accelerated Bridge Construction (ABC) is mandated in order to minimize travel delays and financial losses to waterfront businesses caused by disruption of traffic during construction. As an attractive signature structure for the redeveloped waterfront, the new bridge will provide clearance for tour boats, and will cantilever over the historically significant billiard parlor.

RCDC specifies steel because fast erection is essential to ABC, and because steel's durability and high level of recycled content contribute to exceptional sustainability. The high strength to weight ratio of steel assures an efficient structure, and prefabricated deck panels expedite ABC.

The congested urban site restricts location and size of the staging area, and the dimensions and weight of equipment and transported material are limited by narrow, thinly paved streets. Navigation must not be restricted by construction barges or permanent abutments in the river. However, a permit has been obtained for a temporary cofferdam. The scope of the bridge contract does not include foundations, approaches, deck panels, or the cofferdam.

Your company's proposal is among those that the RCDC has deemed responsive, and winning the contract would be a step toward leadership in ABC. 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. The RCDC has selected a panel of engineers to 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.

4.2.3 A team shall consist only of undergraduate and graduate students in good standing with their ASCE student organization. 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.

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 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.

4.3.5 A team must consist only of members who are or were students in good standing with their ASCE student organization 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, 2012, are reprinted in this sub-section (4.4) but are subject to change. The current version is at http://www.asce.org/studentorgs/competition-eligibility/. 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 Activities (CSA) 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 <u>does not</u> count as an entry into the Student Conference Paper Competition."*

Section 5

RULE CHANGES

The following items in this section (5) identify some of the major changes from the 2012 rules. Not all changes are included. Contestants, hosts, and judges are cautioned to **read this entire document carefully and disregard rules and clarifications from previous years**.

(1) Scoring and penalties have been revised.
(2) Bridge and site dimensions are different.
(3) Interlocking connections that were acceptable last year, such as typical dovetails, tees, and those that lock by twisting, will be penalized this year.
(4) Responsibilities are assigned to team captains.
(5) Bridges that collapse or deflect excessively will be withdrawn from competition.

Section 6

SAFETY

Safety has the highest priority – risk of personal injury will not be tolerated. Sub-sections 9.2, 10.1, 11.2, 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-sections 12.1, 12.2, and 12.3. Sub-sections 12.4, 12.5, and 12.6 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.

Section 7

SCORING

7.1 RECORDING DATA AND SUBMITTING SCORES

Scoring data should be recorded for every team that competes, using judges' data forms printed from the official scoring spreadsheet downloaded from http://www.nssbc.info. Data from those forms are then entered on 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 team captain is given adequate time to verify the data before signing the form.

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

7.2 CATEGORIES OF COMPETITION

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

7.2.2 Display

7.2.2.1 Display is the tie-breaker for all categories of competition. Judges shall not declare ties in display. The bridge is displayed exactly as it will be erected during timed construction. Display is judged by the following criteria

7.2.2.2 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.

7.2.2.3 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 must appear on member(s) of the bridge in letters that are all, by measurement, at least one inch high, and must be formed from steel or applied to steel with paint or decals. A bridge that lacks appropriate identification will receive a very low display rating.

7.2.2.4 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 brief computation demonstrating design for one limit state,
(6) discuss provisions for sustainability, if any, for example, by listing or designating on the drawing those parts of the bridge that were salvaged from previous bridges or projects, or obtained from salvage yards,
(7) acknowledge university technicians, faculty, and others who helped fabricate the bridge or provided advice, and
(8) 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.

7.2.3 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 11.4 and 11.8.1, plus two minutes if repair time is commenced, plus double the repair time modified by construction penalties prescribed in 11.4 (see 11.10.1). There are upper limits on construction and repair time (see 11.8.2 and 11.10.2).

7.2.4 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 9.3, 9.4, and 10.2. Decking, tools, temporary pier, lateral restraint devices, and posters are not included in total weight.

7.2.5 Stiffness

The bridge with the lowest aggregate deflection will win in the stiffness category. Aggregate deflection is determined from measurements as prescribed in 12.5.

7.2.6 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 number of builders x 50,000 ($/builder-minute) + load test penalties ($).

Total time is defined in 7.2.3, and load test time penalties are prescribed in 12.2, 12.4, and 12.5. The number of builders includes all members and associates of the competing organization who physically assist the team at any time during timed construction or repair. A captain who is not a builder and does not physically assist with construction or repair is not included in number of builders.

7.2.7 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 10,000 ($/pound)
+ Aggregate deflection (inches) x 1,000,000 ($/inch)
+ Load test penalties ($)

For a bridge that weighs more than 400 pounds,

C_s = [Total weight (pounds)]^2 x 25 ($/pound^2)
+ Aggregate deflection (inches) x 1,000,000 ($/inch)
+ Load test penalties ($)

Total weight is defined in 7.2.4, aggregate deflection is defined in 7.2.5, and load test weight penalties are prescribed in 12.4 and 12.5.

7.2.8 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.

7.3 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 8

SCHEDULE OF COMPETITION

In the months before the competition, students design their bridges, fabricate members, test load, practice construction, and select the captain and builders for timed construction. The following events occur during the competition

(1) 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, and repair as described in 11.10.
(2) Bridges are disassembled.
(3) In a meeting at which all team captains are present, the head judge clarifies rules and conditions of the competition and answers questions.
(4) The head judge selects the location of the load on the back span and the locations of two of the three vertical deflection targets. See 12.5.1, the Lateral Loading Diagram, and the Vertical Loading Diagram. Selection is done in the presence of the team captains by rolling a die twice. For each possible result S1 of the first roll, Table 8.1 gives the dimension M for positioning the load on the back span and the dimension TB for placing the vertical deflection target on the back span.

TABLE 8.1 Determination of M and TB from first roll of die

S1	even	odd
M	3’0”	7’0”
TB	4’6”	8’6”

For each possible result S2 of the second roll, Table 8.2 gives the dimension TC for placing a vertical deflection target on the cantilever.

TABLE 8.2 Determination of TC from second roll of die

S2	1	2	3	4	5	6
TC	1’0”	1’3”	1’6”	1’9”	2’0”	2’6”

The same locations will be used for all bridges in the competition.
(5) Using a random process, the head judge determines the order in which teams will compete.
(6) Bridge members, fasteners, tools, and the temporary pier are staged for construction and inspected by the judges. See section 10, “Material and Component Specifications,” 9.4.5, 9.4.6, 11.2, and 11.6 for details.
(7) Timed construction and repair. See section 11, “Construction Regulations,” for details.
(8) Judges inspect assembled bridges. For details, see section 9, “Dimension and Support Specifications,” (including 9.4.5 and 9.4.6 as they apply to installation of fasteners) and 10.1.3.
(9) Bridges are weighed (if it is impractical to weigh the entire bridge, its parts may be weighed prior to construction). All bridges must be weighed, including those that are withdrawn from competition.
(10) Load testing. See section 12, “Load Tests,” for details.

(11) Scores and rankings are determined using the official scoring spreadsheet found at www.nssbc.info.
(12) The host ASCE student organization submits the completed official scoring spreadsheet by e-mailing it to the address given on that spreadsheet.
(13) Copies of the summary score sheets are distributed to all teams or posted on the conference host's web site.
(14) The host student organization retains judges' data forms for two weeks.

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 repairs as described in 11.10 and 12.2. 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 9

DIMENSION AND SUPPORT SPECIFICATIONS

9.1 MEASUREMENT

Dimensions and support will be checked with the bridge in its as-built condition after construction and repair are completed, 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.

9.2 FUNCTIONALITY AND SAFETY

9.2.1 If any of the following rules in this sub-section (9.2) is violated, the bridge will not be approved for load testing and will not be eligible for awards in any category.

9.2.2 The back span is the part of the bridge that has supports at both ends. The back span must span the river completely without touching it. The river is twelve feet wide. See the Site Plan on the Site and Bridge Diagram.

9.2.3 The cantilever is the part of the bridge that has an unsupported end. The part of the bridge farthest from the staging yard must be a cantilever.

9.2.4 The bridge must have two surfaces on which the sides of the decking will bear. These decking support surfaces are continuous in the span direction of the bridge. See the Elevation and Section on the Site and Bridge Diagram.

9.2.5 The bridge must provide access for safely placing the decking and load.

9.2.6 The decking must not be attached or anchored to the bridge, and it must not be used to distort the bridge from its as-built condition.

9.2.7 The bridge must not be anchored or tied to the floor.

9.2.8 It must 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 must accommodate local conditions.**

9.3 USABILITY

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

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

(1) 50 pounds for a dimensional violation of ½ inch or less,
(2) 150 pounds for a dimensional violation greater than ½ inch but not exceeding 1.0 inch,
(3) 300 pounds for a dimensional violation greater than 1.0 inch but not exceeding 2.0 inches, and
(4) If a dimensional violation exceeds 2.0 inches, the bridge will not be approved for load testing and will not be eligible for awards in any category.

9.3.2 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.

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

9.3.4 The length of each decking support surface shall not exceed 17’0”.

9.3.5 At every section along the full length of the bridge, each decking support surface shall be flat, level, and at least ½ inch wide.

9.3.6 The decking support surfaces shall be smooth and free of vertical protrusions except for the fastener bolt heads that are no higher than ¼ inch.

9.3.7 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.

9.3.8 A gap is a discontinuity or depression that extends laterally across the full width of a decking support surface. No gap shall exceed ¼ inch measured in the span direction of the bridge.

9.3.9 The decking support surfaces shall be no more than 3’0” above the surface of the river or ground at any point. See the Section on the Site and Bridge Diagram.

9.3.10 A vehicle passageway must 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. See the Section on the Site and Bridge Diagram.

9.3.11 Vertical clearance must be provided under the bridge at all points directly over the river. The clearance must be at least 1’7” high, measured from the surface of the river. See the Elevation on the Site and Bridge Diagram.

9.3.12 Vertical clearance must be provided under the bridge for a minimum of 3’6” from the unsupported cantilever end of the decking support surfaces. The clearance must be at least 1’7” high, measured from the ground. See the Elevation on the Site and Bridge Diagram.

9.4 MEMBER-TO-MEMBER CONNECTIONS

9.4.1 Violations of the rules in this sub-section (9.4) will result in penalties being added to the weight of the bridge. The penalty for each violation is 25 pounds.

9.4.2 There shall be a connection at every place where one member contacts another, and by the end of timed construction there must be at least one fastener in every connection so that it cannot be taken apart without first turning the nut or the bolt and removing the nut from the bolt. Definitions of “member” and “fastener” are given in 10.2.3 and 10.2.4, respectively.

9.4.3 A faying surface is either of a pair of surfaces that are, or will be, in contact at a connection. Every member must have one or more faying surfaces at each connection. Faying surfaces must be flat and smooth, and must not have protrusions, ridges, studs, teeth, threads, holes (other than those for fasteners), or sockets that would lock into connecting members.

9.4.4 Every faying surface must be penetrated by a fastener.

9.4.5 The bolt must penetrate completely through a hole in each of the members that it connects. Dimension(s) of the hole must be small enough so that neither the head of the bolt nor the nut can pass through the hole.

9.4.6 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.

9.4.7 The bolt must fully engage the threads of the nut. That is, the terminal threads on the bolt must extend beyond, or be flush with, the outer face of the nut.

Section 10

MATERIAL AND COMPONENT SPECIFICATIONS

10.1 SAFETY

10.1.1 If any one of the rules in this sub-section (10.1) is violated, the bridge will not be approved for construction or load testing, and will not be eligible for awards in any category.

10.1.2 A member must not weigh more than twenty pounds. See 10.2.3 for definition of “member.”

10.1.3 A bridge must 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.

10.2 DURABILITY AND CONSTRUCTABILITY

10.2.1 Penalties

Violation of the rules in this sub-section (10.2) will result in penalties being added to the weight of the bridge. The penalty is 25 pounds for each member or fastener that is in violation.

10.2.2 Bridge

A bridge must 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.

10.2.3 Members

10.2.3.1 A member is a rigid component comprised of steel parts welded together. A member must 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.

10.2.3.2 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.

10.2.4 Fasteners

10.2.4.1 A fastener is a bolt that is not part of a member, with one nut that is not part of a member. Grade and diameter are 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

10.2.4.2 The bolt in a fastener must be solid and no more than 1½-inch nominal length (bottom of head to end) with a head that is hexagonal in shape. Bolts must be commercially available and shall not be mechanically altered or modified in any way but may be painted.

10.2.4.3 The nut for a fastener must 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 must be solid and hexagonal in shape, and must be available commercially. Only one bolt and nothing else shall be threaded into a nut. Nuts must not be mechanically altered or modified in any way but may be painted.

Section 11

CONSTRUCTION REGULATIONS

11.1 DEFINITIONS

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

11.1.2 "Ground" is the floor inside the construction site boundary, except for the river. Ground includes the cofferdam.

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

11.1.4 A “team” is all the builders from the competing organization who are within the construction site boundary during timed construction.

11.1.5 A “captain” is an undergraduate or graduate student member of a competing student organization. A team designates one person to serve as captain for the entire competition. The captain may or may not be a builder but will observe timed construction, repair, weighing, and load testing, and will sign data forms.

11.1.6 “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.

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

11.1.8 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.

11.1.9 A “temporary pier” is an optional device that bears on the cofferdam and 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.

11.1.10 “Member-to-member connection” is defined in 9.4. “Member” and “fastener” are defined in 10.2.3 and 10.2.4, respectively.

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

11.1.12 To “fasten” means making a member-to-member connection by installing a fastener (i.e., bolt and nut) to attach a member to the constructed portion or to attach two non-contiguous parts of the constructed portion.

11.2 GENERAL SAFETY CONDITIONS

11.2.1 Timed construction or repair will not commence or will be stopped if any provision of this sub-section (11.2) is violated.

11.2.2 Builders, captains, judges, host personnel, and spectators must not be exposed to risk of personal injury.

11.2.3 Only builders and judges are permitted within the construction site boundary during timed construction and repair. The captain, if not a builder, must observe construction and be accessible to the judges, but shall not interfere with them. 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.

11.2.4 The team shall include no more than six builders.

11.2.5 At all times during timed construction and repair every builder must wear personal protective equipment in the proper manner (e.g., hardhat with peak in front).

11.2.6 A tool or unassembled part of a tool must not weigh more than twenty pounds, and 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. Welding machines and tools requiring external power connections shall not be used during timed construction or repair. Tools must be rigid except for rotary tools such as ratchet wrenches and battery-powered drivers.

11.2.7 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".

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

11.3 SAFE CONSTRUCTION PRACTICES

11.3.1 If any rule in this sub-section (11.3) is violated during timed construction or repair, the judge will stop the clock and explain the violation. Before the clock is restarted, builders, tools, parts of tools, members, fasteners, and the temporary pier will be returned to the positions they occupied before the violation. Then the team will be asked to resume construction using safe procedures. A team will have the opportunity to construct its bridge safely. However, if the 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.

11.3.2 Construction of every non-contiguous part of the constructed portion shall commence by placing a member on the ground. 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.

11.3.3 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 and, after being placed, must be in contact with the ground continuously for the remaining duration of timed construction and repair.

11.3.4 A temporary pier shall not support tools or fasteners.

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

11.3.6 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.

11.3.7 Throwing anything is prohibited.

11.3.8 A builder shall not cross from the ground on one side of the river to the ground on the other side or to the cofferdam. A builder shall not cross from the cofferdam to the ground adjacent to the river.

11.3.9 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.

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

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

11.3.12 A builder must not use the bridge, a constructed portion of the bridge, 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 both feet on the floor.

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

11.4 ACCIDENTS

11.4.1 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 (11.4).

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, builders, tools, members, temporary pier, and fasteners will be returned to the positions they occupied before the accident.

11.4.2 A builder or a 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.

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

11.4.4 The temporary pier touches the river, the ground outside the cofferdam, or the floor outside the staging yard. Penalty is 1/4 minute (15 seconds) for every occurrence.

11.4.5 A member, constructed portion, tool, nut, bolt, or personal protective equipment touches the floor outside the staging yard, the river, or the ground (which includes the cofferdam). 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 outside the river without penalty.

11.4.6 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.

11.5 CONSTRUCTION SITE

11.5.1 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.

11.6 START

11.6.1 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 on the ground, which includes the cofferdam and both sides of the river. 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. Builders are wearing personal protective equipment as well as optional clothing such as pouches.

11.6.2 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 11.2.6 and 11.2.7, 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.

11.6.3 Timing and construction begin when the captain signifies that the team is ready and the judge declares the start.

11.7 TIME

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

(1) if a builder, captain, or judge sees a condition that could cause injury, or
(2) when a safety rule has been violated (see 11.2 and 11.3), 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 11.4), or
(4) if a builder, captain, or judge is injured.

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

11.8 TIME LIMIT

11.8.1 If construction time, not including penalties and repair time, exceeds thirty minutes, construction time will be counted as 180 minutes for scoring. "Accidents" (11.4) that occur after thirty minutes will not be penalized but safety rules (11.2 and 11.3) will still be enforced. Judges may inform the team when this time limit is approaching and must inform them when it is reached.

11.8.2 If construction time, not including penalties and repair time, exceeds 45 minutes, judges must 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.

11.9 FINISH

11.9.1 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 part 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 part of the staging yard designated on the Site and Bridge Diagram, and
(4) the captain informs the judge that construction is complete.

11.9.2 Installation of decking is not included in timed construction.

11.9.3 After construction is finished the bridge must not be modified except for repair as permitted by 11.10.

11.10 REPAIR

11.10.1 Before the judges inspect and measure the bridge, and before the bridge is moved from the construction site, two builders, or one builder and the captain, 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 mistakes found by their inspectors. Repairs are made with the clock restarted and begin with builders and necessary items arranged in the staging yard as prescribed by 11.6.1. Safety precautions (11.2 and 11.3) are enforced and accidents (11.4) are counted. The repair period ends when the conditions listed in 11.9.1 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.

It is not necessary to inspect, measure, or repair a bridge that exceeded the 45-minute time limit prescribed in 11.8.2.

11.10.2 If the repair time, not including penalties, exceeds five minutes, judges must 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.

Section 12

LOAD TESTS

12.1 SAFETY PRECAUTIONS

An activity will be halted if the judge considers it to be hazardous.

A bridge could suddenly collapse or sway in any direction during load tests. Therefore, the number of people near the bridge while it is being tested shall be minimized. Usually, the load should be placed on the bridge by only two competitors. Competitors who are not participating in loading, faculty, advisers, and other spectators must observe from an area designated by the judges and host student organization.

People should be kept clear of the unsupported end of the cantilever; load should be placed from the sides;

While participating in load testing, competitors must wear hardhats meeting ANSI standard Z89.1, protective eyewear or safety goggles meeting ANSI standard Z87.1, 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.

During testing, safety supports must be in place below the decking. The safety supports shall be of sufficient height, strength, number, and extent that none of the load will fall more than approximately five inches if the bridge collapses.

All preparations for load testing, including placement of safety supports, must be completed before any load is on the bridge so that it will not be necessary for anyone to reach, crawl, or step under the loaded bridge. However, if safety supports must be adjusted during loading, the load must first be removed without disturbing the bridge, adjustments made, and the load replaced as it was before being removed.

If team members cannot load their bridge safely, loading will cease and the bridge will not be eligible for awards in any category.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking.

12.2 DAMAGE

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

If a bolt or nut is missing or the threads of a nut are not fully engaged, the fastener will be reinstalled correctly, and a penalty of $1,000,000 will be added to the Construction Economy score for every bolt and every nut that was reinstalled.

A bridge with damage that would reduce its strength or stability (such as a fractured weld, or missing or broken member) will 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 provided by the preceding paragraph of this subsection (12.2).

12.3 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 to 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 (12), the bridge will not be load tested and will not be eligible for awards in any category.

12.4 LATERAL LOAD TESTS

12.4.1 The provisions of this sub-section (12.4) are illustrated by the Lateral Loading Diagram. “Sway” is translation in any horizontal direction.

The lateral load tests are conducted with one unit of decking placed at the center of the back span and approximately 75 pounds of weight on the decking near the “B” side of the bridge. This load is intended to prevent the bearing surfaces of the bridge from lifting off the floor when lateral load is applied.

Bearing surfaces are prevented from sliding by lateral restraint applied by team members or the captain. This lateral restraint does not restrain rotation or uplift. The restraint is applied as close to the ground as possible, at the locations shown on the Lateral Loading Diagram. Teams may provide and use optional devices to prevent sliding. A 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.

12.4.2 Lateral Load Test of the Back Span

A sway target is established for measurement on the “A” side of the bridge, 6’6” from the end of the decking support surface at the end of the bridge that is not cantilevered. The sway target is located as close as possible to the decking support surface, which is at the same level as 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 four inches from the sway target. To pass the lateral load test, the sway must not exceed 1/2 inch.

If the bridge does not pass this lateral load test it is not approved for further testing. **Do not conduct any other load test**. Check the appropriate box on the judges’ data 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 of the back span, proceed with the lateral load test of the cantilever.

12.4.3 Lateral Load Test of the Cantilever

A sway target is established for measurement on the “A” side of the bridge, at the end of the decking support surface at the unsupported end of the cantilever. The sway target is located as close as possible to the decking support surface, which is at the same level as 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 four inches from the sway target. To pass the lateral load test, sway must not exceed 1/2 inch.

If the bridge does not pass this lateral load test it is not approved for further testing. **Do not conduct any other load test**. Check the appropriate box on the judge’s data 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 this lateral load test, remove the load and decking, and proceed with the vertical load test.

12.5 VERTICAL LOAD TESTS

12.5.1 The provisions of this section are illustrated by the Vertical Loading Diagram.

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

Decking units are three feet long in the longitudinal (span) direction of the bridge. Place one decking unit at a distance M from the end of the decking support surfaces at the end of the bridge that is not cantilevered. M is determined at the beginning of the competition as described by Table 8.1 in section 8, "Schedule of Competition." Place the other decking unit at a distance of one inch measured from the end of the decking support surfaces at the unsupported end of the cantilever. Decking units are placed square with the bridge and centered laterally with the main bars spanning laterally over the decking support surfaces. Decking units must not be attached to the bridge and must not distort it (see 9.2.5 and 9.2.6).

Three targets are established for measuring vertical deflections at locations determined by the following dimensions

- TB from the end of the decking support surface at the end of the bridge that is not cantilevered, on the "B" side of the bridge
- TC from the end of the decking support surface at the cantilevered end of the bridge, on the "A" side of the bridge
- One inch from the end of the decking support surface at the cantilevered end of the bridge, on the "B" side of the bridge.

TB and TC are determined at the beginning of the competition as described by Tables 8.1 and 8.2 in section 8, "Schedule of Competition." Vertical deflection targets are located on the decking.

Position measuring devices on the three vertical deflection targets.

Uniformly distribute 100 pounds of preload on the decking unit on the back span. Then uniformly distribute 50 pounds of preload on the decking unit on the cantilever. Preloads are laterally centered on the decking units. Preloads are distributed and aligned identically for every bridge.

If, after the preload is installed, decking does not contact the decking support surface at a vertical deflection target, the judge will clamp the decking to the decking support surface at that location and leave the clamp in place during vertical load testing.

If a competitor disturbs a measuring device after it has been initialized and before loading is completed and all measurement have been recorded, the judge will require the team to disassemble the bridge and repeat timed construction beginning with the initial conditions prescribed in 11.6. 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.

The two steps (increments) of vertical loading produce four measurements

(1) DB1 = absolute value of vertical deflection at the target on the "B" side of the back span that occurs during step 1 (loading the back span).
(2) DCA = absolute value of vertical deflection at the target on the "A" side of the cantilever that occurs during step 2 (loading the cantilever with the load from step 1 remaining in place).
(3) DCB = absolute value of vertical deflection at the target on the "B" side of the cantilever that occurs during step 2 (loading the cantilever with the load from step 1 remaining in place).
(4) DB2 = absolute value of vertical deflection at the target on the "B" side of the back span that occurs from the beginning of step 1 to the end of step 2.

The scoring spreadsheet computes aggregate deflection as the sum of DCA, DCB, and the larger of DB1 and DB2.

12.5.2 Step 1 – Vertical Load Test of the Back Span

Load the decking unit on the back span and measure the deflection, using the following procedure

(1) The two preloads remain in place.
(2) Initialize the sway measurement device on the back span.
(3) Initialize the sway measurement device on the cantilever.
(4) Initialize the vertical deflection measuring device on the back span or record the initial reading.
(5) Team members place 1400 pounds of additional load on the decking unit on the back span. The 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.
(6) As the load is being placed, observe the deflection target on the back span and both sway targets. Stop loading if

    (a) sway at either sway target exceeds 0.5 inch from the beginning of step 1, or
    (b) deflection at the deflection target on the back span exceeds three inches downward from the beginning of step 1, 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.

<u>If loading is stopped</u> 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 data form.

<u>If the bridge passes step 1</u>, record the measured value DB1. If DB1 exceeds 1.5 inches, the scoring spreadsheet will add penalties of $8,000,000 to the Construction Economy score and $20,000,000 to the Structural Efficiency score.

12.5.3 Step 2 – Vertical Load Test of the Cantilever

Load the decking unit on the cantilever and measure the deflections, using the following procedure

(1) The two preloads and the load from step 1 remain in place.
(2) Do **not** initialize the vertical deflection measuring device on the back span.
(3) Do **not** initialize the sway measurement devices on the back span and cantilever.
(4) Initialize the vertical deflection measuring devices on the cantilever.
(5) Team members place 950 pounds of additional load on the decking unit on the cantilever. The 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.
(6) As the load is being placed, observe the three deflection targets and both sway targets. Stop loading if

(a) sway at either sway target exceeds 0.5 inch from the beginning of step 1, or
(b.1) deflection at the deflection target on the back span exceeds three inches downward from the beginning of step 1, or
(b.2) deflection at either deflection target on the cantilever exceeds two inches downward from the beginning of step 2, 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.

<u>If loading is stopped</u> for any of the situations a, b.1, b.2, 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 data form.

<u>If the bridge passes step 2</u>, record the measured values of DB2, DCA, and DCB. If DB2 exceeds 1.5 inches but DB1 did not, or If DCA or DCB exceeds one inch, the scoring spreadsheet will add penalties of $6,000,000 to the Construction Economy score and $15,000,000 to the Structural Efficiency score.

12.6 Unloading

Remove all load from the cantilever before removing any load from the back span.

<u>If the bridge collapses during unloading</u> (situation c, d, or e), it will not be eligible for awards in any category.

Section 13

EQUIPMENT PROVIDED BY HOST

13.1 SOURCES OF INFORMATION

The Competition Guide at http://www.nssbc.info should be reviewed by judges, host personnel, and competitors. It has detailed descriptions and illustrations of contest procedures and hosting equipment. The following provisions of this section (13) describe some of the equipment that is needed for the competition and is intended to help competitors know what to expect. Competitors should acquire similar equipment for use in practice and testing before the competition.

13.2 FLOOR

The floor in both the construction site and loading area shall be solid, stable and as nearly flat and level as possible.

13.3 LATERAL LOAD DEVICE

The lateral load device should be capable of applying a force of 50 pounds in the horizontal direction.

13.4 SWAY MEASUREMENT

Sway is horizontal translation and is measured at two points by any accurate method. A suggested method is to suspend a plumb bob from the sway target and measure sway from a point marked on the floor.

13.5 DEFLECTION MEASUREMENT

Deflection is vertical translation and is measured at three points by any accurate method.

13.6 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 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.

13.7 CLAMPS AND SMALL STEEL PLATES

Clamps may be needed to hold the decking in contact with the decking support surfaces of a bridge. Small steel plates may be needed as bearing surfaces for clamps and measuring devices.

13.8 SAFETY SUPPORTS

The safety supports must be used during load tests and are intended to limit the consequences of a bridge collapsing. The safety supports shall be of sufficient height, strength, number, and extent so that none of the load will fall more than approximately five inches if the bridge collapses. Safety supports may be steel, nested stacks of plastic buckets, timbers, sand bags, or masonry units.

13.9 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.

13.10 OFFICIAL SCORING SPREADSHEET AND DATA FORMS

Results will not be official until the completed official scoring spreadsheet is submitted to ssbc.results@gmail.com to report outcomes. It may be downloaded at http://www.nssbc.info. Judges’ forms for recording data are accessed from the spreadsheet. The host student organization retains the judges’ data forms for two weeks after the competition.

Section 14

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 13, 2013.

Section 15

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 16

APPEALS

16.1 CONFERENCE COMPETITIONS

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

16.1.2 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 data sheet before signing it. Participants are reminded that civility and ethical behavior are expected during the competition and particularly concerning appeals.

16.1.3 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' data forms documenting the problem.

16.1.4 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.

16.2 NATIONAL COMPETITION

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

16.2.2 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.

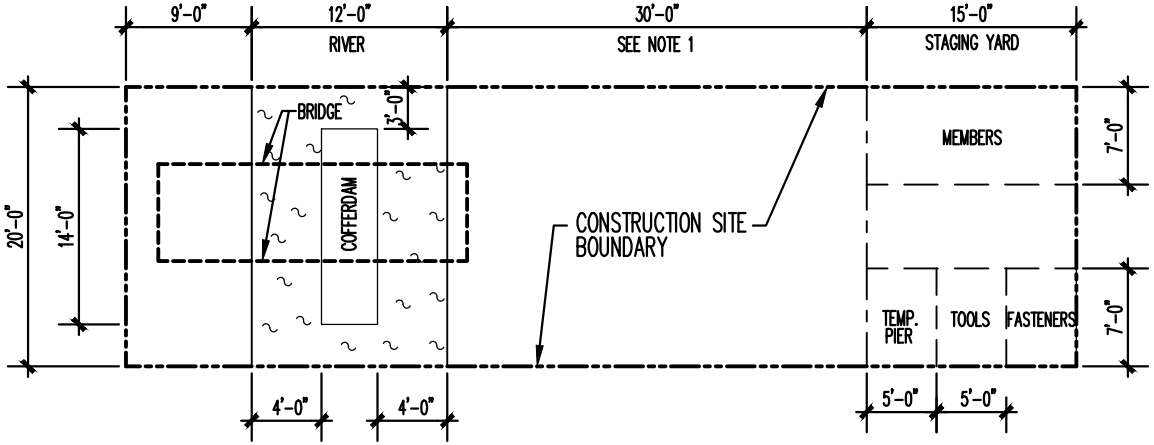
16.2.3 After hearing the SHJ's ruling, the team captain may request a five-minute recess to discuss the issue with the team. During the recess, the conditions at issue will not be changed. Immediately after that recess, if the team has justification to contest the SHJ's ruling, the captain has the option 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.

16.2.4 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.

16.2.5 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 17

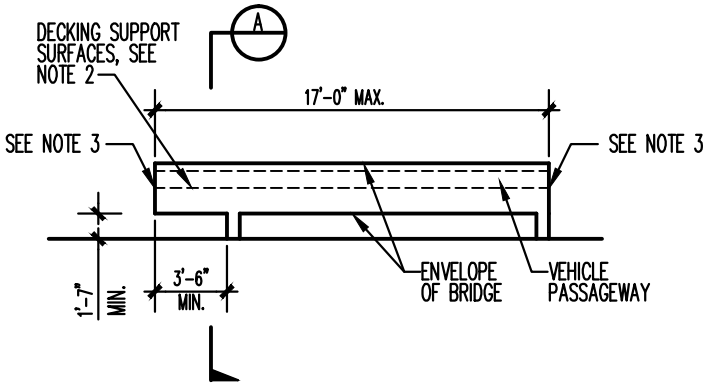
INDEX OF DEFINITION



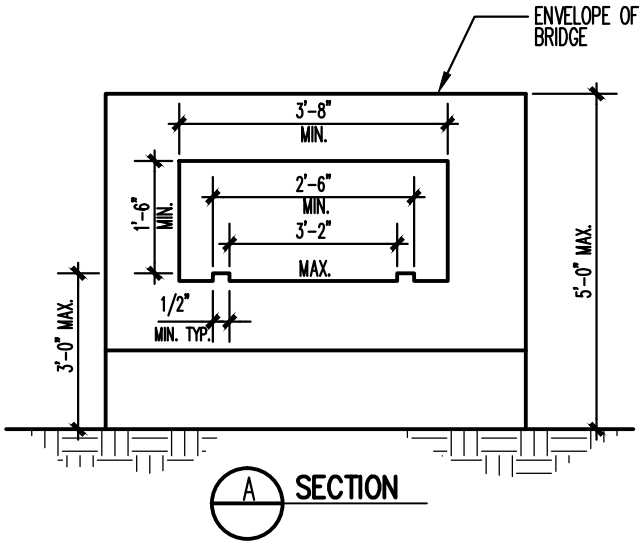
NOTES:

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 9 & 11



ELEVATION – REFER TO CHAPTER 9



A SECTION

REV.	BY	DATE	APP	REC NO.	EXPIRES	SEAL HOLDER	2012 SSBC RULES DESCRIPTION	DESIGNED BY	F. HATFIELD	ASCE-AISC STUDENT STEEL BRIDGE CONTEST	SITE AND BRIDGE DIAGRAM
								DRAWN BY	D. SEPULVEDA		
								CHECKED BY	RULES COMM.		
								IN CHARGE	N. GAVLIN		
								DATE	08-01-2012		

MEMBER

American Society of Civil Engineers

SUBMITTED

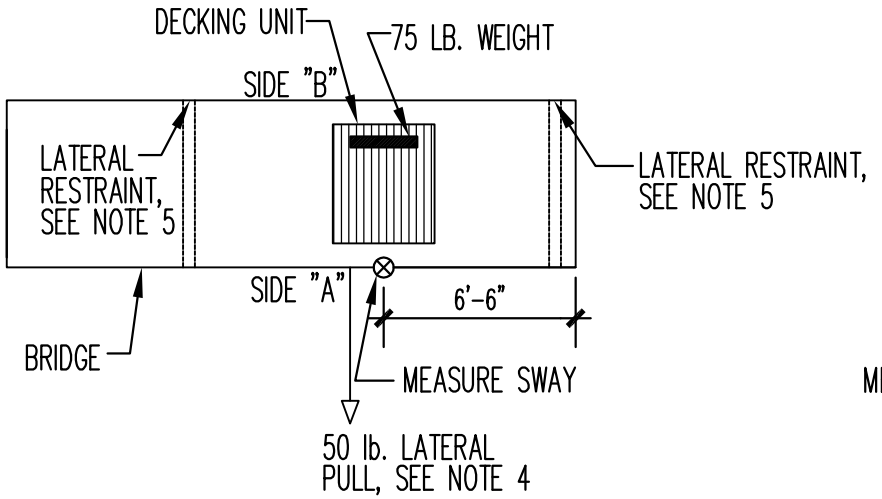
APPROVED

CONTACT NUMBER

DRAWING NO. DWG 1

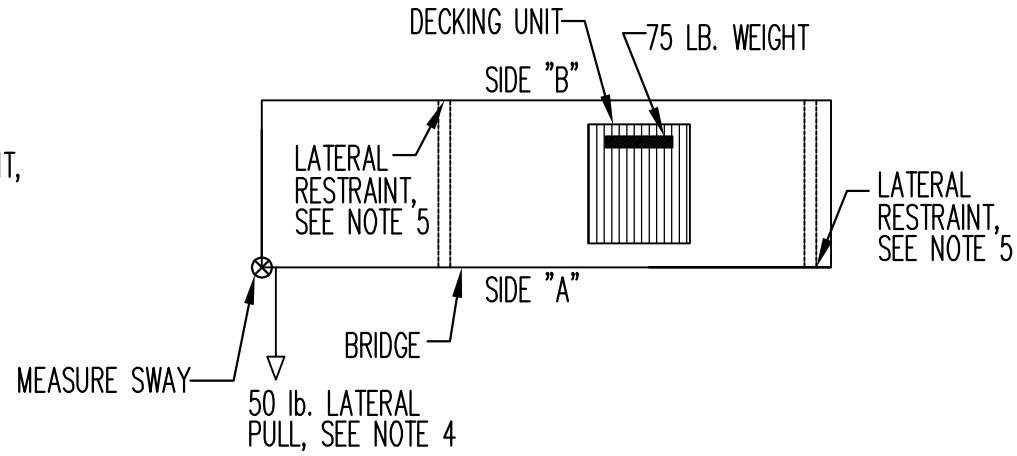
SCALE NTS

SHEET NO.



STEP 1

REFER TO 12.4.2



STEP 2

REFER TO 12.4.3

LATERAL LOAD TESTS

REFER TO 12.4

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. ALL SWAY TARGETS ARE TO REMAIN IN PLACE THROUGHOUT LOADING PROCESS.
4. LOCATION OF 50 lb. PULL SHALL NOT EXCEED 4" FROM SWAY TARGET.
5. LATERAL RESTRAINT MUST BE APPLIED CLOSE TO THE GROUND AND MUST NOT RESTRAIN ROTATION, UPLIFT, OR TRANSLATION IN OTHER THAN THE LATERAL DIRECTION.

REV.	BY	DATE	APP	REC NO.	EXPIRES	SEAL HOLDER	DESCRIPTION
							2012 SSBC RULES

DESIGNED BY	F. HATFIELD
DRAWN BY	D. SEPULVEDA
CHECKED BY	RULES COMM.
IN CHARGE	N. GAVLIN
DATE	08-01-2012

MEMBER

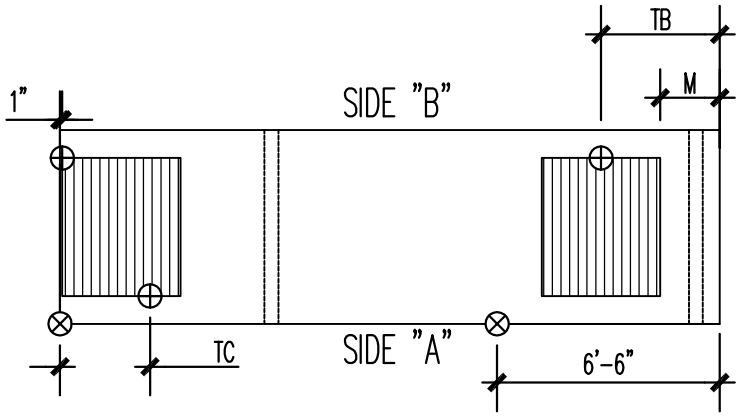
ASCE-AISC
STUDENT STEEL BRIDGE CONTEST

ASCE American Society of Civil Engineers

SUBMITTED _____
APPROVED _____

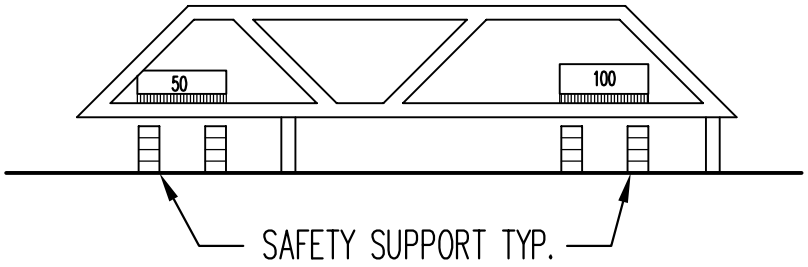
LATERIAL LOADING DIAGRAM

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



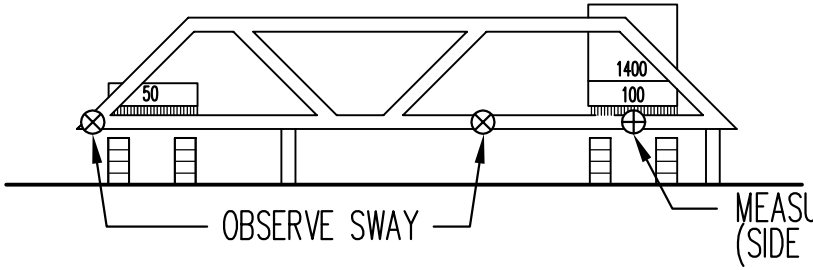
PLAN–LOCATION OF DECKING AND TARGETS

REFER TO 12.5.1



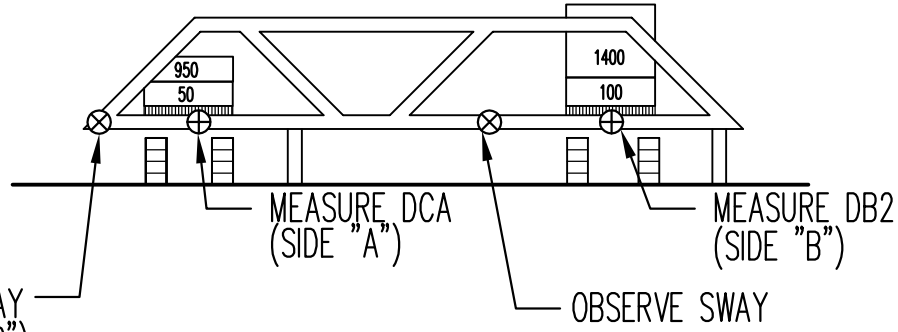
VERTICAL LOAD TEST PRELOAD

REFER TO 12.5.1



STEP 1

REFER TO 12.5.2



STEP 2

REFER TO 12.5.3

⊕ TARGET FOR MEASURING VERTICAL DEFLECTION

⊗ TARGET FOR MEASURING SWAY

NOTES:

1. SAFETY SUPPORTS TO BE IN PLACE AT ALL TIMES DURING LOADING.
2. ALL LOADING PROCEDURES TO BE FOLLOWED.
3. LOADS ARE CENTERED LATERALLY AND DISTRIBUTED OVER THE DECKING UNIT AS UNIFORMLY AS POSSIBLE DURING LOADING
4. OBSERVE SWAY AND TERMINATE LOADING IF SWAY EXCEEDS ½ INCH.

REV.	BY	DATE	APP.	REC NO.	EXPIRES	SEAL HOLDER	DESCRIPTION
							2012 SSBC RULES

DESIGNED BY	F. HATFIELD
DRAWN BY	D. SEPULVEDA
CHECKED BY	RULES COMM.
IN CHARGE	N. GAVLIN
DATE	08-01-2012

AISC MEMBER

ASCE American Society of Civil Engineers

ASCE–AISC
STUDENT STEEL BRIDGE CONTEST

SUBMITTED _____

APPROVED _____

VERTICAL LOADING DIAGRAM

CONTACT NUMBER

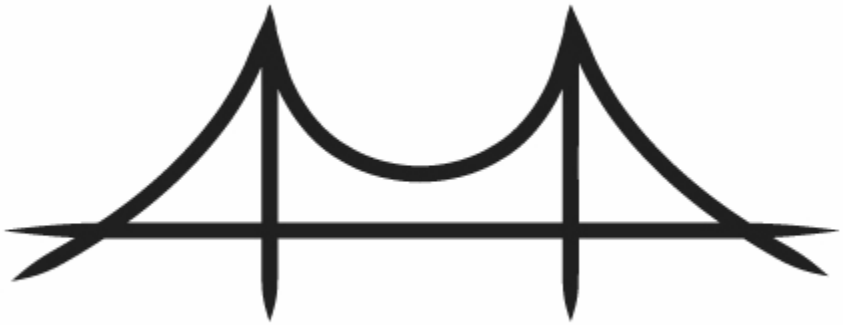
DRAWING NO. DWG 3

SCALE NTS

SHEET NO.

STUDENT STEEL BRIDGE COMPETITION

2012 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, and cost. Success in inter-collegiate competition requires effective teamwork and project management. 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

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)

TABLE OF CONTENTS

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 2012 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 14, “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
- Brian Raff, Marketing Director, NSBA
- Don Sepulveda, P.E., Executive Officer, Los Angeles Metropolitan Transportation Authority
- Ping Wei, Director of Educational Activities, ASCE
- James C. Williams, P.E., Professor, University of Texas at Arlington

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 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 regulations 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 exceed 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 fast water of Phantom River attracts multitudes of rafters and kayakers, and Broken Paddle Resort, Inc., proposes to build a lodge and a bridge.

The Broken Paddle construction manager (CM) requests design/build proposals for the new bridge that will provide vehicle access to the lodge and support utilities under the deck. Clearance is necessary under the bridge to prevent damage by flash floods.

Steel is specified as the material because of its fast erection and exceptional sustainability rating, based on durability and high level of recycled content. The bridge must be able to carry specified patterns of loads without exceeding sway and deflection limits. Based on past experience with performance and maintenance, the CM prefers bridges that are relatively light and stiff.

The Phantom River Valley is protected by the state Department of Natural Resources, which has granted easements for foundations set back from the river banks and has issued a permit for a temporary cofferdam in the river. Piers in the river are prohibited. A cantilever is needed at one end where geotechnical conditions are unfavorable for footings. River banks are protected during construction by staging material and equipment in a confined area far back from one bank, and by limiting the weight of transported loads. Phantom River is too fast for barges.

The foundations, approach spans, and cofferdam are not included in the scope of the contract.

Your company's design/build proposal is among those that the CM has deemed responsive, and winning the contract would be a step toward becoming a leader in the short-span bridge market. 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 then load tested. The CM and a panel of consulting engineers will judge the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy, and display. The contract will be awarded to the company whose model best meets the specified needs and requirements. 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 rejection of the model and termination of 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.

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.

4.2.3 A team shall consist only of undergraduate and graduate students in good standing with their ASCE student organization. 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.

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 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.

4.3.5 A team must consist only of members who are or were students in good standing with their ASCE student organization 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, 2011, are reprinted in this sub-section (4.4) but are subject to change. The current version is at http://www.asce.org/Content.aspx?id=21594. 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 Activities (CSA) 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 <u>does not</u> count as an entry into the Student Conference Paper Competition."*

Section 5

RULE CHANGES

The following items in this section (5) identify some of the major changes from the 2011 rules. Not all changes are included. Contestants, hosts, and judges are cautioned to **read this entire document carefully and disregard rules and clarifications from previous years**.

(1) Bridge and site dimensions are different.
(2) Formula for structural efficiency score has been revised.
(3) Size limit for tools is different.
(4) Tools may be assembled from parts during timed construction.
(5) Barges are not allowed.
(6) There is only one temporary pier. It is cost free but location is restricted.
(7) A member must be fastened before being released.
(8) Lateral and vertical load magnitudes and locations are different.
(9) The team is responsible for preventing its bridge from sliding during lateral load tests and may provide devices for this purpose.

Section 6

SAFETY

Safety has the highest priority. Judges are empowered to halt any activity that they deem hazardous. Judges will stop construction procedures that could cause personal injury. A bridge that cannot be constructed and loaded safely is not eligible for awards in any category and must be withdrawn from participation. Judges will not allow additional load to be placed on a bridge that has collapsed, that is approaching a collapse that could be dangerous, or that has swayed or deflected in excess of limits specified in section 12, "Load Tests."

Section 7

SCORING

7.1 RECORDING DATA AND SUBMITTING SCORES

Scoring data should be recorded for every team that competes, using forms printed from the official scoring spreadsheet downloaded from http://www.nssbc.info. Data from those forms are then entered on 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 team captain is given adequate time to verify the data.

The completed official scoring spreadsheet for a conference competition shall be submitted to ssbc.results@gmail.com by the student host 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.

7.2 CATEGORIES OF COMPETITION

7.2.1 Categories of competition are display, construction speed, lightness, stiffness, construction economy, and structural efficiency. In addition, overall performance is rated. A bridge that was not approved for load testing is not eligible for awards in any category.

7.2.2 Display

7.2.2.1 Display is the tie-breaker for all categories of competition. Judges shall not declare ties in display. The bridge is displayed exactly as it will be erected during timed construction. Display is judged by the following criteria

7.2.2.2 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.

7.2.2.3 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 must appear on the bridge with all letters at least one inch high. The name must be formed from steel or applied to steel with paint or decals. A thirty-pound weight penalty will be imposed if the bridge lacks appropriate identification.

7.2.2.4 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 brief computation demonstrating design for one limit state,
(6) discuss provisions for sustainability, if any, for example, by listing or designating on the drawing those parts of the bridge that were salvaged from previous bridges or projects, or obtained from salvage yards,
(7) acknowledge university technicians, faculty, and others who helped fabricate the bridge or provided advice, and
(8) 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 fifty-pound weight penalty 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 of the required English language design poster into the local language.

7.2.3 Construction Speed

The bridge with the lowest total time will win in the construction speed category. Total time is defined as the time required for construction modified by penalties prescribed in 11.4, 11.8.1, 12.2, 12.4, 12.5, and 12.6, plus two minutes if repair time is commenced, plus double the repair time modified by penalties prescribed in 11.4 and 11.8.1 (see 11.10.1). There are upper limits on construction and repair time (see 11.8.2 and 11.10.2).

7.2.4 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 Number of builders x $50,000 per builder-minute.

Total time is defined in 7.2.3 and includes penalties. The number of builders includes all members and associates of the competing organization who are within the construction site or physically assist the team at any time during timed construction or repair.

7.2.5 Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in 7.2.2, 9.3, 9.4, 10.2, 12.4, 12.5, and 12.6. Decking, tools, temporary pier, lateral restraint devices, and posters are not included in total weight.

7.2.6 Stiffness

The bridge with the lowest aggregate deflection will win in the stiffness category. Aggregate deflection is determined from measurements as prescribed in 12.5, or is a penalty value prescribed in that sub-section and in 12.4 and 12.6.

7.2.7 Structural Efficiency

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

C_s = Total weight (pounds) x $10,000 per pound
+ Aggregate deflection (inches) x $1,000,000.

Total weight is defined in 7.2.5 and includes penalties. Aggregate deflection is defined in 7.2.6 and includes penalties.

7.2.8 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.

7.3 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 8

SCHEDULE OF COMPETITION

In the months before the competition, students design their bridges, fabricate members, test load, practice construction, and select the captain and builders for timed construction. The following events occur during the competition

(1) 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, and repair as described in 11.10.
(2) Bridges are disassembled.
(3) In a meeting at which all team captains are present, the head judge clarifies rules and conditions of the competition and answers questions.
(4) The head judge selects the location of the load on the back span and the locations of two of the three vertical deflection targets. See 12.5.1, the Lateral Loading Diagram, and the Vertical Loading Diagram. Selection is done in the presence of the team captains by rolling a die twice. For each possible result S1 of the first roll, Table 8.1 gives the dimension L for positioning the load on the back span and the dimension TB for placing the vertical deflection target on the back span.

TABLE 8.1 Determination of L and TB from first roll of die

S1	1	2	3	4	5	6
L	3’6”	5’0”	6’0”	7’0”	8’0”	9’6”
TB	5’0”	6’6”	7’6”	8’6”	9’6”	11’0”

For each possible result S2 of the second roll, Table 8.2 gives the dimension TC for placing a vertical deflection target on the cantilever.

TABLE 8.2 Determination of TC from second roll of die

S2	1	2	3	4	5	6
TC	1’0”	1’6”	2’0”	2’0”	2’6”	3’0”

The same locations will be used for all bridges in the competition.
(5) Using a random process, the head judge determines the order in which teams will compete.
(6) Bridge members, fasteners, tools, and the temporary pier are staged for construction and inspected by the judges. See section 10, “Materials, Components, and Equipment,” 9.4.4, 9.4.5, 11.2, and 11.6 for details.
(7) Timed construction. See section 11, “Construction,” for details.
(8) Judges inspect assembled bridges. For details, see section 9, “Dimensions and Support,” (including 9.4.4 and 9.4.5 as they apply to installation of fasteners), 10.1.5 and 10.1.6.
(9) Bridges are weighed (if it is impractical to weigh the entire bridge, its parts may be weighed prior to construction).
(10) Load testing. See section 12, “Load Tests,” for details.

(11) Scores and rankings are determined using the official scoring spreadsheet found at www.nssbc.info.
(12) The host ASCE student organization submits the completed official scoring spreadsheet by e-mailing it to the address given on that spreadsheet.
(13) Copies of the summary score sheets are distributed to all teams or posted on the conference host's web site.

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 repairs as described in 11.10 and 12.2.

Section 9

DIMENSIONS AND SUPPORT

9.1 MEASUREMENT

Dimensions and support will be checked with the bridge in its as-built condition after construction and repair are completed 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.

9.2 FUNCTIONALITY AND SAFETY

9.2.1 If any of the following rules in this sub-section (9.2) is violated, the bridge will not be approved for load testing and will not be eligible for awards in any category.

9.2.2 The back span is the part of the bridge that has supports at both ends. The back span must span the river completely without touching it. See the Site Plan on the Site and Bridge Diagram.

9.2.3 The cantilever is the part of the bridge that has support at only one end. The bridge must have a cantilever.

9.2.4 The bridge must provide support for the decking along both of the edges that run in the span direction of the bridge. See the Elevation on the Site and Bridge Diagram.

9.2.5 The bridge must provide access for safely placing the decking and load.

9.2.6 The decking must not be attached or anchored to the bridge, and it must not be used to distort the bridge from its as-built condition.

9.2.7 The bridge must not be anchored or tied to the floor.

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

9.3 USABILITY

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

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

(1) 50 pounds for a dimensional violation of ½ inch or less,
(2) 150 pounds for a dimensional violation greater than ½ inch but not exceeding 1.0 inch,
(3) 300 pounds for a dimensional violation greater than 1.0 inch but not exceeding 2.0 inches, and
(4) If a dimensional violation exceeds 2.0 inches, the bridge will not be approved for load testing and will not be eligible for awards in any category.

9.3.2 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.

9.3.3 The decking support surfaces at the end of the bridge that is not cantilevered shall not extend beyond the edge of the foundation easement that is farthest from the river.

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

9.3.5 The length of each decking support surface shall not be less than 22’6” nor greater than 23’6”.

9.3.6 The inner edges of the two decking support surfaces shall be no less than 2'6" from one another, measured perpendicularly to the span of the bridge. At no point within these limits shall any part of the bridge be within the space bounded above by a surface at the elevation of the decking support surfaces and below by a parallel surface that is 3½ inches below the decking support surfaces. See the Section on the Site and Bridge Diagram.

9.3.7 The outer edges of the two decking support surfaces shall be no more than 3'0" apart, measured perpendicularly to the span of the bridge. At no point within six inches beyond these limits shall any part of the bridge be within the space bounded above by a surface at the elevation of the decking support surfaces and below by a parallel surface that is 3½ inches below the decking support surfaces. See the Section on the Site and Bridge Diagram.

9.3.8 The decking support surfaces must be smooth, without vertical protrusions or abrupt changes in elevation. This rule may be checked by sliding a decking unit or template along the full overall end-to-end length of the decking support surfaces, in either or both directions. The rule is violated if the progress of the decking unit or template is impeded.

9.3.9 A gap is a discontinuity or depression that extends laterally across the full width of a decking support surface. No gap shall exceed ¼ inch measured in the span direction of the bridge.

9.3.10 The decking support surfaces must be no more than 2'9" and no less than 2'6" above the surface of the river or ground at any point. See the Section on the Site and Bridge Diagram.

9.3.11 A vehicle passageway must 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 4'0" wide measured perpendicularly to the span of the bridge. See the Section on the Site and Bridge Diagram.

9.3.12 Vertical clearance must be provided under the bridge at all points directly over the river and ground except directly over the foundation easements. The clearance must be at least 1'6" high, measured from the surface of the river or ground. Clearance is not required directly over the foundation easements. See the Elevation on the Site and Bridge Diagram.

9.3.13 Regardless of any reason other than that allowed by 11.4.1, after timed construction and repair the bridge shall bear only on the ground within the foundation easements. See the Site Plan on the Site and Bridge Diagram.

9.4 MEMBER-TO-MEMBER CONNECTIONS

9.4.1 Violations of the rules in this sub-section (9.4) will result in penalties being added to the weight of the bridge. The penalty for each violation is 25 pounds.

9.4.2 Each member must be connected directly to every member that it touches by at least one fastener so that the connection cannot be taken apart without first turning the nut or the bolt and removing the nut from the bolt. Definitions of "member" and "fastener" are given in 10.2.3 and 10.2.4, respectively.

9.4.3 No fastener shall connect more than two members.

9.4.4 The bolt must penetrate completely through a hole in each of the members that it connects. Dimension(s) of the hole must be small enough so that neither the head of the bolt nor the nut specified in 10.2.4 can pass through the hole.

9.4.5 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.

9.4.6 The bolt must fully engage the threads of the nut. That is, the terminal threads on the bolt must extend beyond, or be flush with, the outer face of the nut.

Section 10

MATERIAL, COMPONENTS, AND EQUIPMENT

10.1 SAFETY

10.1.1 If any one of the rules in this sub-section (10.1) is violated, the bridge will not be approved for construction or load testing, and will not be eligible for awards in any category.

10.1.2 A member must not weigh more than twenty pounds. See 10.2.3 for definition of "member."

10.1.3 A tool or unassembled part of a tool must not weigh more than twenty pounds. See 11.1.7 for definition of "tool."

10.1.4 The temporary pier must not weigh more than twenty pounds. See 11.1.8 for definition of "temporary pier."

10.1.5 A bridge must 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.

10.1.6 After completion of construction and repair, energy shall not be transmitted to or from a bridge (for example, by applying or releasing mechanical, magnetic, fluidic, or other force; by sound, light, radio, or other wave or ray; by conduction or convection of heat; or by electric current). The exceptions are forces necessary to the competition (for example, those associated with load testing and with moving the bridge from place to place), and changes in ambient conditions that are not controlled by competitors (such as wind, temperature, and lighting).

10.2 DURABILITY AND CONSTRUCTABILITY

10.2.1 Penalties

Violation of the rules in this sub-section (10.2) will result in penalties being added to the weight of the bridge. The penalty is 25 pounds for each member, fastener, or piece of equipment that is in violation.

10.2.2 Bridge

A bridge must 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.

10.2.3 Members

10.2.3.1 A member is a rigid component. A member must 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.

10.2.3.2 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.

10.2.3.3 A member may consist of multiple parts rigidly joined together before timed construction begins. Those parts must remain rigidly joined throughout timed construction and in the completed bridge. Parts shall be joined by welding or with connectors such as bolts, screws, and rivets. If nuts are used, their threads must be fully engaged (that is, the terminal threads of the bolt or stud must be flush with or extend beyond the outer face of the nut). Nuts and bolts that connect parts of a member but do not connect a member to other members are not considered fasteners and are not governed by provisions of 10.2.4.

10.2.4 Fasteners

10.2.4.1 A fastener is a bolt that is not part of a member, with a nut that is not part of a member. Grade and diameter are not restricted. Specialty and 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

10.2.4.2 The bolt in a fastener must be no more than 1½-inch nominal length (bottom of head to end) with a hexagonal head. Bolts must be commercially-available tap bolts, machine bolts, or cap screws. Bolts shall not be mechanically altered or modified in any way but may be painted.

10.2.4.3 The nut for a fastener must 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 must be solid and hexagonal, and must be available commercially. Only one bolt and nothing else shall be threaded into a nut. Nuts must not be mechanically altered or modified in any way but may be painted.

10.2.5 Equipment

10.2.5.1 A tool or unassembled part of a tool 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.

10.2.5.2 A temporary pier must not exceed 1’6” in any horizontal dimension when in use. That is, it should fit inside a vertical cylinder with diameter of 1’6”.

Section 11

CONSTRUCTION

11.1 DEFINITIONS

11.1.1 "River, "staging yard," "foundation easement," "cofferdam," and "construction site boundary" are delineated by the Site Plan on the Site and Bridge Diagram.

11.1.2 "Ground" is the floor inside the construction site boundary, except for the river. Ground includes the cofferdam and foundation easements.

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

11.1.4 A "team" is all the builders from the competing organization who are within the construction site boundary during timed construction.

11.1.5 "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.

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

11.1.7 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. A tool may be assembled during timed construction.

11.1.8 The "temporary pier" is an optional device that bears on the cofferdam and 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.

11.1.9 "Member" and "fastener" are defined in 10.2.3 and 10.2.4, respectively. "Member-to-member connection" is defined in 9.4.

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

11.1.11 To "fasten" means making a member-to-member connection by installing a fastener (i.e., bolt and nut) to attach a member to the constructed portion or to attach two non-contiguous parts of the constructed portion.

11.2 GENERAL SAFETY CONDITIONS

11.2.1 Timed construction or repair will not commence or will be stopped if any provision of this sub-section (11.2) is violated.

11.2.2 Builders, judges, host personnel, and spectators must not be exposed to risk of personal injury.

11.2.3 Only builders and judges are permitted within the construction site boundary during timed construction and repair. 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.

11.2.4 The team shall include no more than six builders.

11.2.5 At all times during timed construction and repair every builder must wear personal protective equipment in the proper manner (e.g., hardhat with peak in front).

11.2.6 Welding machines and tools requiring external power connections must not be used during timed construction or repair.

11.2.7 There shall be only one temporary pier.

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

11.3 SAFE CONSTRUCTION PRACTICES

11.3.1 If any rule in this sub-section (11.3) is violated during timed construction or repair, the judge will stop the clock and explain the violation. Before the clock is restarted, builders, tools, parts of tools, members, fasteners, and the temporary pier will be returned to the positions they occupied before the violation. Then the team will be asked to resume construction using safe procedures. A team will have the opportunity to construct its bridge safely. However, if the 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.

11.3.2 Construction of every non-contiguous part of the constructed portion shall commence by placing a member on a foundation easement. That member becomes part of the constructed portion. When a member is fastened to the constructed portion both the member and its fasteners become part of the constructed portion.

11.3.3 A member shall not be in contact with another member unless one or both members are part of the constructed portion.

11.3.4 A member that is in contact with the constructed portion must be held by a builder or fastened to the constructed portion. See 11.1.11 for definition of "fasten." However, the bolt is not required to fully engage the threads of the nut until the end of timed construction.

11.3.5 Surfaces of the constructed portion that bear on the foundation easements shall be the same surfaces that will bear on the same foundation easements in the completed bridge and, after being placed, must continuously support the constructed portion for the remaining duration of timed construction and repair.

11.3.6 A temporary pier shall not support tools or fasteners.

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

11.3.8 The temporary pier shall not be moved while it is supporting the constructed portion.

11.3.9 Throwing anything is prohibited.

11.3.10 A builder shall not cross from the ground on one side of the river to the ground on the other side or to the cofferdam. A builder shall not cross from the cofferdam to the ground adjacent to the river.

11.3.11 Outside the staging yard, a builder shall not contribute simultaneously to moving or supporting more than one of the following items: the temporary pier, the constructed portion, a non-contiguous part of the constructed portion, or a member that is not part of the constructed portion. In other words, a builder cannot simultaneously move or support more than one of those items.

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

11.3.13 A builder must not use the bridge, a portion of the bridge, 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 both feet on the floor.

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

11.4 ACCIDENTS

11.4.1 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 (11.4).

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, builders, tools, members, temporary pier, and fasteners will be returned to the positions they occupied before the accident. Exception: Construction may proceed if it is no longer possible to hold all bearing surfaces within the foundation easements simultaneously. In this situation, the team captain may request that the clock be stopped in order to demonstrate the difficulty to the judge. If the judge is convinced, no additional accidents will be cited for bearing surfaces touching the ground outside the foundation easements (rule 11.4.5), the clock will be restarted, construction will resume, and a penalty will be assessed for a two-inch violation of rule 9.3.13 (even if the bearing surfaces fall within the footings when the bridge is completed).

11.4.2 A builder or a 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.

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

11.4.4 The temporary pier touches the river, the ground outside the cofferdam, or the floor outside the staging yard. Penalty is 1/4 minute (15 seconds) for every occurrence.

11.4.5 A member, constructed portion, tool, nut, bolt, or personal protective equipment touches the floor outside the staging yard, the river, or the ground (which includes the cofferdam). Penalty is 1/4 minute (15 seconds) for every item during every occurrence. Exceptions: (1) There is no penalty for the constructed portion touching the ground within the foundation easements. (2) There is no penalty if a tool used exclusively for measuring touches the ground during use while being held by a builder.

11.5 CONSTRUCTION SITE

11.5.1 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.

11.5.2 Only builders and judges are permitted within the construction site boundary during timed construction. Only judges are permitted near the construction site. Spectators, including coaches, faculty, advisers, and other associates of the team, must observe from areas designated by the judges and host student organization. These areas must be far enough from the construction site so that spectators are not at risk, cannot physically assist builders, and cannot interfere with the competition.

11.6 START

11.6.1 Before construction begins, only the following items are in the staging yard: the temporary pier, all members, fasteners, and 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 on the ground, which includes the cofferdam and both sides of the river. 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. Builders are wearing personal protective equipment as well as optional clothing such as pouches.

11.6.2 Judges inspect members, tools, fasteners, and the temporary pier as they are placed in the staging yard. After inspection and throughout timed construction and repair, additional members, 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.

11.6.3 Timing and construction begin when one of the builders signifies that the team is ready and the judge declares the start.

11.7 TIME

11.7.1 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 rule has been violated (see 11.2 and 11.3), 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 11.4), or
(4) if a builder or judge is injured.

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

11.8 TIME LIMIT

11.8.1 If the total of construction time, not including penalties, exceeds thirty minutes, construction time will be counted as 180 minutes for scoring. "Accidents" (11.4) that occur after thirty minutes will not be penalized but safety rules (11.2 and 11.3) will still be enforced. Judges will inform the team when this time limit is approaching and again when it is reached.

11.8.2 If the total of construction time, not including penalties, exceeds 45 minutes, judges may halt construction or may move the bridge off site for continued, untimed construction if it can be done safely. The bridge will not be eligible for awards in any category.

11.9 FINISH

11.9.1 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,
(2) the temporary pier is in the part of the staging yard designated on the Site and Bridge Diagram,
(3) every tool is held by a builder, or is in clothing worn by a builder, or is on the ground in the part of the staging yard designated on the Site and Bridge Diagram, and
(4) a builder informs the judge that construction is complete.

11.9.2 Extra fasteners may be in the designated part of the staging yard or held by or in the clothing of builders.

11.9.3 Installation of decking is not included in timed construction.

11.9.4 After construction is finished the bridge must not be modified except for repair as permitted by 11.10.

11.10 REPAIR

11.10.1 Before the judges inspect and measure the bridge, and before the bridge is moved from the construction site, two builders 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 mistakes found by their inspectors. Repairs are made with the clock restarted and begin with builders and necessary items arranged in the staging yard as prescribed by 11.6.1. Safety precautions (11.2 and 11.3) are enforced and accidents (11.4) are counted. The repair period ends when the conditions listed in 11.9.1 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.

It is not necessary to inspect, measure, or repair a bridge that exceeded the 45-minute time limit prescribed in 11.8.2.

11.10.2 If the repair time, not including penalties, exceeds five minutes, judges may halt construction or may move the bridge off site for continued, untimed construction if it can be done safely. The bridge will not be eligible for awards in any category.

Section 12

LOAD TESTS

12.1 SAFETY PRECAUTIONS

An activity will be halted if the judge considers it to be hazardous.

A bridge could suddenly collapse or sway in any direction during load tests. Therefore, the number of people near the bridge while it is being tested shall be minimized. Usually, the load should be placed on the bridge by only two competitors. Competitors who are not participating in loading, faculty, advisers, and other spectators must observe from an area designated by the judges and host student organization.

People should be kept clear of the unsupported end of the cantilever; load should be placed from the sides;

While participating in load testing, competitors must wear hardhats meeting ANSI standard Z89.1, protective eyewear or safety goggles meeting ANSI standard Z87.1, 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.

During testing, safety supports must be in place below the decking. The safety supports shall be of sufficient height, strength, number, and extent that none of the load will fall more than approximately six inches if the bridge collapses.

All preparations for load testing, including placement of safety supports, must be completed before any load is on the bridge so that it will not be necessary for anyone to reach, crawl, or step under the loaded bridge. However, if safety supports must be adjusted during loading, the load must first be removed without disturbing the bridge, adjustments made, and the load replaced as it was before being removed.

If team members cannot load their bridge safely, loading will cease and the bridge will not be eligible for awards in any category.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking.

12.2 DAMAGE

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

If a nut falls off its bolt while the bridge is being transported or prepared for load testing, or if the threads of a nut are not fully engaged, the connection will be repaired, the nut will be reinstalled correctly, and a penalty of two minutes will be added to construction time for every nut that was reinstalled.

A bridge with damage that would reduce its strength or stability (such as a missing or broken member or fastener) will 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 provided by the preceding paragraph of this subsection (12.2).

12.3 PREPARATION

The temporary pier is not used during load testing.

The judge designates the “A” side of the bridge by a random process. The “B” side is opposite to 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 or measuring devices.

12.4 LATERAL LOAD TESTS

12.4.1 The provisions of this sub-section (12.4) are illustrated by the Lateral Loading Diagram. “Sway” is translation in any horizontal direction.

The lateral load tests are conducted with one unit of decking placed at the center of the back span and approximately 75 pounds of weight on the decking near the “B” side of the bridge. This load is intended to prevent the bearing surfaces of the bridge from lifting off the floor when lateral load is applied.

Bearing surfaces are prevented from sliding by lateral restraint applied by team members. This lateral restraint does not restrain rotation or uplift. The restraint is applied as close to the ground as possible, at the locations shown on the Lateral Loading Diagram. Team members may provide and use devices to prevent sliding. A 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.

12.4.2 Lateral Load Test of the Back Span

A sway target is established for measurement on the "A" side of the bridge, eight feet from the end of the decking support surface at the end of the bridge that is not cantilevered. The sway target is located as close as possible to the decking support surface, which is the same as 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 four inches from the sway target. To pass the lateral load test, the sway must not exceed 1/2 inch.

If the bridge does not pass this lateral load test it is not approved for further testing. **Do not conduct any other load test**. Check the appropriate box on the judge's data form. The spreadsheet will add a penalty of 900 pounds to the weight of the bridge, a penalty of thirty minutes to the construction time, and will apply an aggregate deflection of thirty inches when the judging data is entered.

If the bridge passes the lateral load test of the back span, proceed with the lateral load test of the cantilever.

12.4.3 Lateral Load Test of the Cantilever

A sway target is established for measurement on the "A" side of the bridge, at the end of the decking support surface at the unsupported end of the cantilever. The sway target is located as close as possible to the decking support surface, which is the same as 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 four inches from the sway target. To pass the lateral load test, sway must not exceed 1/2 inch.

If the bridge does not pass this lateral load test it is not approved for further testing. **Do not conduct any other load test**. Check the appropriate box on the judge's data form. The spreadsheet will add a penalty of 900 pounds to the weight of the bridge, a penalty of thirty minutes to the construction time, and will apply an aggregate deflection of thirty inches when the judging data is entered.

If the bridge passes this lateral load test, remove the load and decking, and proceed with the vertical load test.

12.5 VERTICAL LOAD TEST

12.5.1 The provisions of this section are illustrated by the Vertical Loading Diagram.

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

Decking units are three feet long in the longitudinal (span) direction of the bridge. Place one decking unit at a distance L from the end of the decking support surfaces at the end of the bridge that is not cantilevered. L is determined at the beginning of the competition as described by Table 8.1 in section 8, "Schedule of Competition." Place the other decking unit at a distance of one inch measured from the end of the decking support surfaces at the unsupported end of the cantilever. Decking units are placed square with the bridge and centered laterally with the main bars spanning laterally over the decking support surfaces. Decking units must not be attached to the bridge and must not distort it (see 9.2.5 and 9.2.6).

Three targets are established for measuring vertical deflections at locations determined by the following dimensions

- TB from the end of the decking support surface at the end of the bridge that is not cantilevered, on the "B" side of the bridge
- TC from the end of the decking support surface at the cantilevered end of the bridge, on the "A" side of the bridge
- One inch from the end of the decking support surface at the cantilevered end of the bridge, on the "B" side of the bridge.

TB and TC are determined at the beginning of the competition as described by Tables 8.1 and 8.2 in section 8, "Schedule of Competition." Vertical deflection targets are located as close as possible to the decking support surface and may be on the bridge or on the decking close to decking support surfaces.

Position measuring devices on the three vertical deflection targets.

Uniformly distribute 100 pounds of preload on the decking unit on the back span. Then uniformly distribute 50 pounds of preload on the decking unit on the cantilever. Preloads are laterally centered on the decking units. Preloads are 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 measurement have been recorded, the judge will require the team to disassemble the bridge and repeat timed construction beginning with the initial conditions prescribed in 11.6. Scoring will be based on the run that results in the larger construction cost, C_c, but will not exceed 125% of C_c for the initial run.

The two steps (increments) of vertical loading produce four measurements

(1) DB1 = absolute value of vertical deflection at the target on the “B” side of the back span that occurs during step 1 (loading the back span).
(2) DCA = absolute value of vertical deflection at the target on the “A” side of the cantilever that occurs during step 2 (loading the cantilever with the load from step 1 remaining in place).
(3) DCB = absolute value of vertical deflection at the target on the “B” side of the cantilever that occurs during step 2 (loading the cantilever with the load from step 1 remaining in place).
(4) DB2 = absolute value of vertical deflection at the target on the “B” side of the back span that occurs from the beginning of step 1 to the end of step 2.

The scoring spreadsheet computes aggregate deflection as the sum of DCA, DCB, and the larger of DB1 and DB2.

12.5.2 Step 1 – Vertical Load Test of the Back Span

Load the decking unit on the back span and measure the deflection, using the following procedure

(1) The two preloads remain in place.
(2) Initialize the sway measurement device on the back span.
(3) Initialize the sway measurement device on the cantilever.
(4) Initialize the vertical deflection measuring device on the back span or record the initial reading.
(5) Team members place 1400 pounds of additional load on the decking unit on the back span. The 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.
(6) As the load is being placed, observe the deflection target on the back span and both sway targets. Stop loading if

    (a) sway at either sway target exceeds 0.5 inch from the beginning of step 1, or
    (b) deflection at the deflection target on the back span exceeds 1.5 inches downward from the beginning of step 1, 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. Remove the load and **do not continue load testing**. Check the appropriate box on the judge's data form. The scoring spreadsheet will add an 800-pound penalty to the weight of the bridge, a penalty of thirty minutes to the construction time, and will apply an aggregate deflection of thirty inches when the judging data is entered.

If the bridge passes step 1, record the first measured value DB1.

12.5.3 Step 2 – Vertical Load Test of the Cantilever

Load the decking unit on the cantilever and measure the deflections, using the following procedure

(1) The two preloads and the load from step 1 remain in place.
(2) Do **not** initialize the vertical deflection measuring device on the back span.
(3) Do **not** initialize the sway measurement devices on the back span and cantilever.
(4) Initialize the vertical deflection measuring devices on the cantilever.
(5) Team members place 950 pounds of additional load on the decking unit on the cantilever. The 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.
(6) As the load is being placed, observe the three deflection targets and both sway targets. Stop loading if

(a) sway at either sway target exceeds 0.5 inch from the beginning of step 1, or
(b.1) deflection at the deflection target on the back span exceeds 1.5 inches downward from the beginning of step 1, or
(b.2) deflection at either deflection target on the cantilever exceeds 0.5 inch downward from the beginning of step 2, 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.1, b.2, c, d, or e, the bridge is not approved for further load testing. Remove the load and **do not continue load testing**. Check the appropriate box on the judge's data form. The scoring spreadsheet will add a 700-pound penalty to the weight of the bridge, a penalty of thirty minutes to the construction time, and will apply an aggregate deflection of thirty inches when the judging data is entered.

If the bridge passes step 2, record the measured values DCA, DCB and the second measured value DB2.

12.6 Unloading

Remove all load from the cantilever before removing any load from the back span.

If the bridge collapses during unloading (situation c, d, or e), it shall be penalized as if it had failed to pass step 2.

Section 13

EQUIPMENT PROVIDED BY HOST

13.1 SOURCES OF INFORMATION

The Competition Guide at http://www.nssbc.info should be reviewed by judges, host personnel, and competitors. It has detailed descriptions and illustrations of contest procedures and hosting equipment. The following provisions of this section (13) describe some of the equipment that is needed for the competition and is intended to help competitors know what to expect. Competitors should acquire similar equipment for use in practice and testing before the competition.

13.2 FLOOR

The floor in both the construction site and loading area shall be solid, stable and as nearly flat and level as possible.

13.3 LATERAL LOAD DEVICE

The lateral load device should be capable of applying a force of 50 pounds in the horizontal direction.

13.4 SWAY MEASUREMENT

Sway is horizontal translation and is measured at two points by any accurate method. A suggested method is to suspend a plumb bob from the sway target and measure sway from a point marked on the floor.

13.5 DEFLECTION MEASUREMENT

Deflection is vertical translation and is measured at three points by any accurate method.

13.6 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 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 of the grating that are perpendicular to the length.

13.7 SAFETY SUPPORTS

The safety supports must be used during load testing and are intended to limit the consequences of a bridge collapsing. The 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, timbers, sand bags, or masonry units.

13.8 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.

13.9 OFFICIAL SCORING SPREADSHEET AND DATA FORMS

Results will not be official until the completed official scoring spreadsheet is submitted to ssbc.results@gmail.com to report outcomes. It may be downloaded at http://www.nssbc.info. Judges' forms for recording data are accessed from the spreadsheet.

Section 14

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 7, 2012.

Section 15

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 16

APPEALS

16.1 CONFERENCE COMPETITIONS

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

16.1.2 A penalty, decision, measurement, score, or condition of competition may be appealed only by a 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 not hear the appeal if he or she is approached by students other than the team captain. The CHJ will hear the appeal as soon as possible and may interrupt the competition. Participants are reminded that civility and ethical behavior are expected during the competition and particularly concerning appeals.

16.1.3 After the conference competition, the team captain has the option to appeal the decision of the CHJ by sending an e-mail message to Ms. Maria Mnookin <mnookin@aisc.org> followed by a letter mailed to Ms. Mnookin (AISC, Suite 700, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to ASCE Student Services (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The e-mail message and letter shall include

(1) name of the college or university making the appeal,
(2) team 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,
(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) team captain's signature (letter only).

16.1.4 Appeals must be made by e-mail followed by letter. An appeal will be considered only if the e-mail is received and 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.

16.2 NATIONAL COMPETITION

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

16.2.2 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.

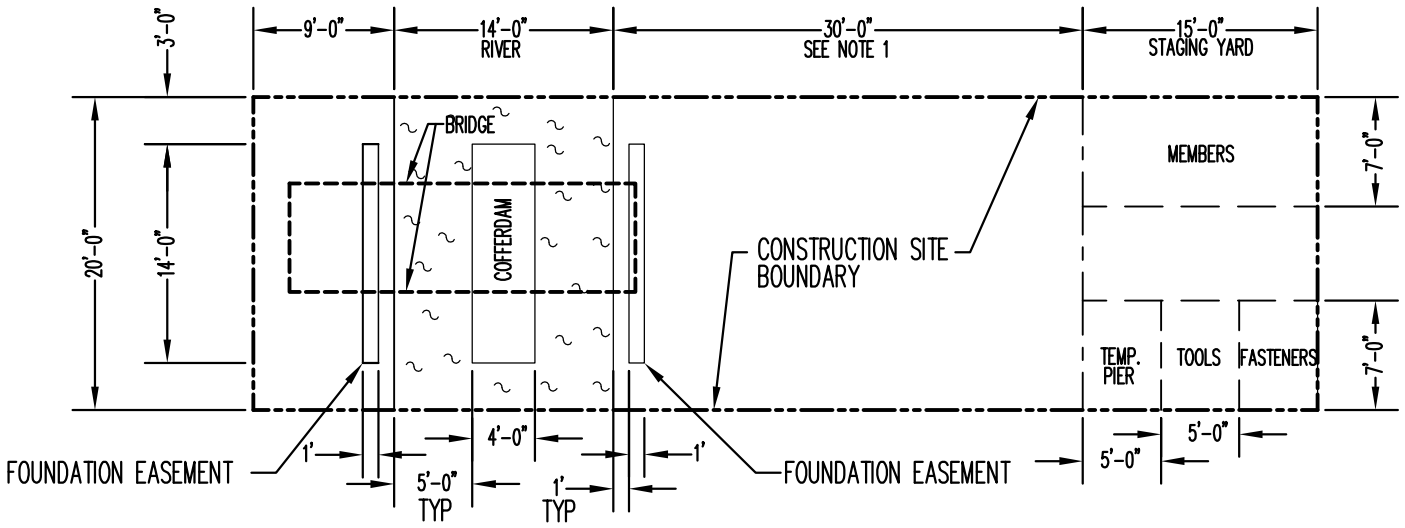
16.2.3 After hearing the SHJ's ruling, the team captain may request a five-minute recess to discuss the issue with the team. During the recess, the conditions at issue will not be changed. Immediately after that recess, if the team has justification to contest the SHJ's ruling, the captain has the option 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.

16.2.4 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.

16.2.5 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 17

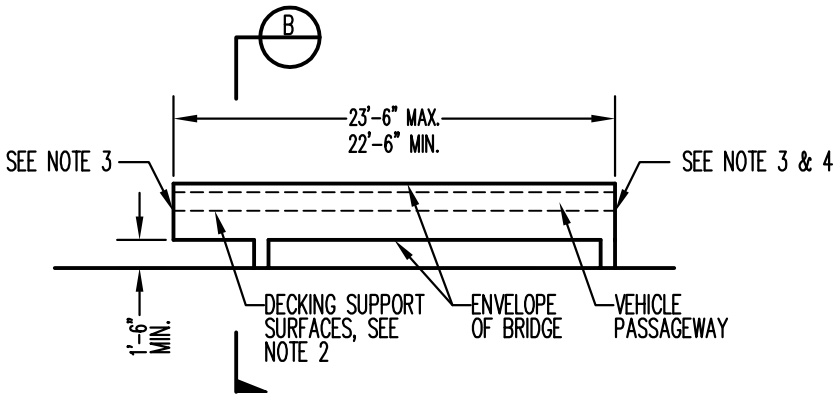
INDEX OF DEFINITIONS



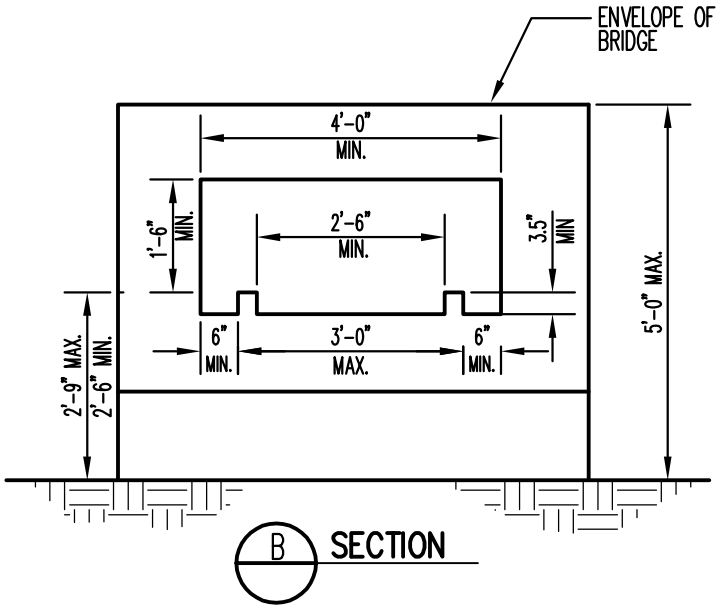
NOTES:

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).
4. DECKING SUPPORT SURFACES SHALL NOT EXTEND BEYOND FOUNDATION EASEMENT AT THIS END.

SITE PLAN – REFER TO CHAPTERS 9 & 11



ELEVATION – REFER TO CHAPTER 9



REV.	BY	DATE	APP	REC NO.	EXPIRES	SEAL HOLDER	DESCRIPTION
							2011 SSBC RULES

DESIGNED BY	F. HATFIELD
DRAWN BY	D. SEPULVEDA
CHECKED BY	RULES COMM.
IN CHARGE	N. GALVIN
DATE	08-01-2011

ASCE-AISC
STUDENT STEEL BRIDGE CONTEST

SUBMITTED

APPROVED

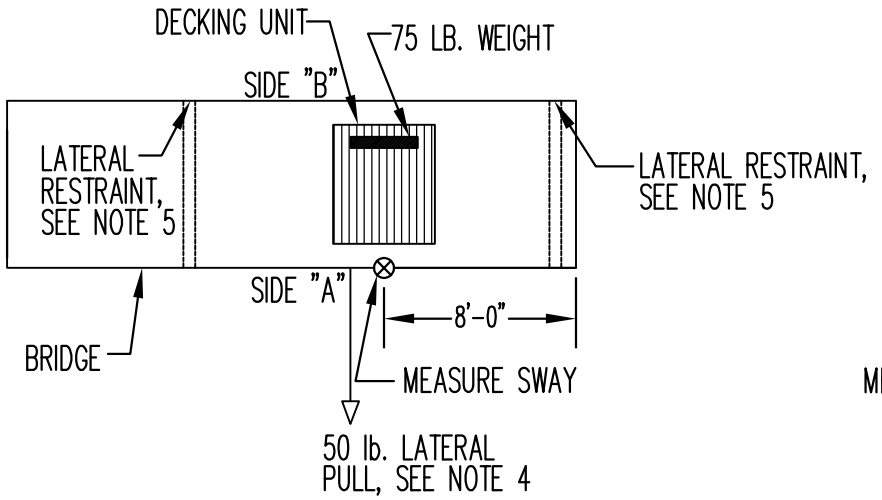
SITE AND BRIDGE DIAGRAM

CONTACT NUMBER

DRAWING NO. DWG 1

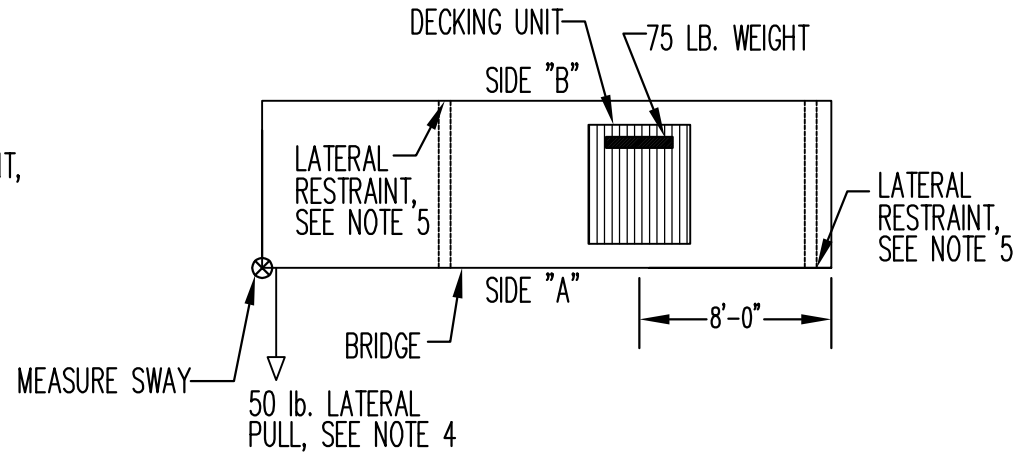
SCALE NTS

SHEET NO.



STEP 1

REFER TO 12.4.2



STEP 2

REFER TO 12.4.3

LATERAL LOAD TESTS

REFER TO 12.4

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. ALL SWAY TARGETS ARE TO REMAIN IN PLACE THROUGHOUT LOADING PROCESS.
4. LOCATION OF 50 lb. PULL SHALL NOT EXCEED 4" FROM SWAY TARGET.
5. LATERAL RESTRAINT MUST BE APPLIED CLOSE TO THE GROUND AND MUST NOT RESTRAIN ROTATION, UPLIFT, OR TRANSLATION IN OTHER THAN THE LATERAL DIRECTION.

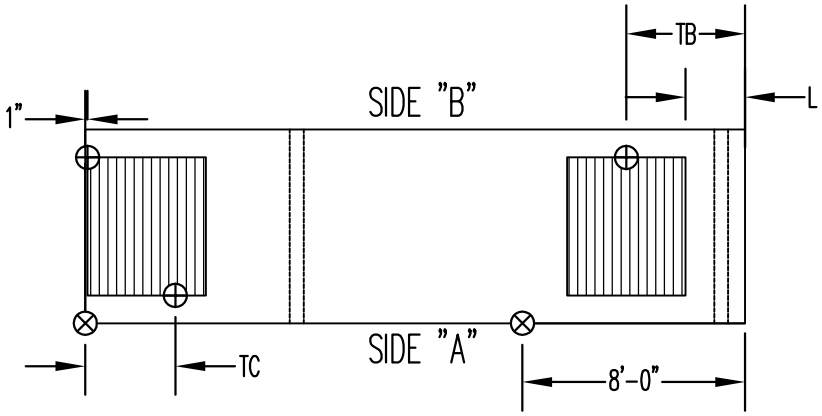
REV.	BY	DATE	APP	REC NO.	EXPIRES	SEAL HOLDER	DESCRIPTION
							2011 SSBC RULES

DESIGNED BY F. HATFIELD
DRAWN BY D. SEPULVEDA
CHECKED BY RULES COMM.
IN CHARGE N. GALVIN
DATE 08-01-2011

ASCE-AISC
STUDENT STEEL BRIDGE CONTEST
SUBMITTED
APPROVED

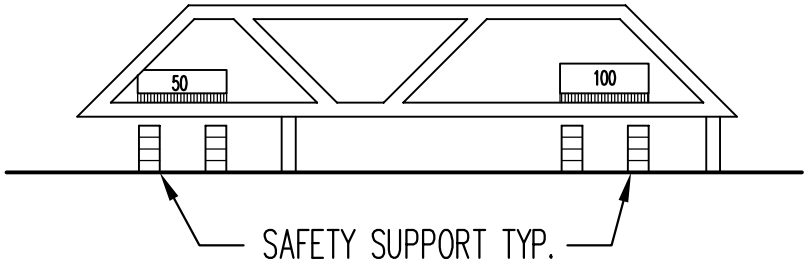
LATERIAL LOADING DIAGRAM

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



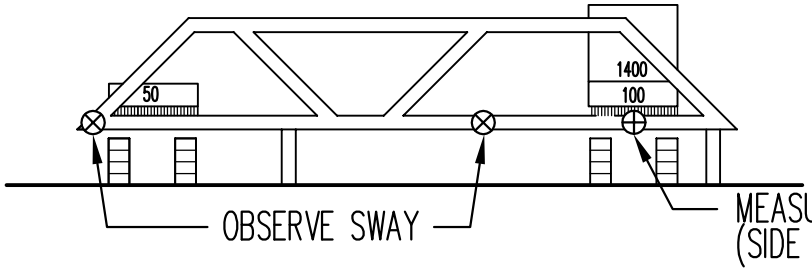
PLAN–LOCATION OF DECKING AND TARGETS

REFER TO 12.5.1



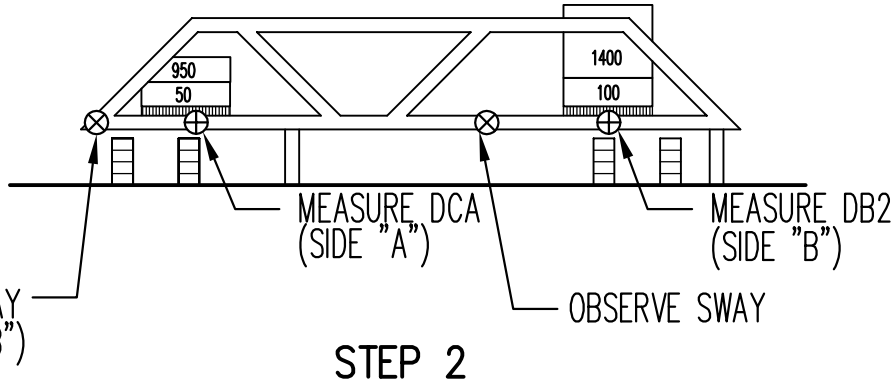
VERTICAL LOAD TEST PRELOAD

REFER TO 12.5.1



STEP 1

REFER TO 12.5.2



STEP 2

REFER TO 12.5.3

⊕ TARGET FOR MEASURING VERTICAL DEFLECTION

⊗ TARGET FOR MEASURING SWAY

NOTES:

1. SAFETY SUPPORTS TO BE IN PLACE AT ALL TIMES DURING LOADING.
2. ALL LOADING PROCEDURES TO BE FOLLOWED.
3. LOADS ARE CENTERED LATERALLY AND DISTRIBUTED OVER THE DECKING UNIT AS UNIFORMLY AS POSSIBLE DURING LOADING
4. OBSERVE SWAY AND TERMINATE LOADING IF SWAY EXCEEDS ½ INCH.

REV.	BY	DATE	APP	REC NO.	EXPIRES	SEAL HOLDER	DESCRIPTION
							2011 SSBC RULES

DESIGNED BY F. HATFIELD
DRAWN BY D. SEPULVEDA
CHECKED BY RULES COMM.
IN CHARGE N. GALVIN
DATE 08–01–2011

MEMBER

ASCE–AISC
STUDENT STEEL BRIDGE CONTEST

ASCE

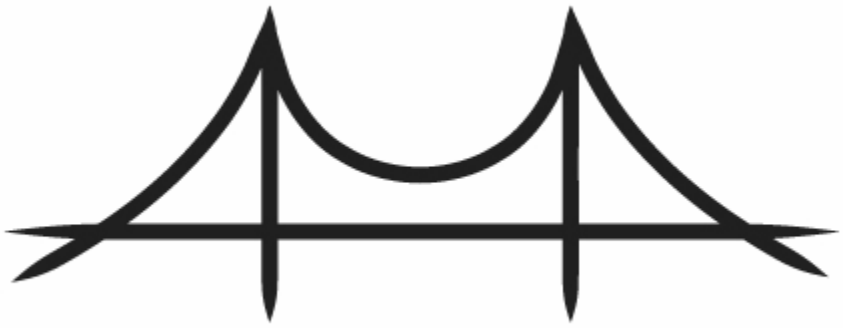
SUBMITTED _____
APPROVED _____

VERTICAL LOADING DIAGRAM

CONTACT NUMBER
DRAWING NO. DWG 3
SCALE NTS
SHEET NO.

STUDENT STEEL BRIDGE COMPETITION

2011 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, and cost. Success in inter-collegiate competition requires effective teamwork and project management. Future engineers are stimulated to innovate, practice professionalism, and use structural steel efficiently.

SPONSORS

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)
- James F. Lincoln Arc Welding Foundation
- National Steel Bridge Alliance (NSBA)
- Nelson Stud Welding
- Nucor Corporation
- Steel Structures Education Foundation (SSEF)

TABLE OF CONTENTS

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 2011 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 14, “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
- T. Bart Quimby, P.E., Professor, University of Alaska Anchorage
- Don Sepulveda, P.E., Senior Project Manager, HNTB Corporation
- Ping Wei, Director of Educational Activities, ASCE
- Reneé Carter Whittenberger, P.E., Bridge Engineer, Michael Baker Jr. Inc.
- James C. Williams, P.E., Professor, University of Texas at Arlington

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 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 regulations 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 exceed 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

A new road in a state park will facilitate travel across the park and improve access to remote areas. A bridge will be constructed over a scenic river and also will carry utilities to a new welcome center and camp ground.

The Park Commission has requested design/build proposals for the new bridge. A deck bridge is specified to minimize visual impact. The bridge must provide clearance for recreational boating and longitudinal passageways for utilities.

Steel is specified as the material because of its fast erection and exceptional sustainability rating, based on durability and high level of recycled content. The bridge must be able to carry specified patterns of loads without exceeding sway and deflection limits. Based on past experience with performance and maintenance, the Commission prefers bridges that are relatively light and stiff.

Concern for the environment is essential. To protect the river and adjacent wetland, permanent supports shall be placed only on natural levees along the two banks of the river. Consequently, there must be a cantilever span over the wetland. However, temporary piers may be used anywhere during construction. Construction barges are allowed in the river but terrestrial equipment shall operate from only one side of the river. The wetland is too shallow for barges and too soft for terrestrial equipment. Stock piles of material are restricted to an existing parking lot, and the weight of transported loads is limited to minimize soil compaction.

Your company's design/build proposal is among those that the Park Commission has deemed responsive, and winning the contract would be a step toward becoming a leader in the short-span bridge market. 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 then load tested. A panel of consulting engineers and park commissioners will judge the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy, and display. The contract will be awarded to the company whose model best meets the specified needs and requirements. 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 rejection of the model and termination of 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.

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.

4.2.3 A team shall consist only of undergraduate and graduate students in good standing with their ASCE student organization. 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 completed official scoring spreadsheet for a conference competition shall be submitted to aftbq@uaa.alaska.edu before teams from that conference will be invited to the National Student Steel Bridge Competition (NSSBC).

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 commenced 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 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.

4.3.5 A team must consist only of members who are or were students in good standing with their ASCE student organization 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, 2010, are reprinted in this sub-section (4.4) but are subject to change. The current version is at http://www.asce.org/Content.aspx?id=21594. 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 Activities (CSA) 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

RULE CHANGES

The following items in this section (5) identify some of the major changes from the 2010 rules. Not all changes are included. Contestants, hosts, and judges are cautioned to **read this entire document carefully and disregard rules and clarifications from previous years**.

(1) One end of the bridge must be cantilevered.
(2) Bridge dimensions are different.
(3) Size limits for members are different.
(4) A fastener shall not connect more than two members.
(5) In the construction site, footings are replaced with foundation easements.
(6) Size limit for tools is different.
(7) The constructed portion may be modified during timed construction.
(8) Lateral and vertical load magnitudes and locations are different.
(9) Sway and vertical deflection limits are different.

Section 6

SAFETY

Safety has the highest priority. Judges are empowered to halt any activity that they deem hazardous. Judges will stop construction procedures that could cause personal injury. A bridge that cannot be constructed and loaded safely is not eligible for awards in any category and must be withdrawn from participation. Judges will not allow additional load to be placed on a bridge that has collapsed, that is approaching a collapse that could be dangerous, or that has swayed or deflected in excess of limits specified in section 12, "Load Tests."

Section 7

SCORING

7.1 RECORDING DATA AND SUBMITTING SCORES

Scoring data should be recorded for every team that competes, using forms printed from the official scoring spreadsheet downloaded from http://www.nssbc.info. Data from those forms are then entered on 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 team captain is given adequate time to verify the data.

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

Teams are encouraged to download, understand, and verify the spreadsheet before the competition. The spreadsheet also is useful for a team to compare alternative designs and construction procedures.

7.2 CATEGORIES OF COMPETITION

7.2.1 Categories of competition are display, construction speed, lightness, stiffness, construction economy, and structural efficiency. In addition, overall performance is rated. A bridge that was not approved for load testing is not eligible for awards in any category.

7.2.2 Display

7.2.2.1 Display is the tie-breaker for all categories of competition. Judges shall not declare ties in display. The bridge is displayed exactly as it will be erected during timed construction. Display is judged by the following criteria

7.2.2.2 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.

7.2.2.3 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 must appear on the bridge with all letters at least one inch high. The name must be formed from steel or applied to steel with paint or decals. A thirty-pound weight penalty will be imposed if the bridge lacks appropriate identification.

7.2.2.4 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 brief computation demonstrating design for one limit state,
(6) discuss provisions for sustainability, if any, for example, by listing or designating on the drawing those parts of the bridge that were salvaged from previous bridges or projects, or obtained from salvage yards, and
(7) acknowledge university technicians, faculty, and others who helped fabricate the bridge or provided advice.

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 fifty-pound weight penalty 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.

7.2.3 Construction Speed

The bridge with the lowest total time will win in the construction speed category. Total time is defined as the time required for construction modified by penalties prescribed in 11.4, 11.8.1, 12.2, 12.4, 12.5, and 12.6, plus 150% of repair time modified by penalties prescribed in 11.4 and 11.8.1 (see 11.10). There is an upper limit on construction time (see 11.8.2).

7.2.4 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 Number of builders (including barges)
x \$50,000 per builder-minute
+ \$30,000 for each temporary pier in the staging yard.

Total time is defined in 7.2.3 and includes penalties. The number of builders includes all members and associates of the competing organization who are within the construction site or physically assist the team at any time during timed construction or repair.

7.2.5 Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in 7.2.2, 9.3, 9.4, 10.2, 12.4, 12.5, and 12.6. Decking, tools, temporary piers, and posters are not included in total weight.

7.2.6 Stiffness

The bridge with the lowest aggregate deflection will win in the stiffness category. Aggregate deflection is determined from measurements as prescribed in 12.5, or is a penalty value prescribed in that sub-section and in 12.4 and 12.6.

7.2.7 Structural Efficiency

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

C_s = Total weight (pounds) x \$4000 per pound
+ [Aggregate deflection (inches)]$^{1.5}$ x \$1,200,000.

Total weight is defined in 7.2.5 and includes penalties. Aggregate deflection is defined in 7.2.6 and includes penalties.

7.2.8 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.

Section 8

SCHEDULE OF COMPETITION

In the months before the competition, students design their bridges, fabricate members, test load, practice construction, and select the captain and builders for timed construction. The following events occur during the competition

(1) 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, and repairs as described in 11.10.
(2) Bridges are disassembled.
(3) In a meeting at which all team captains are present, the head judge clarifies rules and conditions of the competition and answers questions.
(4) The head judge selects the location of the load on the back span and the locations of two of the three vertical deflection targets. See 12.5.1 and the Vertical Load Test elevations on the Bridge Loading Diagram. Selection is done in the presence of the team captains by rolling a die twice. For each possible result S1 of the first roll, Table 8.1 gives the

dimension L for positioning the load on the back span and the dimension TB for placing the vertical deflection target on the back span.

TABLE 8.1 Determination of L and TB from first roll of die

S1	1	2	3	4	5	6
L	0	3'0"	6'0"	7'0"	9'0"	12'0"
TB	3'0"	6'0"	9'0"	7'0"	9'0"	12'0"

For each possible result S2 of the second roll, Table 8.2 gives the dimension TC for placing the vertical deflection target on the cantilever.

TABLE 8.2 Determination of TC from second roll of die

S2	1	2	3	4	5	6
TC	1'0"	1'6"	1'6"	2'0"	2'0"	2'6"

The same locations will be used for all bridges in the competition.

(5) Bridge members, fasteners, tools, and temporary piers are staged for construction and inspected by the judges. See section 10, "Materials and Components," 9.4.4, 9.4.5, 11.2, and 11.6 for details.
(6) Timed construction. See section 11, "Construction," for details.
(7) Judges inspect assembled bridges. For details, see section 9, "Dimensions and Support," (including 9.4.4 and 9.4.5 as they apply to installation of fasteners), 10.1.3 and 10.1.4.
(8) Bridges are weighed (if it is impractical to weigh the entire bridge, its parts may be weighed prior to construction).
(9) Load testing. See section 12, "Load Tests," for details.
(10) Scores and rankings are determined using the official scoring spreadsheet found at www.nssbc.info.
(11) The host ASCE student organization submits the completed official scoring spreadsheet by e-mailing it to the address given on that spreadsheet.
(12) Copies of the summary score sheets are distributed to all teams or posted on the conference host's web site.

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 repairs as described in 11.10.

Section 9

DIMENSIONS AND SUPPORT

9.1 MEASUREMENT

Dimensions and support will be checked with the bridge in its as-built condition after construction and repairs are completed 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.

9.2 FUNCTIONALITY AND SAFETY

9.2.1 If any of the following rules in this sub-section (9.2) is violated, the bridge will not be approved for load testing and will not be eligible for awards in any category.

9.2.2 The back span is the part of the bridge that has supports at both ends. The back span must span the river completely without touching it. See the Site Plan on the Site and Bridge Diagram. However, 9.3.12 prescribes a penalty in lieu of ineligibility for a deviation within the limits set by 9.3.1.

9.2.3 The cantilever is the part of the bridge that has support at only one end. The bridge must be cantilevered over the wetland. However, 9.3.2 and 9.3.4 prescribe penalties in lieu of ineligibility for deviations within the limits set by 9.3.1.

9.2.4 The bridge must provide support for the decking along both of the edges that run in the span direction of the bridge. Each of these two decking support surfaces must be smooth, continuous, and extend for the full overall length of the bridge. See the Elevation on the Site and Bridge Diagram. However, 9.3.3, 9.3.7, and 9.3.8 prescribe penalties in lieu of ineligibility for deviations within the limits set by 9.3.1.

9.2.5 The bridge must provide access for safely placing the decking and load.

9.2.6 The decking must not be attached or anchored to the bridge, and it must not be used to distort the bridge from its as-built condition.

9.2.7 The bridge must not be anchored or tied to the floor.

9.2.8 It must be possible to construct and load the bridge safely using the site and equipment provided by the host student organization. **Bridges must accommodate local conditions.**

9.3 USABILITY

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

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

(1) 50 pounds for a dimensional violation of ½ inch or less
(2) 150 pounds for a dimensional violation greater than ½ inch but not exceeding 1.0 inch
(3) 300 pounds for a dimensional violation greater than 1.0 inch but not exceeding 2.0 inches
(4) If a dimensional violation exceeds 2.0 inches, the bridge will not be approved for load testing and will not be eligible for awards in any category.

9.3.2 The decking support surfaces at the end of the bridge that is not cantilevered shall not extend beyond the edge of the foundation easement that is farthest from the river.

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

9.3.4 The length of each decking support surface shall not be less than 21 feet nor greater than 22 feet.

9.3.5 The inner edges of the two decking support surfaces shall be no less than 2'6" from one another, as measured perpendicularly to the span of the bridge. At no point within this separation shall any part of the bridge be above a plane located 3½ inches below the decking support surfaces.

9.3.6 The outer edges of the two decking support surfaces shall be no more than 3'0" apart, as measured perpendicularly to the span of the bridge. At no point beyond these limits shall any part of the bridge be above a plane located 3½ inches below the decking support surfaces

9.3.7 The decking support surfaces must be smooth, without vertical protrusions or abrupt changes in elevation. This rule may be checked by sliding a decking unit or template along the full overall end-to-end length of the decking support surfaces, in either or both directions. The rule is violated if the progress of the decking unit or template is impeded.

9.3.8 A gap is a discontinuity or depression that extends laterally across the full width of a decking support surface. No gap shall exceed ¼ inch measured in the span direction of the bridge.

9.3.9 The decking support surfaces must be no more than 2’9” above the surface of the river or ground (including the wetland) at any point. See the Elevation on the Site and Bridge Diagram.

9.3.10 Vertical clearance must be provided under the bridge at all points directly over the river and ground (including the wetland) except directly over the foundation easements. The clearance must be at least one foot high, measured from the surface of the river or ground (including the wetland). See the Elevation on the Site and Bridge Diagram.

9.3.11 A straight passageway under the bridge must traverse it completely from end to end. It must be at least 1'6" high measured from the surface of the river and ground (including the wetland), and must be at least 2'6" wide measured perpendicularly to the span of the bridge. See Section B on the Site and Bridge Diagram.

9.3.12 Regardless of any reason other than that allowed by 11.4.1, after timed construction and repair the bridge shall bear only on the ground within the foundation easements. See the Site Plan on the Site and Bridge Diagram.

9.4 MEMBER-TO-MEMBER CONNECTIONS

9.4.1 Violations of the rules in this sub-section (9.4) will result in penalties being added to the weight of the bridge. The penalty for each violation is 25 pounds.

9.4.2 Each member must be connected directly to every member that it touches by at least one fastener installed during timed construction so that the connection cannot be taken apart without first turning the nut or the bolt and removing the nut from the bolt. Definitions of “member” and “fastener” are given in 10.2.3 and 10.2.4, respectively.

9.4.3 No fastener shall connect more than two members.

9.4.4 The bolt must penetrate completely through a hole in each of the members that it connects. Dimension(s) of the hole must be small enough so that neither the head of the bolt nor the nut specified in 10.2.4 can pass through the hole.

9.4.5 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.

9.4.6 The bolt must fully engage the threads of the nut. That is, the end of the bolt must extend beyond, or be flush with, the outer surface of the nut.

Section 10

MATERIAL AND COMPONENTS

10.1 SAFETY

10.1.1 If any one of the rules in this sub-section (10.1) is violated, the bridge will not be approved for construction or load testing, and will not be eligible for awards in any category.

10.1.2 A member must not weigh more than twenty pounds. See 10.2.3 for definition of "member."

10.1.3 A bridge must 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.

10.1.4 After completion of construction and repair, energy shall not be transmitted to or from a bridge (for example, by applying or releasing mechanical, magnetic, fluidic, or other force; by sound, light, radio, or other wave or ray; by conduction or convection of heat; or by electric current). The exceptions are forces necessary to the competition (for example, those associated with load testing and with moving the bridge from place to place), and changes in ambient conditions that are not controlled by competitors (such as wind, temperature, and lighting).

10.2 DURABILITY AND CONSTRUCTABILITY

10.2.1 Penalties

Violation of the rules in this sub-section (10.2) will result in penalties being added to the weight of the bridge. The penalty is 25 pounds for each member or fastener that is in violation.

10.2.2 Bridge

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

10.2.3 Members

10.2.3.1 A member is a rigid steel component. A member must 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.

10.2.3.2 A member must not exceed overall dimensions of 3'0" x 6" x 4". That is, it must fit in a prismatic box of those dimensions.

10.2.3.3 A member may consist of multiple parts rigidly joined together before timed construction begins. Those parts must remain rigidly joined throughout timed construction and in the completed bridge. Parts shall be joined by welding or with steel connectors such as bolts, screws, and rivets. If nuts are used, their threads must be fully engaged (that is, the end of the bolt or threaded stud must be flush with or extend beyond the outer face of the nut).

10.2.4 Fasteners

10.2.4.1 A fastener is a steel bolt that is not part of a member, with a steel nut that is not part of a member. Grade and diameter are not restricted. Specialty and 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

10.2.4.2 The bolt in a fastener must be no more than 1½-inch nominal length (bottom of head to end) with a hexagonal head. Bolts must be commercially-available tap bolts, machine bolts, or cap screws. Bolts shall not be mechanically altered or modified in any way but may be painted.

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

10.2.4.4 Nuts and bolts that connect the parts of a member but do not connect a member to other members are not considered to be fasteners and are not governed by the preceding provisions of this sub-sub-section (10.2.4).

Section 11

CONSTRUCTION

11.1 DEFINITIONS

11.1.1 "River," "wetland," "staging yard," "foundation easement," "moorage" and "construction site boundary" are delineated by the Site and Bridge Diagram.

11.1.2 "Ground" is the floor inside the construction site boundary, except for the river. Ground includes the wetland and foundation easements.

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

11.1.4 A "barge" is a builder who is designated to begin, remain, and end timed construction in the river. Builders cannot be designated as barges after the start of timed construction and builders so designated remain barges for the duration of timed construction. The use of barges is optional. Barges are counted as builders.

11.1.5 A "team" is all the builders from the competing organization who are within the construction site boundary during timed construction. The team shall include no more than six builders. No more than three of those builders shall be designated as barges.

11.1.6 "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.

11.1.7 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.

11.1.8 "Member" and "fastener" are defined in 10.2.3 and 10.2.4, respectively. "Member-to-member connection" is defined in 9.4.

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

11.1.10 "Temporary piers" are optional devices that bear on the river or ground (including the wetland), and are used to support the constructed portion of the bridge during timed construction. They have no other purpose, are not tools, and are not part of the completed bridge. A team provides its own temporary piers, which must be labeled "pier." The construction cost, C_c, includes an increment for every temporary pier in the staging yard at the start of the inspection described in item 5 of section 8, "Schedule of Competition."

11.1.11 To be “moored” means that a barge is in the river with one foot on a portion of the line marking the edge of the river that is designated as a moorage. Only one barge can be moored at each moorage.

11.1.12 The “constructed portion” is comprised of members and fasteners and is created during timed construction. The constructed portion is not required to be contiguous.

11.2 GENERAL SAFETY CONDITIONS

11.2.1 Timed construction or repair will not commence or will be stopped if any provision of this sub-section (11.2) is violated.

11.2.2 Builders, judges, host personnel, and spectators must not be exposed to risk of personal injury.

11.2.3 Only builders and judges are permitted within the construction site boundary during timed construction and repair. 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.

11.2.4 At all times during timed construction and repair every builder must wear personal protective equipment in the proper manner (e.g., hardhat with peak in front).

11.2.5 Welding machines and tools requiring external power connections must not be used during timed construction or repair.

11.2.6 A tool must not weigh more than twenty pounds and must not exceed 3’0” in any linear dimension when fully assembled and extended.

11.2.7 A temporary pier must not weigh more than twenty pounds and must not exceed 1’6” in any horizontal dimension when in use. That is, it should fit inside a vertical cylinder with diameter of 1’6”.

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

11.3 SAFE CONSTRUCTION PRACTICES

11.3.1 If any rule in this sub-section (11.3) is violated during timed construction or repair, the judge will stop the clock and explain the violation. Before the clock is restarted, builders, tools, members, fasteners, and temporary piers will be returned to the positions they occupied before the violation. Then the team will be asked to resume construction using safe procedures. A team will have the opportunity to construct its bridge safely. However, if the 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.

11.3.2 Construction of every non-contiguous part of the constructed portion shall commence by placing a member on a foundation easement. That member becomes part of the constructed portion. When a member or fastener is placed in contact with the constructed portion it becomes part of the constructed portion and is no longer considered to be a member or fastener.

11.3.3 A member shall not be in contact with another member but may be in contact with a former member that is now part of the constructed portion.

11.3.4 Surfaces of the constructed portion that bear on the foundation easements shall be the same surfaces that will bear on the same foundation easements in the completed bridge and, after being placed, must continuously support the constructed portion for the remaining duration of timed construction and repair.

11.3.5 A member shall not be supported by a temporary pier unless it is simultaneously supported by a builder.

11.3.6 A temporary pier shall not be moved while it is supporting the constructed portion.

11.3.7 A builder shall not remove an item of personal protective equipment nor wear it incorrectly (e.g., hardhat with peak in back).

11.3.8 Throwing anything is prohibited.

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

11.3.10 Outside the staging yard, a builder shall not contribute simultaneously to moving or supporting more than one of the following items: a member, a temporary pier, the constructed portion, or a non-contiguous part of the constructed portion. In other words, a builder cannot simultaneously move or support more than one of those items.

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

11.3.12 A builder must not use the bridge, a portion of the bridge, a 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 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 both feet on the floor.

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

11.4 ACCIDENTS

11.4.1 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 (11.4).

A time penalty is assessed for every accident. If an accident is continuous (for example, a builder who is not a barge 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, temporary piers, and fasteners will be returned to the positions they occupied before the accident. Exception: Construction may proceed if it is no longer possible to hold all bearing surfaces within the foundation easements simultaneously. In this situation, the team captain may request that the clock be stopped in order to demonstrate the difficulty to the judge. If the judge is convinced, no additional accidents will be cited for bearing surfaces touching the ground outside the foundation easements (rule 11.4.5), the clock will be restarted, construction will resume, and a penalty will be assessed for a two-inch violation of rule 9.3.12 (even if the bearing surfaces fall within the footings when the bridge is completed).

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

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

11.4.4 A barge or a barge's clothing touches ground (which includes the wetland) or floor outside the boundary of the construction site. Penalty is 1/2 minute (30 seconds) for every occurrence. Exception: There is no penalty for stepping out of bounds or on ground to retrieve an object that has been dropped, such as a member, tool, nut, bolt, or personal protective equipment.

11.4.5 A member, constructed portion, tool, nut, bolt, or personal protective equipment touches river, ground (which includes the wetland), or floor outside the staging yard. Penalty is 1/4 minute (15 seconds) for every item during every occurrence. Exceptions: (1) There is no penalty for the constructed portion touching the ground within the foundation easements. (2) There is no penalty if a tool used exclusively for measuring touches the ground during use while being held by a builder.

11.5 CONSTRUCTION SITE

11.5.1 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 tape, not the centerline, designate the lines shown on the Site Plan.

11.5.2 Only builders and judges are permitted within the construction site boundary during timed construction. Only judges are permitted near the construction site. Spectators, including coaches, faculty, advisers, and other associates of the team, must observe from areas designated by the judges and host student organization. These areas must be far enough from the construction site so that spectators are not at risk, cannot physically assist builders, and cannot interfere with the competition.

11.6 START

11.6.1 Before construction begins, only the following items are in the staging yard: all members, fasteners, tools, and temporary piers. Temporary piers must be labeled "pier." Every member, tool, temporary pier, and fastener must be in contact with the ground within assigned areas of the staging yard as designated on the Site and Bridge Diagram. No object shall be in contact with another object except that fasteners may be in contact with other fasteners. Builders who are not barges are in the staging yard. Every barge is moored at a different moorage. Barges start without tools and fasteners, which may be passed to them by other builders after timed construction begins. Builders, including barges, are wearing personal protective equipment as well as optional clothing such as pouches.

11.6.2 Judges inspect members, tools, fasteners, and temporary piers after the team arranges them in the staging yard and signifies readiness for inspection. After the beginning of inspection and throughout timed construction and repairs, additional members, 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.

11.6.3 Timing and construction begin when one of the builders signifies that the team is ready and the judge declares the start.

11.7 TIME

11.7.1 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 rule has been violated (see 11.2 and 11.3), 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 11.4), or
(4) if a builder or judge is injured.

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

11.8 TIME LIMIT

11.8.1 If the total of construction time, not including penalties, plus repair time, not including penalties, but factored by 1.5 exceeds thirty minutes, construction time will be counted as 180 minutes for scoring. "Accidents" (11.4) that occur after thirty minutes will not be penalized but safety rules (11.2 and 11.3) will still be enforced. Judges will inform the team when this time limit is approaching and again when it is reached.

11.8.2 If the total of construction time, not including penalties, plus repair time, not including penalties, but factored by 1.5 exceeds 45 minutes, judges may halt construction or may move the bridge off site for continued, untimed construction if it can be done safely. The bridge will not be eligible for awards in any category.

11.9 FINISH

11.9.1 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,
(2) builders who are not barges are back in the staging yard,
(3) every barge is moored at a moorage, with no more than one barge at each moorage,
(4) every temporary pier is in the part of the staging yard designated on the Site and Bridge Diagram,
(5) every tool is held by a builder, or is in clothing worn by a builder, or is on the ground in the part of the staging yard designated on the Site and Bridge Diagram, and
(6) a builder informs the judge that construction is complete.

11.9.2 Extra fasteners may be in the designated part of the staging yard or held by or in the clothing of builders.

11.9.3 Installation of decking is not included in timed construction.

11.9.4 After construction is finished the bridge must not be modified except for repairs as permitted by 11.10.

11.10 REPAIRS

Before the judges inspect and measure the bridge, and before the bridge is moved from the construction site, two builders 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 mistakes found by their inspectors. Repairs are made with the clock restarted and begin with builders and necessary items arranged in the staging yard as prescribed by 11.6. Safety precautions (11.2 and 11.3) are enforced and accidents (11.4) are counted. The time limits specified in 11.8.1 and 11.8.2 apply. The repair period ends when the conditions listed in 11.9.1 are fulfilled and shall not be resumed. Judges will not inspect the bridge prior to the end of the repair period.

The scoring spreadsheet will multiply the time required to make repairs and any time penalties assessed during repairs by 1.5 and will add that product to the construction time to compute total time.

It is not necessary to inspect, measure, or repair a bridge that exceeded the 45-minute time limit prescribed in 11.8.2.

Section 12

LOAD TESTS

12.1 SAFETY PRECAUTIONS

An activity will be halted if the judge considers it to be hazardous.

A bridge could suddenly collapse or sway in any direction during load tests. Therefore, the number of people near the bridge while it is being tested shall be minimized. Usually, the load should be placed on the bridge by only two competitors. Competitors who are not participating in loading, faculty, advisers, and other spectators must observe from an area designated by the judges and host student organization.

Load on the cantilever should be placed from the sides; people should be kept clear of the unsupported end of the cantilever.

While participating in load testing, competitors must wear hardhats meeting ANSI standard Z89.1, protective eyewear or safety goggles meeting ANSI standard Z87.1, 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.

During testing, safety supports must be in place below the decking. The safety supports shall be of sufficient height, strength, number, and extent that none of the load will fall more than approximately six inches if the bridge collapses.

All preparations for load testing, including placement of safety supports, must be completed before any load is on the bridge so that it will not be necessary for anyone to reach, crawl, or step under the loaded bridge. However, if safety supports must be adjusted during loading, the load must first be removed without disturbing the bridge, adjustments made, and the load replaced as it was before being removed.

If team members cannot load their bridge safely, loading will cease and the bridge will not be eligible for awards in any category.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking.

12.2 DAMAGE

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

If a nut falls off its bolt while the bridge is being transported or prepared for load testing, or if the threads of a nut are not fully engaged, the connection will be repaired, the nut will be reinstalled correctly, and a penalty of two minutes will be added to construction time for every nut that was reinstalled.

A bridge with damage that would reduce its strength or stability (such as a missing or broken member or fastener) will not be approved for load testing and is not eligible for awards in any category. Repairs are not permitted after commencement of load testing.

12.3 PREPARATION

Temporary piers are not used during load testing.

The judge designates the “A” and “B” sides of the bridge by a random process.

Teams must accept imperfect field conditions such as bent decking and sloping floors.

12.4 LATERAL LOAD TESTS

12.4.1 The provisions of this sub-section (12.4) are illustrated by the two Lateral Load Test plans on the Bridge Loading Diagram. “Sway” is translation in any horizontal direction.

The lateral load tests are conducted with one unit of decking placed at the center of the back span and approximately 75 pounds of weight on the decking near the “B” side of the bridge. This load is intended to prevent the bearing surfaces of the bridge from lifting off the floor when lateral load is applied.

Bearing surfaces are prevented from sliding by lateral restraint applied as close as possible to the ground at two abutments. This lateral restraint does not restrain rotation of the abutments and is identical for all bridges.

12.4.2 Lateral Load Test of the Back Span

A sway target is established for measurement on the “A” side of the bridge, eight feet from the end of the decking support surface at the end of the bridge that is not cantilevered. The sway target is located as close as possible to the top of the decking support surface, which is the same as the bottom of the decking.

Apply a 75 pound lateral pull at the sway target and measure the sway. To pass the lateral load test, the sway must not exceed 1/2 inch.

If the bridge does not pass this lateral load test it is not approved for further testing. **Do not conduct any other load test**. Check the appropriate box on the judge's data form. The spreadsheet will add a penalty of 900 pounds to the weight of the bridge, a penalty of thirty minutes to the construction time, and will apply an aggregate deflection of thirty inches when the judging data is entered.

If the bridge passes the lateral load test of the back span, proceed with the lateral load test of the cantilever.

12.4.3 Lateral Load Test of the Cantilever

A sway target is established for measurement on the "A" side of the bridge, at the end of the decking support surface at the unsupported end of the cantilever span. The sway target is located as close as possible to the top of the decking support surface, which is the same as the bottom of the decking.

Apply a 75 pound lateral pull at the sway target and measure the sway. To pass the lateral load test, the sway must not exceed 1/2 inch.

If the bridge does not pass this lateral load test it is not approved for further testing. **Do not conduct any other load test**. Check the appropriate box on the judge's data form. The spreadsheet will add a penalty of 900 pounds to the weight of the bridge, a penalty of thirty minutes to the construction time, and will apply an aggregate deflection of thirty inches when the judging data is entered.

If the bridge passes this lateral load test, remove the load and decking, and proceed with the vertical load test.

12.5 VERTICAL LOAD TEST

12.5.1 The provisions of this section are illustrated by the three Vertical Load Test elevations on the Bridge Loading Diagram.

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

Decking units are three feet long in the longitudinal (span) direction of the bridge. Place one decking unit at a distance L from the end of the decking support surfaces at the end of the bridge that is not cantilevered. L is determined at the beginning of the competition as described by Table 8.1 in section 8, "Schedule of Competition." Place the other decking unit at a distance of one inch measured from the end of the decking support surfaces at the unsupported end of the cantilever. Decking units are placed square with the bridge and centered laterally with the main bars spanning laterally over the decking support surfaces. Decking units must not be attached to the bridge and must not distort it (see 9.2.5 and 9.2.6).

Three targets are established for measuring vertical deflections at locations determined by the following dimensions

- TB from the end of the decking support surface at the end of the bridge that is not cantilevered, on the "A" side of the bridge
- TC from the end of the decking support surface at the cantilevered end of the bridge, on the "B" side of the bridge
- One inch from the end of the decking support surface at the cantilevered end of the bridge, on the "A" side of the bridge.

TB and TC are determined at the beginning of the competition as described by Tables 8.1 and 8.2 in section 8, "Schedule of Competition." Vertical deflection targets are located as close as possible to the top of the decking support surface and may be on the bridge or on the decking close to decking support 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 or measuring devices.

Position measuring devices on the three vertical deflection targets.

Uniformly distribute 200 pounds of preload on the decking unit on the back span. Then uniformly distribute 50 pounds of preload on the decking unit on the cantilever span. Preloads are laterally centered on the decking units. Preloads are 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 measurement have been recorded, the judge will require the team to disassemble the bridge and repeat timed construction beginning with the initial conditions prescribed in 11.6. Scoring will be based on the run that results in the larger construction cost, C_c, but will not exceed 125% of C_c for the initial run.

The two steps (increments) of vertical loading produce four measurements

(1) DB1 = absolute value of vertical deflection at the target on the “A” side of the back span that occurs during step 1 (loading the back span).
(2) DCA = absolute value of vertical deflection at the target on the “A” side of the cantilever that occurs during step 2 (loading the cantilever with the load from step 1 remaining in place).
(3) DCB = absolute value of vertical deflection at the target on the “B” side of the cantilever that occurs during step 2 (loading the cantilever with the load from step 1 remaining in place).
(4) DB2 = absolute value of vertical deflection at the target on the “A” side of the back span that occurs from the beginning of step 1 to the end of step 2.

The scoring spreadsheet computes aggregate deflection as the sum of DCA, DCB, and the larger of DB1 and DB2.

12.5.2 Step 1 – Vertical Load Test of the Back Span

Load the decking unit on the back span and measure the deflection, using the following procedure

(1) The two preloads remain in place.
(2) Initialize the sway measurement device on the back span.
(3) Initialize the sway measurement device on the cantilever.
(4) Initialize the vertical deflection measuring device on the back span or record the initial reading.
(5) Team members place 1600 pounds of additional load on the decking unit on the back span. The 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.
(6) As the load is being placed, observe the deflection target on the back span and both sway targets. Stop loading if

    (a) sway at either sway target exceeds 0.5 inch from the beginning of step 1, or
    (b) deflection at the deflection target on the back span exceeds 1.5 inches downward from the beginning of step 1, 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. Remove the load and **do not continue load testing**. Check the appropriate box on the judge's data form. The scoring spreadsheet will add an 800-pound penalty to the weight of the bridge, a penalty of thirty minutes to the construction time, and will apply an aggregate deflection of thirty inches when the judging data is entered.

If the bridge passes step 1, record the first measured value DB1.

12.5.3 Step 2 – Vertical Load Test of the Cantilever

Load the decking unit on the cantilever span and measure the deflections, using the following procedure

(1) The two preloads and the load from step 1 remain in place.
(2) Do **not** initialize the vertical deflection measuring device on the back span.
(3) Do **not** initialize the sway measurement devices on the back span and cantilever.
(4) Initialize the vertical deflection measuring devices on the cantilever.
(5) Team members place 650 pounds of additional load on the decking unit on the cantilever. The 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.
(6) As the load is being placed, observe the three deflection targets and both sway targets. Stop loading if

   (a) sway at either sway target exceeds 0.5 inch from the beginning of step 1, or
   (b.1) deflection at the deflection target on the back span exceeds 1.5 inches downward from the beginning of step 1, or
   (b.2) deflection at either deflection target on the cantilever exceeds 0.5 inch downward from the beginning of step 2, 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.1, b.2, c, d, or e, the bridge is not approved for further load testing. Remove the load and **do not continue load testing**. Check the appropriate box on the judge's data form. The scoring spreadsheet will add a 700-pound penalty to the weight of the bridge, a penalty of thirty minutes to the construction time, and will apply an aggregate deflection of thirty inches when the judging data is entered.

If the bridge passes step 2, record the measured values DCA, DCB and the second measured value DB2.

12.6 Unloading

Remove all load from the cantilever before removing any load from the back span.

If the bridge collapses during unloading (situation c, d, or e), it shall be penalized as if it had failed to pass step 2.

Section 13

EQUIPMENT PROVIDED BY HOST

13.1 SOURCES OF INFORMATION

The Competition Guide at http://www.nssbc.info should be reviewed by judges, host personnel, and competitors. It has detailed descriptions and illustrations of contest procedures and hosting equipment. The following provisions of this section (13) describe some of the equipment that is needed for the competition and is intended to help competitors know what to expect. Competitors should acquire similar equipment for use in practice and testing before the competition.

13.2 FLOOR

The floor in both the construction site and loading area shall be solid, stable and as nearly flat and level as possible.

13.3 LATERAL LOAD DEVICE

The lateral load device should be capable of applying a force of 75 pounds in the horizontal direction.

13.4 SWAY MEASUREMENT

Sway is horizontal translation and is measured at two points by any accurate method. A suggested method is to suspend a plumb bob from the sway target and measure sway from a point marked on the floor.

13.5 DEFLECTION MEASUREMENT

Deflection is vertical translation and is measured at three points by any accurate method.

13.6 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 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 of the grating that are perpendicular to the length.

13.7 SAFETY SUPPORTS

The safety supports must be used during load testing and are intended to limit the consequences of a bridge collapsing. The 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, timbers, sand bags, or masonry units.

13.8 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.

13.9 OFFICIAL SCORING SPREADSHEET AND DATA FORMS

Results will not be official until the completed official scoring spreadsheet is submitted to aftbq@uaa.alaska.edu to report outcomes. It may be downloaded at http://www.nssbc.info. Judges' forms for recording data are accessed from the spreadsheet.

Section 14

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 2, 2011.

Section 15

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 16

APPEALS

16.1 CONFERENCE COMPETITIONS

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

16.1.2 A penalty, decision, measurement, score, or condition of competition may be appealed only by a 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 not hear the appeal if he or she is approached by students other than the team captain. The CHJ will hear the appeal as soon as possible and may interrupt the competition. Participants are reminded that civility and ethical behavior are expected during the competition and particularly concerning appeals.

16.1.3 After the conference competition, the team captain has the option to appeal the decision of the CHJ by sending an e-mail message to Ms. Maria Mnookin <mnookin@aisc.org> followed by a letter mailed to Ms. Mnookin (AISC, Suite 700, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to ASCE Student Services (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The e-mail message and letter shall include

(1) name of the college or university making the appeal,
(2) team 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,
(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) team captain's signature (letter only).

16.1.4 Appeals must be made by e-mail followed by letter. An appeal will be considered only if the e-mail is received and 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 aftbq@uaa.alaska.edu. 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.

16.2 NATIONAL COMPETITION

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

16.2.2 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.

16.2.3 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.

16.2.4 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.

16.2.5 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 17

SUMMARY OF SCORING

17.1 SCORING

This form summarizes section 7, "Scoring." However, official scoring data shall be recorded on the scoring spreadsheet that is available in the Competition Guide at http://www.nssbc.info. That spreadsheet also is useful for a team to compare alternative designs and construction procedures. The completed official scoring spreadsheet for a conference competition shall be submitted to aftbq@uaa.alaska.edu. Conference results are not final until the spreadsheet is submitted by the host organization. Questions and comments regarding the spreadsheet should be sent to aftbq@uaa.alaska.edu.

17.2 DISPLAY

See 7.2.2 for detailed description. Judges shall not declare ties in display. The following criteria are included

(1) Appearance: balance, proportion, elegance, finish
(2) Name of college or university on bridge in letters at least one inch high
(3) Poster describing design and fabrication, no larger than 2 x 3 feet

DISPLAY SCORE = _____

17.3 CONSTRUCTION SPEED AND TIME PENALTIES

Construction clock time, CT _____ minutes
Repair time, RT x 1.5 (see 11.10) _____ minutes
If (CT + 1.5 x RT) ≤ 30 minutes, enter CT
If 30 < (CT + 1.5 x RT) ≤ 45, enter 180 (see 11.8) _____ minutes
Time penalties during construction (see 11.4)
11.4.2, 3, & 4: violations _____ x 1/2 + _____ minutes
11.4.5: violations _____ x 1/4 + _____ minutes
Repair time, RT (see 11.10) _____ x 1.5 + _____ minutes
Time penalties during repair (see 11.4, 11.10)
11.4.2, 3, & 4: violations _____ x 1/2 x 1.5 + _____ minutes
11.4.5: violations _____ x 1/4 x 1.5 + _____ minutes
Time penalty, damage (see 12.2) + _____ minutes
Time penalty, load tests, 30 min (see 12.4, 12.5, & 12.6) + _____ minutes

TOTAL TIME = _____ minutes
Lowest total wins.

17.4 CONSTRUCTION ECONOMY

Number of builders, including barges (_____ builders
Total time (from 17.3) x _____ minutes
x $50,000)
Number or temporary piers + (_____
x $30,000)

CONSTRUCTION COST: C_c = $ _____
Lowest cost wins.

17.5 LIGHTNESS AND WEIGHT PENALTIES

Bridge weight _____ pounds
Weight penalties,
7.2.2, “Display” (30, 50, or 80) + _____ pounds
9.3, “Usability”
Rules violated ≤ ½ inch _____x 50 + _____ pounds
Rules violated ½ - 1 inch _____x 150 + _____ pounds
Rules violated 1 - 2 inch _____x 300 + _____ pounds
9.4, “Member-to-member Connections”
Number of violations _____ x 25 + _____ pounds
10.2, “Durability & Constructability”
Number of violations _____ x 25 + _____ pounds
12.4, .5, and .6 “Lateral Load” and “Vertical Load”
(900, 800 or 700) + _____ pounds

TOTAL WEIGHT = _____ pounds
Lowest weight wins.

17.6 STIFFNESS

AGGREGATE DEFLECTION:
(Larger of DB1 or DB2) + DCA + DCB
or 30 (from 12.4, 12.5, or 12.6) = _____ inches
Lowest deflection wins.

17.7 STRUCTURAL EFFICIENCY

Total weight (from 17.5) (_____ pounds
x __$4000__)
Aggregate deflection (from 17.6) + [(_____ inches)$^{1.5}$
x $1,200,000]

STRUCTURAL COST: C_s = $ _____
Lowest cost wins.

17.8 OVERALL PERFORMANCE

C_c (from 17.4) _____ + C_s (from 17.7) _____ = $_____
Lowest total wins.

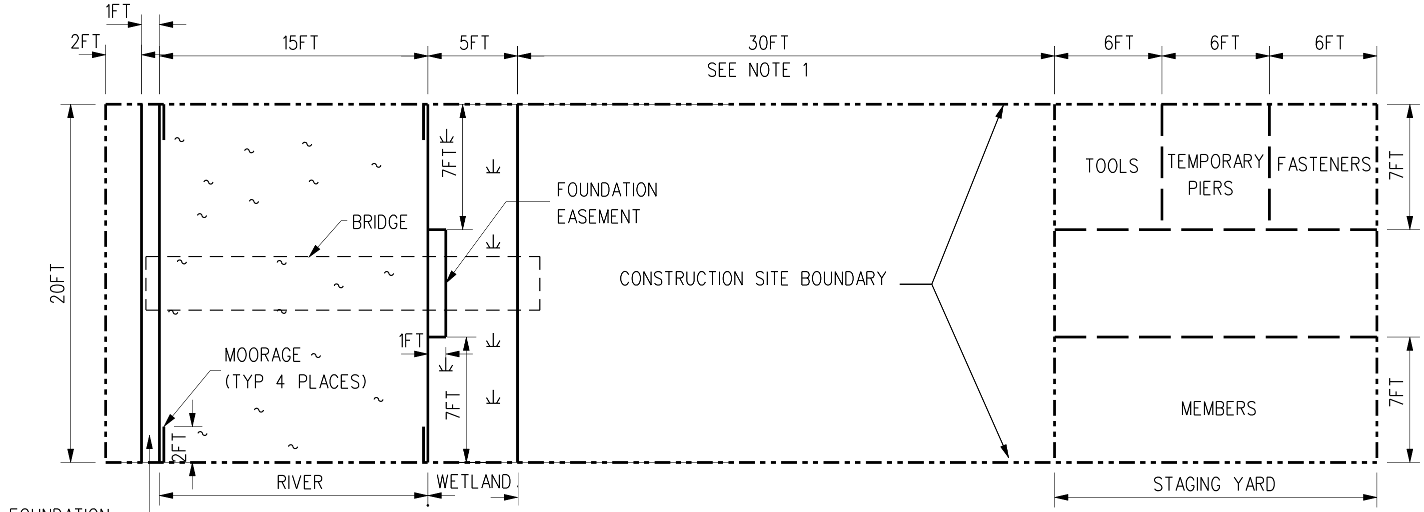
17.9 RANKS

Display is the tie-breaker for all categories. A bridge will not be ranked if it was not approved for construction or load testing.

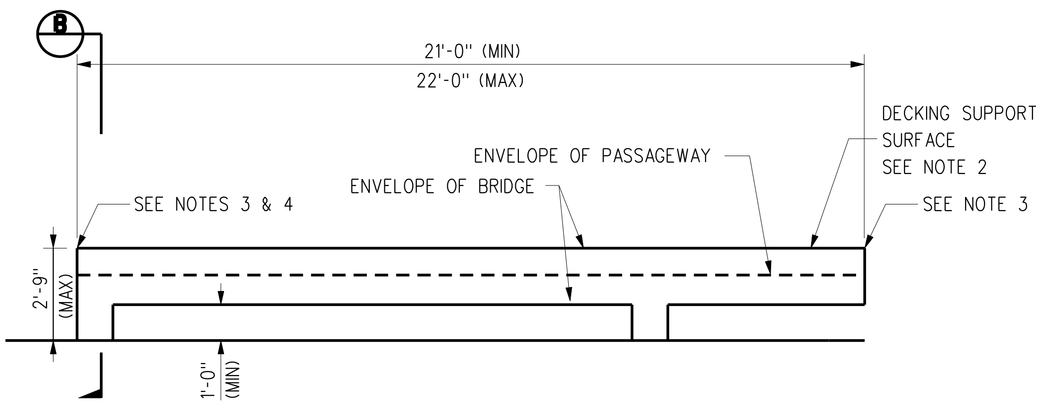
Display _____ Construction Speed _____ Lightness _____
Stiffness _____ Construction Economy _____ Structural Efficiency _____
Overall Performance _____

Section 18

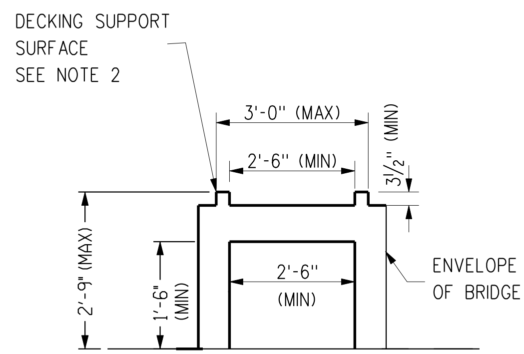
INDEX OF DEFINITIONS



SITE PLAN - REFER TO SECTIONS 9 & 11



ELEVATION - REFER TO SECTION 9



B SECTION
NO SCALE

NOTES:

1. LENGTH CAN BE ADJUSTED TO FIT SITE CONDITIONS.
2. BRIDGE SHALL ACCOMODATE DECKING THROUGHOUT OVERALL LENGTH OF DECKING SUPPORT SURFACES.
3. NO PART OF BRIDGE SHALL EXTEND BEYOND DECKING SUPPORT SURFACE.
4. DECKING SUPPORT SURFACES SHALL NOT EXTEND BEYOND FOUNDATION EASEMENT AT THIS END.
5. SITE SHALL BE LAID OUT SO THAT TAPE DESIGNATES LINES AS WET OR OUT OF BOUNDS. THE LINES ON THIS SITE PLAN DESIGNATE THE EDGES OF TAPE.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION
A	8-14-09						2011 SSBC RULES

DESIGNED BY F. HATFIELD
DRAWN BY D. SEPULVEDA
CHECKED BY RULES COMM.
IN CHARGE N. GAVLIN
DATE 8-1-2010

ASCE - AISC
STUDENT STEEL BRIDGE CONTEST

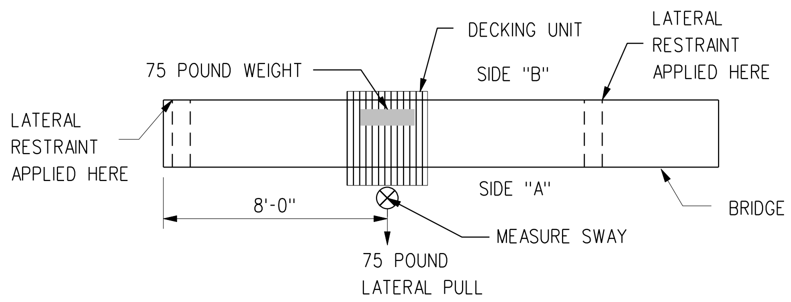
ASCE AMERICAN SOCIETY OF CIVIL ENGINEERS

SUBMITTED
APPROVED

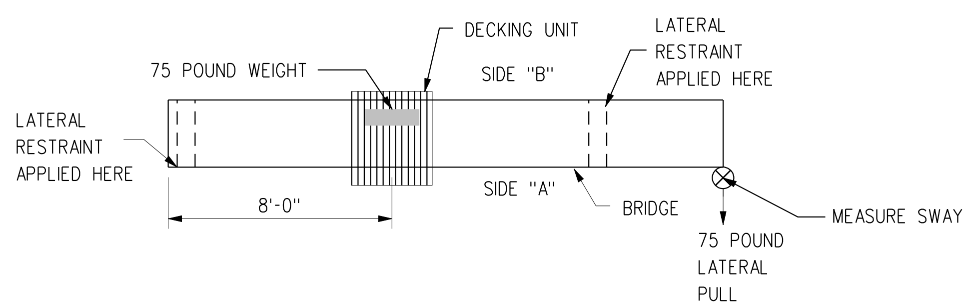
SITE AND BRIDGE DIAGRAM

CONTRACT NO
DRAWING NO DRAWING 1
REV
SCALE NONE
SHEET NO

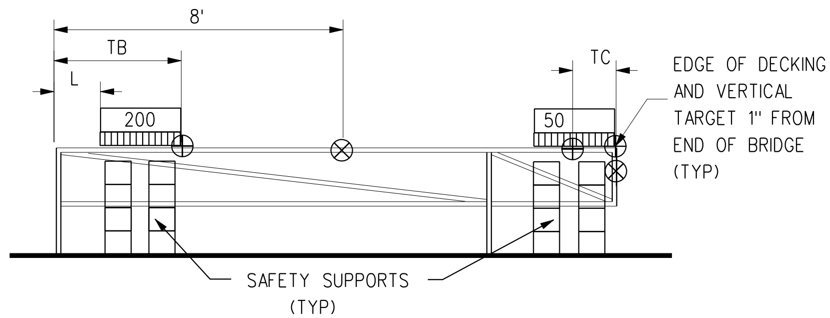
NSSBC_Site_2011.dgn 7/19/2010 1:57:09 PM



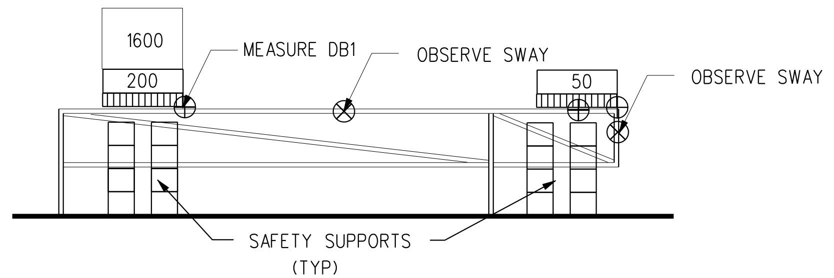
A LATERAL LOAD TEST OF BACKSPAN - PLAN
REFER TO 12.1 THROUGH 12.4



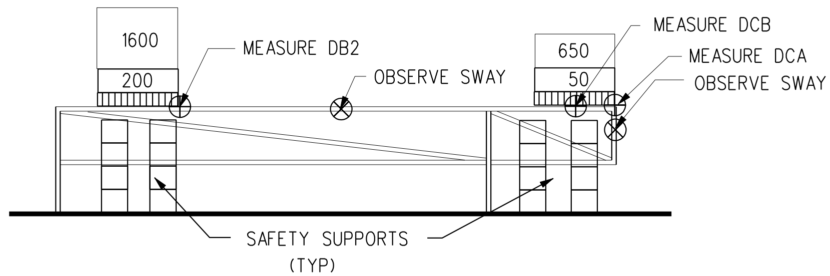
B LATERAL LOAD TEST OF CANTILEVER - PLAN



0 VERTICAL LOAD TEST - PRELOAD SEE NOTE 8
REFER TO 12.1, 12.2, 12.3, AND 12.5



1 VERTICAL LOAD TEST - STEP 1
REFER TO NOTES DURING LOADING PROCESS



2 VERTICAL LOAD TEST - STEP 2
REFER TO NOTES DURING LOADING PROCESS

LEGEND

⊕ TARGETS FOR MEASURING VERTICAL DEFLECTION ⊗ TARGETS FOR MEASURING SWAY

NOTES

1. LOADS ARE CENTERED LATERALLY ON DECKING UNITS AND DISTRIBUTED OVER THE LENGTH OF THE DECKING UNIT AS UNIFORMLY AS POSSIBLE DURING LOADING.
2. DURING STEPS 1 AND 2, OBSERVE THE SWAY TARGETS ON THE "A" SIDE OF THE BACK SPAN AND CANTILEVER. LOADING TERMINATES IF THE SWAY AT EITHER OF THOSE TARGETS EXCEEDS ½".
3. DURING STEP 1. OBSERVE THE VERTICAL TARGET ON THE "A" SIDE OF THE BACK SPAN. LOADING TERMINATES IF DEFLECTION AT THAT TARGET EXCEEDS 1-1/2 ".
4. DURING STEP 2, OBSERVE THE VERTICAL TARGETS ON THE "A" SIDE OF THE BACK SPAN AND ON BOTH SIDES OF THE CANTILEVER. LOADING TERMINATES IF DEFLECTION AT THE TARGET ON THE BACK SPAN EXCEEDS 1-1/2 " OR DEFLECTION AT EITHER TARGET ON THE CANTILVER EXCEEDS ½".
5. SAFETY SUPPORTS TO BE IN PLACE AT ALL TIMES DURING LOADING.
6. BRIDGE TO BE UNLOADED IN THE REVERSE ORDER OF LOADING.
7. ALL LOADING SAFETY PROCEDURES TO BE FOLLOWED.
8. LOCATIONS OF DECKING UNITS, VERTICAL TARGETS, AND SWAY TARGETS REMAIN THE SAME THROUGHOUT THE VERTICAL LOAD TEST.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION
A	8-14-09						2011 SSBC RULES

DESIGNED BY F. HATFIELD
DRAWN BY D. SEPULVEDA
CHECKED BY RULES COMM.
IN CHARGE N. GAVLIN
DATE 8-1-2010

ASCE - AISC
STUDENT STEEL BRIDGE CONTEST

ASCE AMERICAN SOCIETY OF CIVIL ENGINEERS

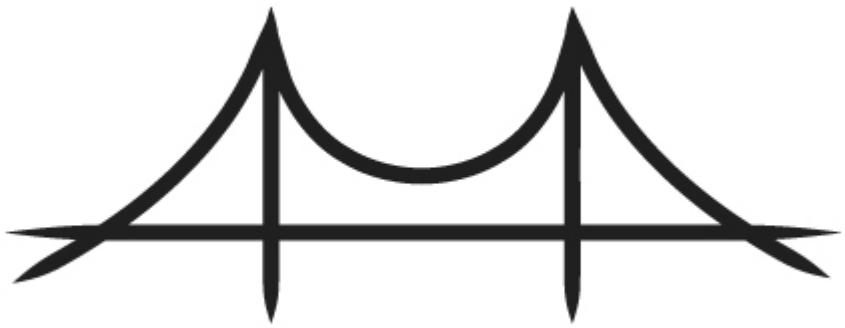
SUBMITTED
APPROVED

BRIDGE LOADING
DIAGRAM

CONTRACT NO
DRAWING NO DRAWING 2
REV
SCALE NONE
SHEET NO

STUDENT STEEL BRIDGE COMPETITION

2010 RULES



MISSION

The mission of the ASCE/AISC 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, esthetics, and cost. Success in inter-collegiate competition requires effective teamwork and project management. Future engineers are stimulated to innovate, practice professionalism, and use structural steel efficiently.

SPONSORS

Sponsors of the Student Steel Bridge Competition are

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

Co-sponsors are

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

TABLE OF CONTENTS

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.

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 from the experience 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 this year, which govern competition 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.

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 chapter 14, “Interpretation of Rules.”

Competitors, judges and host personnel also should review the Competition Guide at http://www.nssbc.info.

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 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. Chapter 6, "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 regulations 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 collapse is imminent or deflection is excessive. Bridges that cannot be constructed 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.

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

3. ELIGIBILITY

There are two levels of competition: conference and national. Conference competitions are held in conjunction with ASCE annual student conferences.

3.1. Conference Competitions

3.1.1. 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.

3.1.2. 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 ASCE student organizations that are assigned to different conferences. Conference assignments are listed in the ASCE Official Register.

3.1.3. A team must consist only of undergraduate and graduate students in good standing with their ASCE student organization. This requirement is waived for guest teams.

3.1.4. The official scoring spreadsheet must 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.

3.2. National Competition

3.2.1. The completed official scoring spreadsheet for a conference competition must be submitted to aftbq@uaa.alaska.edu before teams from that conference will be invited to the National Student Steel Bridge Competition (NSSBC).

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

- a guest team as defined in rule 3.1.2 or
- from an organization that is not in good standing with ASCE or
- from an organization that has not satisfied ASCE requirements regarding participation in its conference or
- ruled to be ineligible to complete its conference competition.

ASCE requirements for good standing and for conference participation, as they existed in July, 2009, are reprinted in section 3.3 but are subject to change. The current version is at http://content.asce.org/student/eligibility.html.

3.2.3. 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 commenced timed construction) but not including guest teams as defined in rule 3.1.2.

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

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

3.2.5. Only one bridge per college or university may be entered in the NSSBC.

3.2.6. A team must consist only of members who are or were students in good standing with their ASCE student organization during all or part of the academic year leading up to the NSSBC.

3.3. ASCE National Competition Eligibility Requirements

The following paragraphs in this section (3.3) were transcribed in July, 2009, from the ASCE web page http://content.asce.org/student/eligibility.html. That page should be consulted for the most recent version. 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 Activities (CSA) 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:

1. Be in good standing with ASCE (annual report and annual dues submitted and received by ASCE prior to the start of the Student Conference).
2. 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.

4. RULE CHANGES

The following list covers some of the major changes from the 2009 rules. Not all changes are listed. Contestants, hosts, and judges are cautioned to **read this entire document carefully and disregard rules and clarifications from previous years**.

1. Costs have changed and the cost of deflection is exponential.
2. Bridge dimensions have changed.
3. Decking support surfaces must be elevated above the rest of the bridge.
4. Holes marking the centerline are closer to the ends of the bridge.
5. Specifications for fasteners have changed.
6. At the start of construction, materials must be in separate designated areas within the staging yard.
7. Temporary piers must be labeled “pier” to distinguish them from members and tools.
8. A builder may not remove his or her pouch, tool belt, or similar accessory.
9. Tools, fasteners, and members may not be stored on temporary piers.
10. Load locations have changed.

5. SAFETY

Safety has the highest priority. Judges are empowered to halt any activity that they deem hazardous. Judges will stop construction procedures that could cause personal injury. A bridge that cannot be constructed safely is not eligible for awards in any category and must be withdrawn from participation. Judges will not allow additional load to be placed on a bridge that has collapsed, that is approaching a collapse that could be dangerous, or that has swayed or deflected in excess of specified limits.

6. PROBLEM STATEMENT

The Boreal Energy Corporation (BEC) is developing a new oil field in the Arctic tundra and needs a bridge to carry equipment over a river and adjacent floodway. The short construction season dictates rapid erection, which is facilitated by prefabricated decking.

BEC has requested design/build proposals for the new bridge. A deck bridge is specified to accommodate very wide and tall loads. The bridge must provide clearance for floods. In addition, pipelines will cross the river directly under the bridge and various utilities will be installed under the decking.

BEC has specified steel as the material because of its fast erection and exceptional sustainability rating, based on durability and high level of recycled content. The bridge must be able to carry specified patterns of loads without exceeding sway and deflection limits. Based on past experience with performance and maintenance, BEC prefers bridges that are relatively light and stiff.

Due to the force of moving ice, permanent piers will not be placed in the river or floodway. However, temporary piers may be used during construction. Footings are restricted to locations of existing thaw-stable gravel deposits on both banks. To minimize impact on the tundra, construction equipment and materials are permitted on only one bank and on barges in the river. Tundra conditions limit the weight of loads that may be moved. The floodway is too shallow for barges and too soft for terrestrial construction machinery.

Your company's design/build proposal is among those that BEC has deemed responsive, and winning the contract would be a step toward becoming a leader in the oil field bridge market. BEC has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. A panel of BEC consultants will judge the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy, and display. The contract will be awarded to the company whose model best meets BEC’s needs and requirements. 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 rejection of the model and termination of the company’s eligibility.

7. SCORING

Scoring data should be recorded for every team that competes, using forms printed from the official scoring spreadsheet downloaded from http://www.nssbc.info. Data from those forms are then entered on the spreadsheet. That spreadsheet also is useful for a team to compare alternative designs and construction procedures. The completed official scoring spreadsheet for a conference competition shall be submitted to aftbq@uaa.alaska.edu. Conference results are not final until the spreadsheet is submitted by the host organization. Questions and comments regarding the spreadsheet should be sent to aftbq@uaa.alaska.edu.

Categories of competition are display, construction speed, lightness, stiffness, construction economy, and structural efficiency. In addition, overall performance is rated. A bridge that was not approved for load testing is not eligible for awards in any category.

7.1. Display

Display is the tie-breaker for all categories of competition. Judges shall not declare ties in display. The bridge is displayed exactly as it will be erected during timed construction. Display is judged by

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

7.1.2. Permanent identification of the bridge consisting of the name of the college or university exactly as shown on the ASCE student web site, http://content.asce.org/student/websites.html. The name must appear on the bridge with all letters at least one inch high. The name must be formed from steel or applied to steel with paint or decals. A thirty-pound weight penalty will be imposed if the bridge lacks appropriate identification.

7.1.3. Poster describing design. The poster must

- 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,
- identify the college or university with the same name that appears on the bridge,
- be illustrated with a scaled, dimensioned side view of the bridge,
- present a brief explanation of why the overall configuration of the bridge was selected,
- include a brief computation demonstrating design for one limit state,
- (optional) discuss provisions for sustainability, for example, by listing or designating on the drawing those parts of the bridge that were salvaged from previous bridges or projects, or obtained from salvage yards, and
- acknowledge university technicians, faculty, and others who helped fabricate the bridge or provided advice.

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 fifty-pound weight penalty 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.

7.2. Construction Speed

The bridge with the lowest total time will win in this category. Total time is defined as the time required for construction, modified by penalties prescribed in sections 11.6, 11.7, 11.9, 12.2, 12.4, and 12.5, plus 150% of repair time (see section 11.9). There is an upper limit on construction time (see section 11.6).

7.3. 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 Number of builders (including barges)
x \$50,000 per builder-minute
+ \$50,000 for one temporary pier even if none is used
+ \$50,000 for each additional temporary pier.

Total time is defined in section 7.2 and includes penalties. The number of builders includes all members and associates of the competing organization who are within the construction site or physically assist the team at any time during timed construction or repair.

7.4. Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in sections 7.1, 9.2, 9.3, 9.4, 10.2, 12.4 and 12.5. Decking, tools, temporary piers, and posters are not included in total weight.

7.5. Stiffness

The bridge with the lowest aggregate deflection will win in the stiffness category. Aggregate deflection is determined from measurements as prescribed in section 12.5.

7.6. Structural Efficiency

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

$$C_s = \text{Total weight (pounds)} \times \$4000 \text{ per pound} + [\text{Aggregate deflection (inches)}]^{1.5} \times \$1{,}200{,}000.$$

Total weight is defined in section 7.4 and includes penalties. Aggregate deflection is defined in section 7.5 and includes penalties.

7.7. 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.

8. SCHEDULE OF COMPETITION

In the months before the competition, students design their bridges, fabricate members, test load, practice construction, and select their captain. The following events occur during the competition

1. 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, and repairs as described in section 11.9.
2. Bridges are disassembled.
3. In a meeting at which all team captains are present, the head judge clarifies rules and conditions of the competition and answers questions.
4. The head judge selects the locations of loads. See section 12.5 and the Locations of Targets and Decking detail on the Bridge Loading Diagram. Selection is done in the presence of the team captains by rolling a die. Let S be the spots from the roll and let L1 and L2 be dimensional locations of decking units in inches.

   $$L1 = 97 + 8\,S \quad \text{and} \quad L2 = 13\,(S - 1)$$

   The same locations will be used for all bridges in the competition.
5. Bridge members, fasteners, tools, and temporary piers are staged for construction and inspected by the judges. See chapter 10, "Materials and Components," rules 9.3.2 and 9.3.3, and section 11.4 for details.
6. Timed construction. See chapter 11, "Construction," for details.
7. Judges inspect assembled bridges. For details, see chapter 9, "Dimensions and Support," (including rules 9.3.2 and 9.3.3 as they apply to installation of fasteners) and rules 10.1.2 and 10.1.3.
8. Bridges are weighed (if it is impractical to weigh the entire bridge, its parts may be weighed prior to construction).
9. Load testing. See chapter 12, "Load Tests," for details.
10. Scores and rankings are determined using the official scoring spreadsheet found at www.nssbc.info.
11. The host ASCE student organization submits the completed official scoring spreadsheet by e-mailing it to the address given on that spreadsheet, which is aftbq@uaa.alaska.edu.
12. Copies of the summary score sheets are distributed to all teams or posted on the host's web site.

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

- bridges are not modified after selection of load locations,
- bridges are not modified between display judging and timed construction,
- no components or tools are added to or removed from the construction site after staging and inspection, and
- modifications between timed construction and load testing are limited to repairs as described in section 11.9.

9. DIMENSIONS AND SUPPORT

Dimensions and support will be checked with the bridge in its as-built condition after construction and repairs are completed 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.

9.1. Functionality and Safety

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

9.1.1. The bridge must span the river and floodway completely without touching them. See the Site Plan on the Site and Bridge Diagram.

9.1.2. The bridge must provide support for the decking for the full overall length of the bridge along both of the edges that run in the span direction of the bridge. See the Elevation on the Site and Bridge Diagram.

9.1.3. The bridge must provide access for placing the decking and load.

9.1.4. The decking must not be attached or anchored to the bridge, and it must not be used to distort the bridge from its as-built condition.

9.1.5. The bridge must not be anchored or tied to the floor.

9.1.6. It must be possible to construct and load the bridge safely using equipment provided by the host student organization. **Bridges must accommodate local conditions.**

9.2. Usability

A weight penalty will be assessed for each rule in this section (9.2) that is violated, rather than for every violation of that rule. If there are multiple violations of the same rule, the penalty will be based on the largest violation.

The penalty for violation of each of the following rules will be an addition to the weight of the bridge determined as follows

- 50 pounds for a dimensional violation of ½ inch or less,
- 150 pounds for a dimensional violation greater than ½ inch but not exceeding 1.0 inch,
- 300 pounds for a dimensional violation greater than 1.0 inch but not exceeding 2.0 inches;
- If a dimensional violation exceeds 2.0 inches, the bridge will not be approved for load testing and will not be eligible for awards in any category.

9.2.1. At every location along the length of the bridge on each side of the bridge, there must be a decking support surface that is between 1’3” and 1’6” from the nominal centerline, measured perpendicularly to that centerline. See the End View on the Site and Bridge Diagram, and section 9.4.

9.2.2. Every part of the bridge that is less than 1’3” or more than 1’6” from the nominal centerline shall be at least 3½ inches below the decking support surfaces.

9.2.3. Decking support surfaces must not be more than 21’6” long and must extend for the overall length of the bridge.

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

9.2.5. The decking support surfaces must be smooth, without vertical protrusions or abrupt changes in elevation. This rule may be checked by sliding a decking unit or template along the full overall end-to-end length of the decking support surfaces.

9.2.6. A gap is a discontinuity or depression that extends laterally across the full width of a decking support surface. A decking support surface shall not have gaps exceeding ¼ inch measured in the span direction of the bridge.

9.2.7. The decking support surfaces must be no more than 2’9” above the surface of the ground or river at any point. See the Elevation on the Site and Bridge Diagram.

9.2.8. Clearance must be provided under the bridge at all points directly over the river, floodway, and ground, except directly over the footings. The clearance must be at least 9¼” high, measured from the surface of the river, floodway, and ground. See the Elevation on the Site and Bridge Diagram.

9.2.9. A straight passageway under the bridge must completely traverse it from end to end. It must be at least 1’6” high measured from the surface of the river, floodway, and ground, must be at least 3’6” wide measured perpendicular to the nominal centerline, and must pass between the footings at both ends of the bridge. See the End View on the Site and Bridge Diagram.

9.2.10. Regardless of any reason other than that allowed by section 11.7, after timed construction and repair the bridge shall bear only on the ground inside the one-foot by one-foot squares that are marked on the construction site to represent footings. See the Site Plan on the Site and Bridge Diagram.

9.3 Member-to-member Connections

Violations of the rules in this section (9.3) will result in penalties being added to the weight of the bridge. The penalty for each violation is 25 pounds.

9.3.1. Each member must be connected directly to every member that it touches by at least one fastener installed during timed construction so that the connection cannot be taken apart without first turning and removing a nut from the bolt. Definitions of “member” and “fastener” are given in section 10.2.

9.3.2. The bolt must penetrate completely through a hole in each of the members that it connects. Dimension(s) of the hole must be small enough so that neither the head of the bolt specified in rule 10.2.8 nor the nut specified in rule 10.2.9 can pass through the hole.

9.3.3. The hole for a fastener shall not be threaded. It must be possible to install and remove the bolt without turning it.

9.3.4. The bolt must fully engage the threads of the nut(s). That is, the end of the bolt must extend beyond, or be flush with, the outer surface of the outermost nut.

9.4. Nominal Centerline

A weight penalty of 100 pounds will be assessed if any of the requirements in this section (9.4) is violated.

9.4.1. The bridge must have a designated straight nominal centerline extending from one end of the bridge to the other. The centerline must be designated by two round holes, one at each end of the bridge, drilled vertically through horizontal steel surfaces. Each hole must be at least ¼ inch in diameter and must be located no more than 1’0” from the vertical plane defined by the ends of the decking support surfaces.

9.4.2. The surfaces in which the centerline holes are drilled shall be no more than 4½ inches below the decking support surfaces. Rule 9.2.2 also applies.

9.4.3. No feature of the bridge shall prevent stretching a string unobstructed along the designated straight nominal centerline.

10. MATERIAL AND COMPONENTS

10.1. Safety

If any one of the following rules in this section (10.1) is violated, the bridge will not be approved for construction or load testing, and will not be eligible for awards in any category.

10.1.1. A member must not weigh more than twenty pounds. See section 10.2 for definition of "member."

10.1.2. A bridge must 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.

10.1.3. After completion of construction and repair, energy must not be transmitted to or from a bridge (for example, by applying or releasing mechanical, magnetic, fluidic, or other force; by sound, light, radio, or other wave or ray; by conduction or convection of heat; or by electric current). The exceptions are forces necessary to the competition (for example, those associated with load testing and with moving the bridge from place to place), and changes in ambient conditions that are not controlled by competitors (such as wind, temperature, and lighting).

10.2. Durability and Constructability

Violation of the following rules in this section (10.2) will result in penalties being added to the weight of the bridge. The penalty for each violation is 25 pounds.

Bridge

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

10.2.2. A bridge must be constructed only of members and fasteners.

Members

10.2.3. A member is a rigid steel component that retains its shape and dimensions during timed construction and in the completed bridge.

10.2.4. A member must not exceed overall dimensions of 3'6" x 6" x 6." That is, it must fit in a prismatic box of those dimensions.

10.2.5. A member must 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.

10.2.6. A member may consist of multiple parts rigidly joined together before timed construction begins. Those parts must remain rigidly joined throughout timed construction and in the completed bridge. Parts shall be joined by welding or with steel connectors such as bolts, screws, and rivets. If nuts are used, their threads must be fully engaged (that is, the end of the bolt or threaded stud must be flush with or extend beyond the outer face of the nut).

Fasteners

10.2.7. A fastener is a steel bolt that is not part of a member, with at least one steel nut that is not part of a member. Grade and diameter are not restricted. Specialty and custom fabricated bolts and nuts will be penalized.

10.2.8. The bolt in a fastener must be no more than 1½-inch nominal length (bottom of head to end) with a hexagonal head. Bolts must be commercially-available tap bolts, machine bolts, or cap screws. Bolts shall not be mechanically altered or modified in any way but may be painted.

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

10.2.10. Nuts and bolts that connect the parts of a member but do not connect a member to other members are not considered to be fasteners and are not governed by rules 10.2.7, 10.2.8, and 10.2.9.

11. CONSTRUCTION

11.1. Definitions

11.1.1. “River,” “floodway,” “staging yard,” “footing,” “moorage” and construction “site boundary” are defined by the Site and Bridge Diagram.

11.1.2. “Ground” is the floor inside the site boundary, except for the river.

11.1.3. “Builders” are undergraduate or graduate student members of a competing student organization. See chapter 3, “Eligibility.”

11.1.4. A “barge” is a builder who is designated to begin, remain, and end timed construction in the river. Builders cannot be designated as barges after the start of timed construction and builders so designated remain barges for the duration of timed construction. The use of barges is optional. Barges are counted as builders.

11.1.5. A “team” is all the builders from the competing organization who are in the construction site during timed construction. The team shall include no more than six builders. No more than three of those builders shall be designated as barges.

11.1.6. “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.

11.1.7. 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.

11.1.8. “Member” and “fastener” are defined in section 10.2. “Member-to-member connection” is defined in section 9.3.

11.1.9. A “pouch” is an article of clothing that may be used to carry fasteners and tools. This definition encompasses tool belts and other accessories worn by builders and having the same function.

11.1.10. “Temporary piers” are optional devices that bear on the river or ground, and are used to support the constructed portion of the bridge during timed construction. They have no other purpose, are not tools, and are not part of the completed bridge. A team provides its own temporary piers, which must be labeled “pier.” The construction cost, C_c, includes an increment for one temporary pier even if none is used, plus an increment for each additional temporary pier.

11.1.11. To be “moored” means that a barge is in the river with one foot on a portion of the line marking the edge of the river that is designated as a moorage. Only one barge can be moored at each moorage.

11.1.12. The “constructed portion” is created during timed construction by placing members in essentially their final positions. The constructed portion is not required to be contiguous.

11.1.13. When a member or fastener is placed in essentially its final position it becomes part of the constructed portion and is no longer considered to be a member or fastener.

11.2. Safety

If any rule in this section (11.2) is violated during timed construction, the judge will stop the clock and explain the violation. Before the clock is restarted, builders, tools, members, fasteners, and temporary piers will be returned to the positions they occupied before the violation. Then the team will be asked to resume construction using safe procedures. A team will have the opportunity to construct its bridge safely. However, if the 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.

Personal Safety

11.2.1. Builders, judges, host personnel, and spectators must not be exposed to risk of personal injury.

11.2.2. Only builders and judges are permitted within the boundaries of the construction site during timed construction and repair. 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 judges.

11.2.3. At all times during timed construction and repair every builder must wear personal protective equipment in the proper manner (e.g., hardhat with peak in front).

11.2.4. Lubricant must not be applied during timed construction or within the construction site at any time. Lubricant must not drop on the floor.

Equipment

11.2.5. Welding machines and tools requiring external power connections must not be used during timed construction or repair.

11.2.6. A tool must not weigh more than twenty pounds and must not exceed 3’6” in any linear dimension when fully assembled and extended.

11.2.7. A temporary pier must not weigh more than twenty pounds and must not exceed 1’6” in any horizontal dimension when in use. That is, it should fit inside a vertical cylinder with diameter of 1’6”.

Temporary Piers

11.2.8. A tool, nut, or bolt shall not be supported by a temporary pier.

11.2.9. A member shall not be supported by a temporary pier unless it is simultaneously supported by a builder or is in its final position, having become all or part of the constructed portion.

11.2.10. A temporary pier must not be moved while it is supporting the constructed portion.

11.2.11. A temporary pier must not collapse or fall over while in use.

11.2.12. A temporary pier must bear on the river or ground and not be supported or stabilized by a builder while it is supporting the constructed portion.

Constructed Portion

11.2.13. A constructed portion must be created in, and remain in, essentially the same location, position, and configuration that it will have in the completed bridge. Exceptions

- A builder may support the constructed portion so that a temporary pier can be moved.
- A former member that is connected to the constructed portion by only one fastener may rotate relative to the constructed portion.
- Due to lack of support from members that have not yet been connected to the constructed portion, part of it may sag or sway.
- The constructed portion may slide from its final position on the footings as an unintended consequence of construction. However, intentional movement of the constructed portion from its final position is a violation.

For all four exceptions, one or more builders may move all or part of the constructed portion in order to make a connection or correct the position of the bridge on the footings. However, rules 11.7.3 and 11.2.20 apply.

11.2.14. A member that is not in its final position must not be supported by the constructed portion.

11.2.15. A member must not contact another member except when it is in its final position and has become part of the constructed portion.

11.2.16. Surfaces of the constructed portion that bear on the footings must be the same surfaces that will bear on the footings in the completed bridge and, after being placed, must remain in contact with the footings for the remaining duration of timed construction and repair.

Work Rules

11.2.17. Throwing anything is prohibited.

11.2.18. A builder must not use the bridge, a portion of the bridge, a 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 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 both feet on the floor.

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

11.2.20. A builder must not support the constructed portion or a non-contiguous part of the constructed portion unless it also is supported on a footing or temporary pier.

11.2.21. Outside the staging yard, a builder shall not contribute simultaneously to moving or supporting more than one of the following items: a member, a temporary pier, the constructed portion, or a non-contiguous part of the constructed portion. However, a builder may adjust the constructed portion as permitted by rule 11.2.13 while simultaneously supporting a member.

11.2.22. A builder must not cross the floodway or the river.

11.2.23. A builder shall not remove a pouch or other article of clothing or hold it in his or her hand(s) during timed construction or repair.

11.3. 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, including the one-foot by one-foot footings, 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 tape, not the centerline, designate the lines shown on the Site Plan.

Only builders and judges are permitted within the boundaries of the construction site during timed construction. Only judges are permitted near the construction site. Spectators, including coaches, faculty, advisers, and other associates of the team, must observe from areas designated by the judges and host student organization. These areas must be far enough from the construction site so that spectators are not at risk, cannot physically assist builders, and cannot interfere with judges.

11.4. Start

Before construction begins, only the following items are in the staging yard: all members, fasteners, tools, and temporary piers. Temporary piers must be labeled “pier.” Every member, tool, temporary pier, and fastener must be in contact with the ground within separate areas of the staging yard designated on the Site and Bridge Diagram. No object shall be in contact with another object except that fasteners may be in contact with other fasteners. Builders who are not barges are in the staging yard. Every barge is moored at a different moorage. Barges start without tools and fasteners, which may be passed to them by other builders after timed construction begins. Builders, including barges, are wearing personal protective equipment as well as optional clothing such as pouches.

Judges inspect members, tools, fasteners, and temporary piers after the team arranges them in the staging yard and signifies readiness for inspection. After the beginning of inspection and throughout timed construction and repairs, additional members, 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.

Timing and construction begin when one of the builders signifies that the team is ready and the judge declares the start.

11.5. Time

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

11.5.1. if a builder or judge sees a condition that could cause injury or

11.5.2. when a safety rule has been violated (see section 11.2) or

11.5.3. 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 section 11.7) or

11.5.4. if a builder or judge is injured.

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

11.6. Time Limit

11.6.1. If the total of construction time and repair time (section 11.9) exceeds thirty minutes, it will be counted as 180 minutes for scoring. “Accidents” (section 11.7) that occur after thirty minutes will not be penalized but safety rules (section 11.2) will still be enforced. Judges will inform the team when this time limit is approaching and again when it is reached.

11.6.2. If the total of construction time and repair time exceeds 45 minutes, judges may halt construction or may move the bridge off site if it can be constructed safely. The bridge will not be eligible for awards in any category.

11.7. Accidents

In general, the clock is not stopped when an "accident" occurs. If an accident is continuous (for example, a builder who is not a barge stands in the river, or a dropped item is not retrieved promptly) it will be counted as multiple incidents. Builders involved in accidents may continue to build, and items involved in accidents must 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, temporary piers, and fasteners will be returned to the positions they occupied before the accident. Exception: Construction may proceed if it is no longer possible to hold all four bearing surfaces within the footings simultaneously. In this situation, the team captain may request that the clock be stopped in order to demonstrate the difficulty to the judge. If the judge is convinced, no additional accidents will be cited for bearing surfaces touching the ground outside the footings (rule 11.7.3), the clock will be restarted, construction will resume, and a penalty will be assessed for a two-inch violation under rule 9.2.10 (even if the bearing surfaces fall within the footings when the bridge is completed).

Types of accidents and the corresponding time penalties, which will be added to the construction time, are

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

11.7.2. A barge or a barge's clothing touches ground (which includes the floodway) or floor outside the boundary of the construction site. Penalty is 1/2 minute (30 seconds) per incident. Exception: There is no penalty for stepping out of bounds or on ground to retrieve an object that has been dropped, such as a member, tool, nut, bolt, or personal protective equipment.

11.7.3. A member, constructed portion, tool, nut, bolt, or personal protective equipment touches river, ground, or floor outside the staging yard. Penalty is 1/4 minute (15 seconds) per incident. Exceptions: (1) There is no penalty for the constructed portion touching the ground within the one-foot by one-foot footings. (2) There is no penalty if a tool used exclusively for measuring touches the ground during use while being held by a builder.

11.8. Finish

Construction ends and the clock is stopped when

- the bridge has been completed by connecting all the members that were in the staging yard, and
- builders who are not barges are back in the staging yard, and
- every barge is moored at a moorage, with no more than one barge at each moorage, and
- every temporary pier is in the part of the staging yard designated on the Site and Bridge Diagram, and
- every tool is held by a builder, or is in clothing worn by a builder, or is on the ground in the part of the staging yard designated on the Site and Bridge Diagram.

Extra fasteners may be in the designated part of the staging yard or held by or in the clothing of builders. Installation of decking is not included in timed construction.

After construction is finished the bridge must not be modified except for repairs as permitted by section 11.9.

11.9. Repairs

Before the judges inspect and measure the bridge, and before the bridge is moved from the construction site, two builders will be given five minutes to inspect the bridge for construction mistakes and to plan corrective action. They must not modify the bridge and they must not touch the bridge except as necessary to use measuring devices. Following this inspection, builders will be permitted, but not required, to repair construction mistakes found by their inspectors. Repairs are made with the clock restarted. Safety precautions (section 11.2) are enforced and accidents (section 11.7) are counted. The scoring spreadsheet will multiply the time required to make repairs and any time penalties assessed during repairs by 1.5 and will add that product to the construction time to compute total time. Time limits (section 11.6) apply. Judges will not inspect the completed bridge for violations of rules until after the team captain is satisfied or the time limit (rule 11.6.2) is reached.

12. LOAD TESTS

12.1. Safety Precautions

The judge will halt any activity that he or she considers to be hazardous.

A bridge could suddenly collapse or sway in any direction during load tests. Therefore, the number of people near the bridge while it is being tested shall be minimized. Usually, the load should be placed on the bridge by only two competitors. Competitors who are not participating in loading, faculty, advisers, and other spectators must observe from an area designated by the judges and host student organization.

While participating in load testing, competitors must wear hardhats meeting ANSI standard Z89.1, protective eyewear or safety goggles meeting ANSI standard Z87.1, 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.

During testing, safety supports must be in place below the decking. The safety supports shall be of sufficient height, strength, number, and extent that none of the load will fall more than approximately six inches if the bridge collapses.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a portion of the decking that is cantilevered over its support.

When any portion of the load is on the bridge, no one is permitted to crawl, reach, or step under the bridge. If such an action is necessary, the load must first be removed.

12.2. Damage

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

If a nut falls off its bolt while the bridge is being transported or prepared for load testing, or if the threads of a nut are not fully engaged, the connection will be repaired, the nut will be installed, and a penalty of two minutes will be added to construction time.

A bridge with irreparable damage that would reduce its strength or stability (such as a missing or broken member or fastener) will not be approved for load testing and is not eligible for awards in any category.

12.3. Preparation

Temporary piers are not used during load testing.

The judge designates the “A” and “B” sides of each bridge by a random process. “Left” and “right” ends are determined by facing the “A” side.

Teams must accept imperfect field conditions such as bent decking and sloping floors.

12.4. Lateral Load Test

The provisions of this section are illustrated by the Lateral Load Test Plan on the Bridge Loading Diagram. “Sway” is translation in any horizontal direction.

The lateral load test is conducted with one unit of decking 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 prevent the bearing surfaces of the bridge from lifting off the floor when lateral load is applied.

A sway target is established for measurement on the “A” side of the bridge, 10’3” from the right end of the decking support surface on that side. The sway target is located at the level of the decking support surface, which is the same as the bottom of the decking. See the Lateral Load Test Plan on the Bridge Loading Diagram.

The two bearing surfaces on the “B” side of the bridge are prevented from sliding by horizontal restraint applied from the inside of the abutments as close as possible to the ground. This horizontal restraint does not restrain rotation of the abutments and is identical for all bridges.

Apply a fifty-pound lateral pull at the sway target and measure the sway. To pass the lateral load test, the sway must not exceed one inch.

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 judge’s data form. The spreadsheet will add a penalty of 900 pounds to the weight of the bridge, a penalty of thirty minutes to the construction time, and will apply an aggregate deflection of thirty inches when the judging data is entered.

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

12.5. Vertical Load Test

The provisions of this section are illustrated by the three Vertical Load Test elevations on the Bridge Loading Diagram.

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

Decking units are three feet long in the longitudinal (span) direction of the bridge. Place the two decking units at distances L1 and L2 measured from the right end of the decking support surface on the "A" side of the bridge to the right edges of the decking units, as shown in the Location of Targets and Decking Plan on the Bridge Loading Diagram. See item 4 in chapter 8, "Schedule of Competition," for determination of L1 and L2. Decking units are placed square with the bridge, with the main bars spanning laterally over the decking support surfaces, and centered on the designated nominal centerline (see section 9.4). Decking units must not be attached to the bridge and must not distort it (see rules 9.1.3 and 9.1.4).

Three targets are established for measuring vertical deflection. One vertical deflection target is located at the left end of the right unit of decking, on the "A" side of the bridge, at the level of the decking. The other two vertical deflection targets are located at the center of the left unit of decking, on the "A" and "B" sides of the bridge, at the level of the decking. Targets may be on the decking or on the bridge.

At their discretion, judges may impose a penalty for a bridge that incorporates parts having the primary function of interfering with placement of targets or measuring devices.

Position measuring devices on the three vertical deflection targets.

Uniformly distribute 100 pounds of preload on the left decking unit and uniformly distribute100 pounds of preload on the right decking unit. Preloads are laterally centered on the decking units. Preloads are distributed and aligned identically for every bridge.

If a competitor disturbs a measuring device after it has been initialized and before the measurement is recorded, the judge will require the team to disassemble the bridge and repeat timed construction. Scoring will be based on the larger of the two construction times but will not exceed 125% of the initial construction time.

The two steps (increments) of vertical loading produce three measurements that the spreadsheet will total automatically to compute the aggregate deflection.

- D1A = value of downward vertical deflection at the left target on the “A” side that occurs during step 1 (loading the left decking unit).
- D1B = value of downward vertical deflection at the left target on the “B” side that occurs during step 1 (loading the left decking unit).
- D2 = absolute value of vertical deflection at the right target that occurs from the beginning of step 1 to the end of step 2 (loading the right decking unit with the load from step 1 remaining in place).

Step 1
Loading the left unit and measuring deflections at those targets

- The two 100-pound preloads remain in place.
- Initialize the sway measurement.
- Initialize the measuring devices on all three vertical deflection targets or record the initial readings.
- Team members place 1150 pounds of additional load on the left decking unit. The 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.
- As the load is being placed, observe sway and deflection. Stop loading if
    a. sway exceeds one inch from the beginning of step 1 or
    b. deflection at any of the three vertical deflection targets exceeds two inches downward from the beginning of step 1 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. Remove the load and **do not continue load testing**. Check the appropriate box on the judge’s data form. The scoring spreadsheet will add an 800-pound penalty to the weight of the bridge, a penalty of thirty minutes to the construction time, and will apply an aggregate deflection of thirty inches when the judging data is entered.

If the bridge passes step 1, record the measured values D1A and D1B.

Step 2
Loading the right unit and measuring deflection at that target

- The two preloads and the load from step 1 remain in place.
- Do **not** re-initialize the sway measurement.
- Do **not** re-initialize the measuring devices on the deflection targets.
- Team members place 1150 pounds of additional load on the right decking unit. The 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.
- As the load is being placed, observe sway and deflection. Stop loading if
    a. sway exceeds one inch from the beginning of step 1 or
    b. deflection at any of the three vertical deflection targets exceeds two inches downward from the beginning of step 1 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. Remove the load and **do not continue load testing**. Check the appropriate box on the judge's data form. The scoring spreadsheet will add a 700-pound penalty to the weight of the bridge, a penalty of thirty minutes to the construction time, and will apply an aggregate deflection of thirty inches when the judging data is entered.

If the bridge passes step 2, record the measured value D2.

If the bridge collapses during unloading (situation c, d or e), it shall be penalized as if it had failed to pass step 2.

13. EQUIPMENT PROVIDED BY HOST

The Competition Guide at http://www.nssbc.info should be reviewed by judges, host personnel, and competitors. It has detailed descriptions and illustrations of contest procedures and hosting equipment. The following partial list is intended to help competitors know what to expect. Competitors should acquire similar equipment for use in practice and testing before the competition.

13.1. Floor

The floor in both the construction site and loading area shall be solid, stable and as nearly flat and level as possible.

13.2. Lateral Load Device

Capable of applying a fifty-pound force in the horizontal direction.

13.3. Equipment for Measuring Sway

Sway is horizontal translation and is measured by any accurate method. A suggested method is to suspend a plumb bob from the sway target and measure sway from a point marked on the floor.

13.4. Equipment for Measuring Deflection

Deflection is vertical translation and is measured at three points by any accurate method.

13.5. 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 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 of the grating that are perpendicular to the length.

13.6. Safety Supports

The safety supports must be used during load testing and are intended to limit the consequences of a bridge collapsing. The 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, timbers, sand bags, or masonry units.

13.7. Load

2500 pounds total. The load 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.

13.8. String

A string is stretched between the holes specified in section 9.4 in order to identify the nominal centerline of the bridge, which guides checking dimensions (rules 9.2.1 and 9.2.2) and placing the decking and load (rule 12.5).

13.9. Official Scoring Spreadsheet and Data Forms

Results will not be official until the completed official scoring spreadsheet is submitted to aftbq@uaa.alaska.edu to report outcomes. It may be downloaded at http://www.nssbc.info. Judges' forms for recording data are accessed from the spreadsheet.

14. INTERPRETATION OF RULES

The web site http://www.aisc.org/steelbridge lists answers to questions about 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 10, 2010.

15. 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.

16. APPEALS

16.1. Conference Competitions

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

16.1.2. A penalty, decision, measurement, score, or condition of competition may be appealed only by a 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 not hear the appeal if he or she is approached by students other than the team captain. The CHJ will hear the appeal as soon as possible and may interrupt the competition. Participants are reminded that civility and ethical behavior are expected during the competition and particularly concerning appeals.

16.1.3. After the conference competition, the team captain has the option to appeal the decision of the CHJ by sending an e-mail message to Ms. Shanna Quinn <quinn@aisc.org> followed by a letter mailed to Ms. Quinn (AISC, Suite 700, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to ASCE Student Services (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The e-mail message and letter shall include

- name of the college or university making the appeal,
- team captain's name, e-mail address, postal address, and telephone number,
- faculty adviser's name, e-mail address, postal address, and telephone number,
- brief description of the problem,
- action taken at the competition to deal with the problem,
- action that the appealing team feels should have been taken,
- data showing that the team should have qualified for national competition, and
- team captain's signature (letter only).

Appeals must be made by e-mail followed by letter. An appeal will be considered only if the e-mail is received and the letter is postmarked by 5:00 PM Eastern Daylight Saving Time on the Wednesday immediately after the conference competition. Ms. Quinn will forward the appeal to the ASCE/AISC 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 aftbq@uaa.alaska.edu. 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.

16.2. National Competition

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

16.2.2. 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.

16.2.3. 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 ASCE/AISC SSBC Rules Committee. The conditions at issue will not be changed during deliberation.

16.2.4. If the team has justification to contest the NHJ's ruling, the team captain has the option to appeal that decision directly to the ASCE/AISC 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.

16.2.5. The decision of the ASCE/AISC SSBC Rules Committee is final; there are no further appeals. However, AISC and ASCE welcome written suggestions for improving future competitions.

17. SUMMARY OF SCORING

This form summarizes chapter 7, "Scoring." However, official scoring data shall be recorded on the scoring spreadsheet that is available in the Competition Guide at http://www.nssbc.info. That spreadsheet also is useful for a team to compare alternative designs and construction procedures. The completed official scoring spreadsheet for a conference competition shall be submitted to aftbq@uaa.alaska.edu. Conference results are not final until the spreadsheet is submitted by the host organization. Questions and comments regarding the spreadsheet should be sent to aftbq@uaa.alaska.edu.

17.1. Display (see section 7.1 - Judges shall not declare ties in display.)

- Appearance: balance, proportion, elegance, finish.
- Name of college or university on bridge in letters at least one inch high.
- Poster describing design and fabrication, no larger than 2 x 3 feet.

DISPLAY SCORE = _____

17.2. Construction Speed and Time Penalties

Construction clock time, CT		_____	minutes
Repair time, RT (see 11.9)		_____	minutes
If (CT + RT) ≤ 30 minutes, enter CT			
If 30 < (CT + RT) ≤ 45, enter 180 (see 11.6)		_____	minutes
Time penalties during construction (see 11.7)			
11.7.1 and 2: violations _____	x 1/2	+ _____	minutes
11.7.3: violations _____	x 1/4	+ _____	minutes
Repair time, RT (see 11.9) _____	x 1.5	+ _____	minutes
Time penalties during repair (see 11.7, 11.9)			
11.7.1 and 2: violations _____	x 1/2 x 1.5	+ _____	minutes
11.7.3: violations _____	x 1/4 x 1.5	+ _____	minutes
Time penalty, damage (see 12.2)		+ _____	minutes
Time penalty, load tests, 30 min (see 12.4 and 12.5)		+ _____	minutes
TOTAL TIME		= _____	minutes

Lowest total wins.

17.3. Construction Economy

Number of builders, including barges		(_____ builders
Total time (from part 17.2)		x _____ minutes
		x $50,000)
Number or temporary piers: minimum of 1 (see 7.3)		+ (_____
		x $50,000)

CONSTRUCTION COST: C_c = $ _____

Lowest cost wins.

17.4. Lightness and Weight Penalties

Bridge weight _____ pounds

Weight penalties,

- 7.1, "Display" (30, 50, or 80) + _____ pounds
- 9.2, "Usability"
  - Rules violated ≤ ½ inch _____ x 50 + _____ pounds
  - Rules violated ½ - 1 inch _____ x 150 + _____ pounds
  - Rules violated 1 - 2 inch _____ x 300 + _____ pounds
- 9.3, "Member-to-member Connections"
  - Number of violations _____ x 25 + _____ pounds
- 9.4, "Nominal Centerline" (100) + _____ pounds
- 10.2, "Durability & Constructability"
  - Number of violations _____ x 25 + _____ pounds
- 12.4 and .5, "Lateral Load" and "Vertical Load" (900, 800 or 700) + _____ pounds

TOTAL WEIGHT = _____ pounds

Lowest weight wins.

17.5. Stiffness

AGGREGATE DEFLECTION: D1A + D1B + D2 = _____ inches

Lowest deflection wins.

17.6. Structural Efficiency

Total weight (from part 17.4) (_____ pounds

x $4000)

Aggregate deflection (from part 17.5) + [(_____ inches)$^{1.5}$

x $1,200,000]

STRUCTURAL COST: C_s = $ _____

Lowest cost wins.

17.7. Overall Performance

C_c (from part 17.3) _____ + C_s (from part 17.6) _____ = $_____

Lowest total wins.

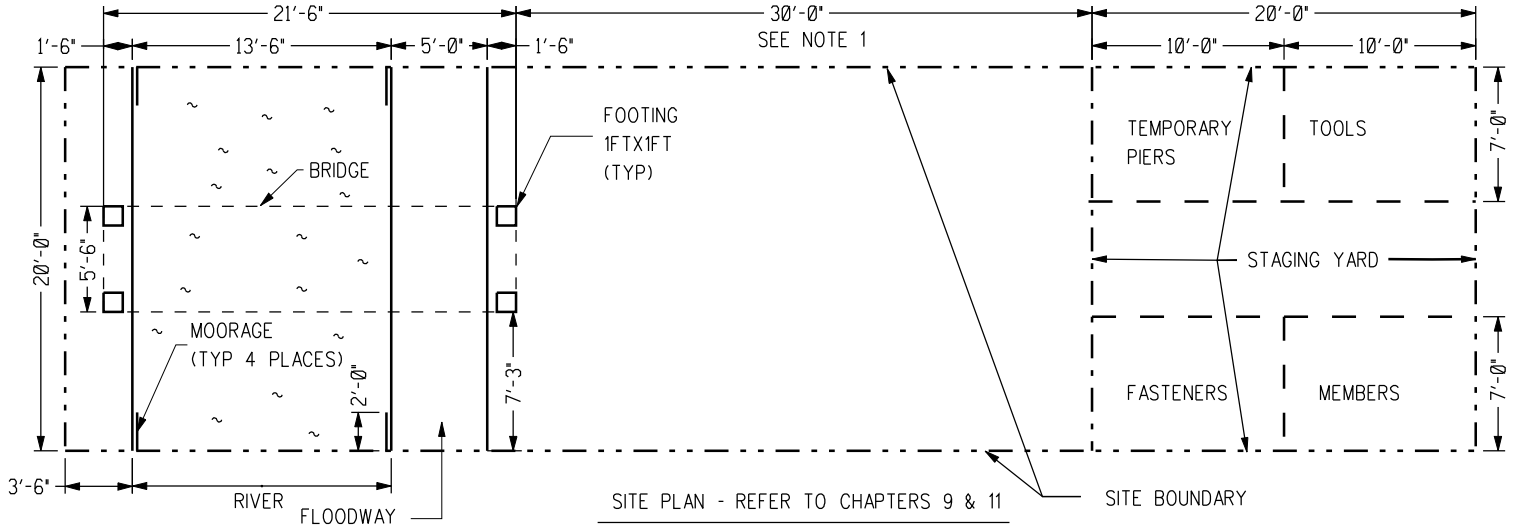
17.8. Ranks (Display is the tie-breaker for all categories)

A bridge will not be ranked if it was not approved for construction or load testing.

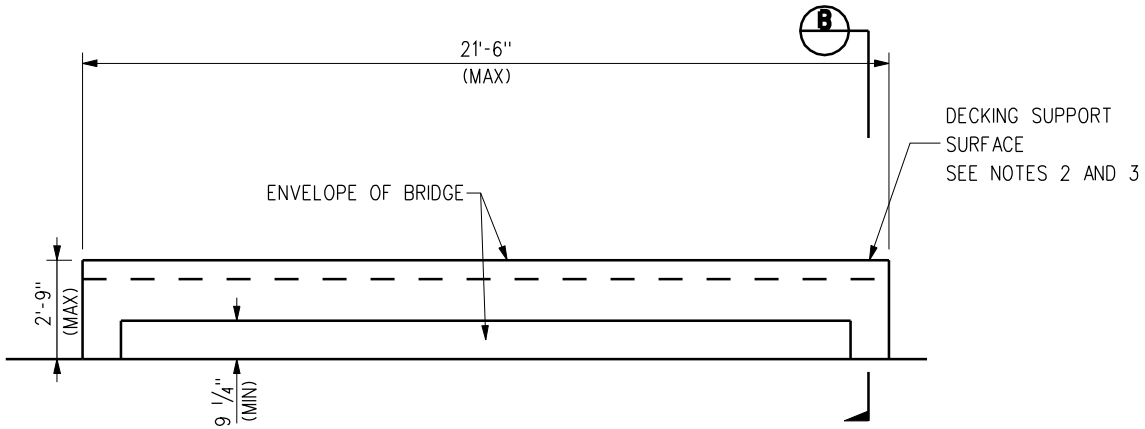
Display _____ Construction Speed _____ Lightness _____

Stiffness _____ Construction Economy _____ Structural Efficiency _____

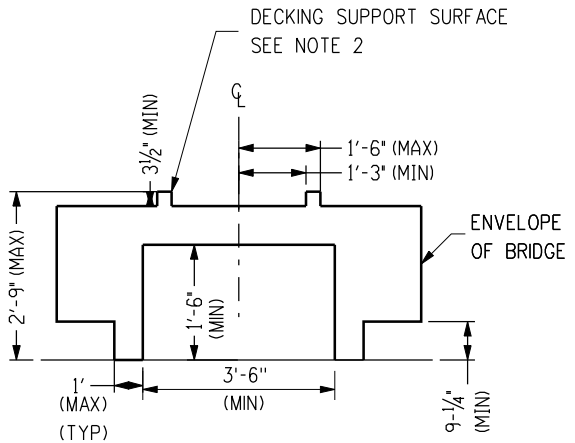
Overall Performance _____



SITE PLAN - REFER TO CHAPTERS 9 & 11



ELEVATION - REFER TO CHAPTER 9



B END VIEW
NO SCALE

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 BRIDGE SHALL EXTEND BEYOND DECKING SUPPORT SURFACE (AT BOTH ENDS).

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION
A	8-14-09						2010 SSBC RULES

DESIGNED BY: F. HATFIELD
DRAWN BY: D. SEPULVEDA
CHECKED BY: RULES COMM.
IN CHARGE: N. GAVLIN
DATE: 7-15-2009

ASCE - AISC
STUDENT STEEL BRIDGE CONTEST

ASCE American Society of Civil Engineers

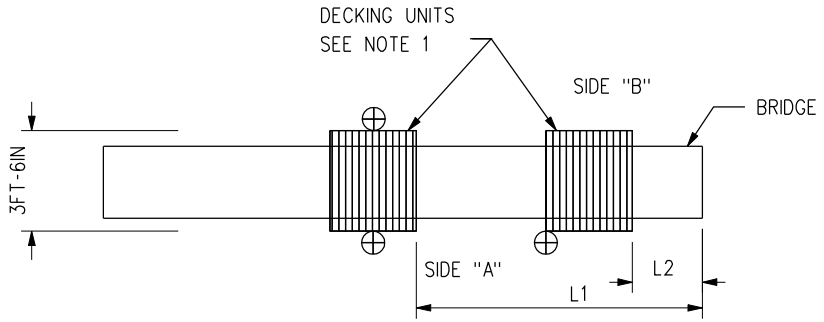
SUBMITTED
APPROVED

SITE AND BRIDGE

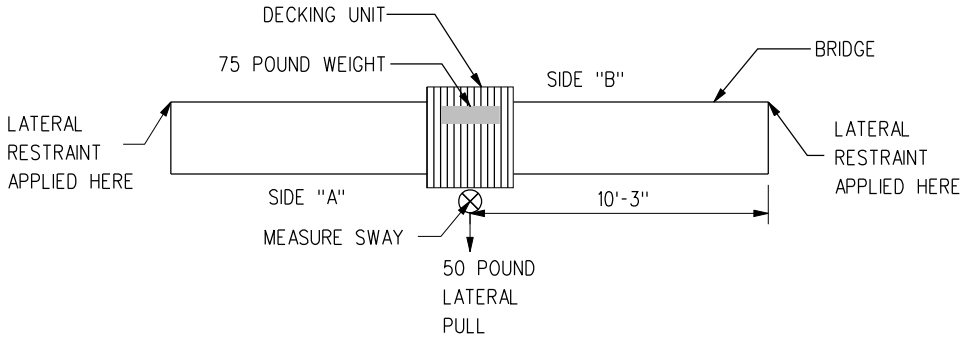
DIAGRAM

CONTRACT NO
DRAWING NO: EXHIBIT 1
REV
SCALE: AS SHOWN
SHEET NO

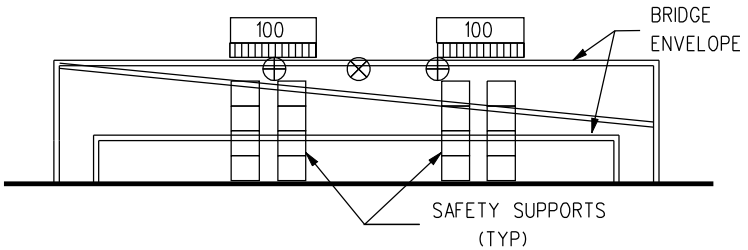
Plotted by: $USERS
$FILES



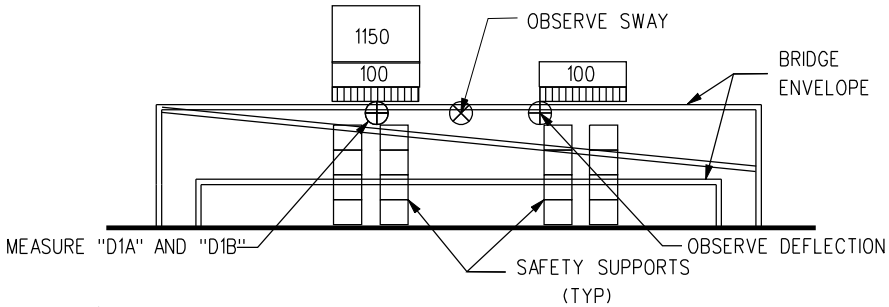
A LOCATIONS OF TARGETS AND DECKING - PLAN
REFER TO CHAPTER 12, SECTIONS 3 & 5



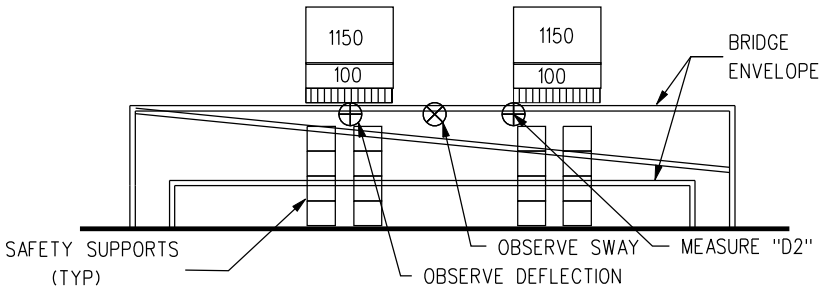
B LATERAL LOAD TEST - PLAN
CHAPTER 12, SECTIONS 3 & 4



0 VERTICAL LOAD TEST - PRELOAD
REFER TO NOTES DURING LOADING PROCESS



1 VERTICAL LOAD TEST - STEP 1
REFER TO NOTES DURING LOADING PROCESS



2 VERTICAL LOAD TEST - STEP 2
REFER TO NOTES DURING LOADING PROCESS

LEGEND

⊕ TARGETS FOR MEASURING VERTICAL DEFLECTION

⊗ TARGET FOR MEASURING SWAY

NOTES

1. THE LOAD IS LATERALLY CENTERED ON THE DECKING UNIT AND DISTRIBUTED OVER THE LENGTH OF THE DECKING UNIT AS UNIFORMLY AS POSSIBLE AT ALL TIMES DURING LOADING.
2. OBSERVE ALL VERTICAL TARGETS ON EACH SIDE OF THE BRIDGE FOR DEFLECTION.
3. LOADING TERMINATES IF DEFLECTION AT ANY OF THE VERTICAL DEFLECTION TARGETS EXCEEDS 2 INCHES DURING STEP 1 AND STEP 2.
4. LOADING TERMINATES IF SWAY AT SWAY TARGET EXCEEDS 1 INCH DURING STEP 1 AND STEP 2.
5. SAFETY SUPPORT TO BE IN PLACE AT ALL TIMES DURING LOADING.
6. BRIDGE TO BE UNLOADED IN THE REVERSE ORDER OF LOADING.
7. ALL LOADING SAFETY PROCEDURES TO BE FOLLOWED.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION
A	8-14-09						2010 SSBC RULES

DESIGNED BY: F. HATFIELD
DRAWN BY: D. SEPULVEDA
CHECKED BY: RULES COMM.
IN CHARGE: N. GAVLIN
DATE: 7-15-2009

ASCE - AISC
STUDENT STEEL BRIDGE CONTEST

ASCE American Society of Civil Engineers

SUBMITTED _____
APPROVED _____

BRIDGE LOADING

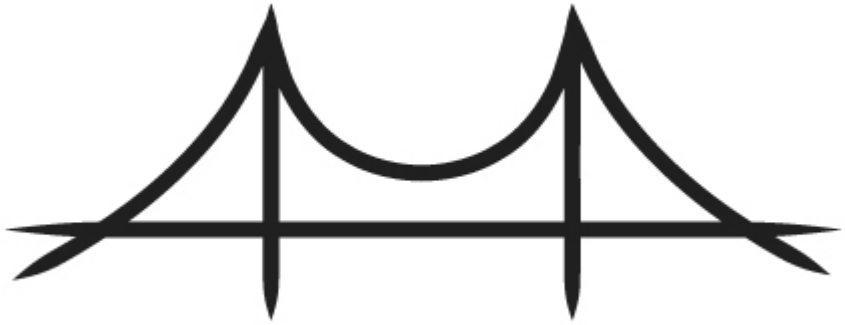
DIAGRAM

CONTRACT NO
DRAWING NO: EXHIBIT 2
REV
SCALE: AS SHOWN
SHEET NO

Plotted by: $USERS
$FILES
$DATES

STUDENT STEEL BRIDGE COMPETITION

2009 RULES



The mission of the ASCE/AISC 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 issues such as spatial constraints, material properties, strength, serviceability, fabrication and erection processes, safety, esthetics and cost. Success in inter-collegiate competition requires effective team work and project management. Future engineers are stimulated to innovate, practice professionalism and use structural steel efficiently.

TABLE OF CONTENTS

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.html. Revisions and clarifications do not appear in this document but are considered formal addenda to the *Rules*.

1. INTRODUCTION

The Student Steel Bridge Competition is sponsored by the American Society of Civil Engineers (ASCE) and the American Institute of Steel Construction (AISC), and co-sponsored by the American Iron and Steel Institute, the Canadian Institute of Steel Construction, the James F. Lincoln Arc Welding Foundation, the National Steel Bridge Alliance, the Nucor Corporation, and the Steel Structure Education Foundation.

Students design and erect a steel bridge by themselves but may seek advice from faculty and student organization advisers. Students gain maximum benefit from the experience 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, volunteers, and spectators.

This document describes the competition and states the rules for this year. It is available at http://www.aisc.org/steelbridge.html, together with related information. These rules govern competition at both regional and national levels. Additional information is available at http://www.nssbc.info. Information and rules at http://www.aisc.org/steelbridge.html will govern if there is a conflict between the two sites.

The rules are changed every year to enhance the competition and assure 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 chapter “14 Interpretation of Rules.” Revisions to the rules, if any, will be incorporated in the clarifications that appear on the web page cited in that chapter.

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 gain practical experience in structural design, fabrication processes, construction planning, organization, and teamwork.

The rules of the competition simulate a request for proposal that requires a scaled model to demonstrate the efficacy of competing designs. Chapter "6 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 regulations 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 (Department of Transportation) and have the authority to accept and reject entries.

The safety of competitors, judges, volunteers, and spectators is paramount. Risky procedures are prohibited, and bridges that cannot be constructed and tested 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.

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

3. ELIGIBILITY

3.1. Regional Competition

There are two levels of competition: regional and national. Regional competitions are held in conjunction with ASCE student conferences. 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.

The ASCE student organizations entering regional competitions are required to be current with their national dues and annual reports. A team must consist only of undergraduate and graduate students in good standing with their ASCE student organization.

The conference host organization may invite a student team to participate as a guest if that team does not have an ASCE student organization that meets the requirements of the preceding paragraph or has been assigned to a different conference. Such guest teams will not be ranked in the competitions nor will they be invited to compete in the National Student Steel Bridge Competition.

An ASCE student organization will not be permitted to participate in the National Student Steel Bridge Competition unless it competes in the ASCE regional conference to which it has been assigned and satisfies ASCE requirements regarding participation in that conference. These requirements, as they existed in July, 2008, are reprinted in section 3.3. The requirements are subject to change; the most recent version is on the web page http://content.asce.org/student/eligibility.html.

The official scoring spreadsheet for a regional competition must be submitted to aftbq@uaa.alaska.edu before the eligible teams from that region will be invited to the national competition.

3.2. National Competition

Invitations to compete at the national level are extended only to the eligible winner from an ASCE student conference in which two, three, or four ASCE student organizations competed in the Student Steel Bridge Competition, to the top two eligible teams from a conference in which five to ten ASCE student organizations competed, and to the top three eligible teams from a conference with eleven or more competing ASCE student organizations. Guest teams and teams that did not present credible bridges will not be counted when determining how many teams will be invited from a conference. Guest teams will not be invited to the national competition. Only one bridge per college or university may be entered in the national competition.

3.3. ASCE National Competition Eligibility Requirements

The following paragraphs on this page were transcribed from the ASCE web page http://content.asce.org/student/eligibility.html on July 18, 2008; that page should be consulted for the most recent version. 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 Activities (CSA) 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:

1. Be in good standing with ASCE (annual report and annual dues submitted and received by ASCE prior to the start of the Student Conference).
2. 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.

4. RULE CHANGES

The following list covers some of the major changes from the 2008 rules. Not all changes are listed. Contestants, hosts, and judges are cautioned to **read this entire document carefully and disregard rules and clarifications from previous years**.

1. A deck bridge is required (i.e., the entire superstructure is below the deck).
2. Required clearances have changed.
3. Decking support surfaces must not have vertical protrusions.
4. Threaded holes are not allowed (e.g., nuts shall not be welded to members).
5. There is only one staging yard.
6. There are no revetments.
7. Assemblies are not permitted.
8. Builders may partially support the constructed portion.
9. Costs have changed.
10. The official scoring spreadsheet for a regional competition must be submitted before appeals are considered and before teams are invited to the national competition.

5. SAFETY

Safety has the highest priority. Judges are empowered to halt any activity that they deem hazardous. Judges will stop construction procedures that could cause personal injury. Judges will not allow additional load to be placed on a bridge that has collapsed, that is approaching a collapse that could be dangerous, or that has swayed or deflected in excess of specified limits. A bridge that cannot be safely constructed or load tested using the equipment provided by the host is not eligible for awards in any category and must be withdrawn from participation.

6. PROBLEM STATEMENT

A century-old highway bridge that spans a scenic river must be replaced. The bridge carries traffic serving residences and resorts that are the foundation of the economy for this rural region. A quick replacement is necessary because no other crossing is available for miles.

The state Department of Transportation (DOT) has requested design/build proposals for replacing the existing bridge. A deck bridge is specified to provide unobstructed views of the river and surrounding scenery. Clearance under the bridge must be provided for passage of kayaks and similar small craft. In addition, the bridge must straddle the right-of-way for a proposed multi-use trail bridge. The DOT has specified steel as the material because of its fast erection and exceptional sustainability rating, based on durability and high level of recycled content. The bridge must be able to carry specified patterns of loads without exceeding sway and deflection limits. Based on past experience with performance and maintenance, the DOT prefers bridges that are relatively light and stiff. The new bridge must accommodate modular decking that was salvaged from another structure.

Due to environmental concerns, construction of permanent piers is permitted only on the existing footings. However, temporary piers may be used. Construction barges are permitted in the river. The floodway adjoining the river is too shallow for barges and too wet for terrestrial construction machinery. Soil conditions limit the weight of loads that may be moved. Site conditions allow construction only from one bank and from barges.

Your company's design/build proposal is among those that the DOT has deemed responsive, and winning the contract would be a step toward becoming a leader in the bridge replacement market. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. A panel of DOT personnel will judge the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy, and display. The contract will be awarded to the company whose model best meets the DOT’s needs and requirements. 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 rejection of the model and termination of the company’s eligibility.

7. SCORING

A bridge will not be ranked if it is entered by an organization that is not in good standing with ASCE or that is competing in a conference to which it has not been assigned by ASCE. A college or university may enter only one bridge in regional competition and may participate in only one regional competition.

Categories of competition are display, construction speed, lightness, stiffness, construction economy, and structural efficiency. In addition, overall performance is rated. A bridge that was not approved for load testing or that failed in load testing is not eligible for awards in any category.

7.1. Display

Display is the tie-breaker for all categories of competition. Judges shall not declare ties in display. The bridge is displayed exactly as it will be erected during timed construction. Display is judged by

7.1.1. Appearance of bridge, including balance, proportion, elegance, and finish. Quality of fabrication shall not be considered because some bridges may be fabricated professionally while others are student work.

7.1.2. Permanent identification of the bridge consisting of the name of the college or university exactly as shown on the ASCE register available at http://content.asce.org/student/websites.html. The name must appear on the bridge in letters at least one inch high and must be formed from steel or applied to steel with paint or decals. A thirty-pound weight penalty will be imposed if the bridge lacks appropriate identification.

7.1.3. Poster describing design. The poster must 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. The poster must identify the college or university with the same name that appears on the bridge and must present a brief explanation of why the overall configuration of the bridge was selected, a brief computation demonstrating design for one limit state, a scaled, dimensioned side view of the bridge, and acknowledgment of companies, university technicians, faculty, and others who helped fabricate the bridge or provided advice. Sustainability of the design is indicated by listing or designating on the drawing those parts of the bridge that were salvaged from previous bridges or projects, or obtained from salvage yards. Additional information may be included. Electronic displays, decorated supports, lights, and sound are not permitted and will result in the worst possible rating for the poster. A fifty-pound weight penalty 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.

7.2. Construction Speed

The bridge with the lowest total time will win in this category. Total time is defined as the time required for construction, modified by penalties prescribed in sections 11.6, 11.7, 11.9, 12.2, 12.4, and 12.5, plus 150% of repair time (see section 11.9), There is an upper limit on construction time (see section 11.6).

7.3. Construction Economy

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

C_c = Total time (minutes) x Number of builders (including barges)
x 50 thousand dollars per builder-minute
+ 50 thousand dollars for one temporary pier even if none is used
+ 50 thousand dollars for each additional temporary pier.

Total time is defined in section "7.2 Construction Speed" and includes penalties. The number of builders includes all members and associates of the competing organization who are within the construction site or physically assist the team at any time during timed construction.

7.4. Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in sections "7.1 Scoring: Display," "9.2, 9.3, and 9.4 Usability, Member-to-member Connections, and Nominal Centerline," "10.2 Durability and Constructability" and "12.4 and 12.5 Lateral Load Test and Vertical Load Test." Decking, tools, temporary piers, and poster are not included in total weight.

7.5. Stiffness

The bridge with the lowest aggregate deflection will win in the stiffness category. Aggregate deflection is determined from measurements as prescribed in section "12.5 Vertical Load Test."

7.6. Structural Efficiency

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

C_s = Total weight (pounds) x 5 thousand dollars per pound
+ Aggregate deflection (inches) x 700 thousand dollars per inch.

Total weight is defined in section "7.4 Lightness" and includes penalties. Aggregate deflection is defined in "7.5 Stiffness" and includes penalties.

7.7. 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.

8. SCHEDULE OF COMPETITION

In the months before the competition, students design their bridges, fabricate members, test load, practice construction, and select a member of the team to serve as its captain. The following events occur during the competition

1. 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, erection, and repairs as described in section "11.9 Construction: Repairs."
2. Bridges are disassembled.
3. In a meeting at which all team captains are present, the head judge clarifies rules and conditions of the competition and answers questions.
4. The head judge selects the locations of loads. See section "12.5 Vertical Load Test" and the "Locations of Targets and Decking" detail on the "Bridge Loading" diagram. Selection is done in the presence of the team captains by rolling a die twice. Let S1 and S2 be the spots from the two rolls and let L1 and L2 be dimensional locations of decking units in inches.

   $$L1 = 40 + 6\,(S1) \quad \text{and} \quad L2 = 110 + 6\,(S2)$$

   The same locations will be used for all bridges in the competition.
5. Bridge members, fasteners, tools, and temporary piers are staged for construction and inspected by the judges. See chapter "10 Material and Components," rules 9.3.2 and 9.3.3, and section "11.4 Start" for details.
6. Timed construction. See chapter "11 Construction" for details.
7. Judges inspect assembled bridges. For details, see chapter "9 Dimensions and Support" (including rules 9.3.2 and 9.3.3 as they apply to installation of fasteners) and rules 10.1.2 and 10.1.3.
8. Bridges are weighed (if it is impractical to weigh the entire bridge, its parts may be weighed prior to construction).
9. Load testing. See chapter "12 Load Tests" for details.
10. Scores and rankings are determined using the official scoring spreadsheet found at www.nssbc.info and the host ASCE student organization submits the completed official scoring spreadsheet by e-mailing it to the address given on that spreadsheet, which is aftbq@uaa.alaska.edu.
11. Summary score sheets can be printed from the official scoring spread-sheet and are distributed to all teams or posted on the host's web site.

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

- bridges are not modified after selection of load locations,
- bridges are not modified between display judging and timed construction,
- no components or tools are added to or removed from the construction site after staging and inspection, and
- modifications between timed construction and load testing are limited to repairs as described in "11.9 Repairs."

9. DIMENSIONS AND SUPPORT

Dimensions and support will be checked with the bridge in its as-built condition after construction is completed 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 any applied load on the bridge.

9.1. Functionality and Safety

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

9.1.1. The bridge must span the river and floodway completely without touching them. See the "Site Plan" on the "Site and Bridge" diagram.

9.1.2. The bridge must provide support for the decking for the full overall length of the bridge along both of the edges that run in the span direction of the bridge. See the "Elevation" on the "Site and Bridge" diagram.

9.1.3. The bridge must provide access for placing the decking and load.

9.1.4. The decking must not be attached or anchored to the bridge, and it must not be used to distort the bridge from its as-built condition.

9.1.5. The bridge must not be anchored or tied to the ground.

9.1.6. It must be possible to construct and load the bridge safely using equipment provided by the host student organization. **Bridges must accommodate local conditions.**

9.2. Usability

A weight penalty will be assessed for each rule in this section (9.2) that is violated, rather than for every violation of that rule.

The penalty for violation of each of the following rules will be an addition to the weight of the bridge determined as follows

- 50 pounds for a dimensional violation of ½ inch or less;
- 150 pounds for a dimensional violation greater than ½ inch but not exceeding 1.0 inch;
- 300 pounds for a dimensional violation greater than 1.0 inch but not exceeding 2.0 inches;
- If a dimensional violation exceeds 2.0 inches, the bridge will not be approved for load testing and will not be eligible for awards in any category.

9.2.1. The bridge must bear on the ground only within the one-foot by one-foot squares that are marked on the construction site to represent existing footings. See the “Site Plan” on the “Site and Bridge” diagram.

9.2.2. Decking support surfaces must not be more than 20’0” long and must extend for the overall length of the bridge.

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

9.2.4. The bridge must be able to accommodate solid decking at all points along the length of the bridge.

9.2.5. The lateral distance from the nominal centerline to the outer edge of the outermost decking support surface on each side of the bridge must not be less than 1’3”. See the “Decking Support” detail on the “Site and Bridge” diagram.

9.2.6. The lateral distance from the nominal centerline to the inner edge of the outermost decking support surface on each side of the bridge must not be more than 1’6½”. See the “Decking Support” detail on the “Site and Bridge” diagram.

9.2.7. The decking support surfaces must not have gaps exceeding ¼ inch measured in the span direction of the bridge.

9.2.8. The decking support surfaces must be smooth, without vertical protrusions or abrupt changes in elevation. This rule may be checked by sliding a decking unit or template along the full overall end-to-end length of the decking support surfaces.

9.2.9. The decking support surfaces must be no more than 2’6” above the surface of the ground or river at any point. See the “Elevation” on the “Site and Bridge” diagram.

9.2.10. No part of the bridge shall extend above the decking support surfaces at any transverse section along the length of the bridge.

9.2.11. Clearance must be provided under the bridge at all points directly over the river, floodway, and ground, except directly over the footings. The clearance must be at least 5½” high, measured from the surface of the river, floodway, and ground. See the “Elevation” on the “Site and Bridge” diagram.

9.2.12. A straight passageway under the bridge must completely traverse it from end to end. It must be at least 2’0” high measured from the surface of the river and ground, must be at least 3’0” wide measured perpendicular to the nominal centerline, and must pass between the footings at each end of the bridge. See the “End View” on the “Site and Bridge” diagram.

9.3 Member-to-member Connections

Violations of the rules in this section (9.3) will result in penalties being added to the weight of the bridge. The penalty for each violation is 25 pounds.

9.3.1. Each member must be connected directly to every member that it touches by at least one fastener installed during timed construction so that the connection cannot be taken apart without first turning and removing a nut from the bolt. Rules governing members and fasteners are stated in chapter 10.

9.3.2. The bolt must penetrate completely through a hole in each of the members that it connects. Dimension(s) of the hole must be small enough so that neither the head of the bolt specified in rule 10.2.8 nor the nut specified in rule 10.2.9 can pass through the hole.

9.3.3. The hole for a fastener shall not be threaded. It must be possible to install and remove the bolt without turning it.

9.3.4. The bolt must fully engage the threads of the nut(s). That is, the end of the bolt must extend beyond, or be flush with, the outer surface of the outermost nut.

9.4. Nominal Centerline

A weight penalty of 100 pounds will be assessed if any of the requirements in this section (9.4) is violated or if some feature of the bridge prevents the judge from stretching a string along a designated straight nominal centerline.

9.4.1. The bridge must have a designated straight nominal centerline extending from one end to the other. The centerline must be designated by two holes, one at each end of the bridge, drilled vertically through horizontal steel surfaces at the level of the decking support surfaces. Each hole must be approximately ¼ inch in diameter and must be located no more than 3’0” from the vertical plane defined by the ends of the decking support surfaces.

10. MATERIAL AND COMPONENTS

10.1. Safety

If any one of the following rules in this section (10.1) is violated, the bridge will not be approved for construction or load testing, and will not be eligible for awards in any category.

10.1.1. A member must not weigh more than twenty pounds. See section 10.2 for definition of "member."

10.1.2. A bridge must 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.

10.1.3. After completion of timed construction, energy must not be transmitted to or from a bridge (for example, by applying or releasing mechanical, magnetic, fluidic, or other force; by sound, light, radio, or other wave or ray; by conduction or convection of heat; or by electric current). The exceptions are forces necessary to the competition (for example, those associated with load testing and with moving the bridge from place to place), and changes in ambient conditions that are not controlled by contestants (such as wind, temperature, and lighting).

10.2. Durability and Constructability

Violation of the following rules in this section (10.2) will result in penalties being added to the weight of the bridge. The penalty for each violation is 25 pounds.

Bridge

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

10.2.2. A bridge must be constructed only of members and fasteners.

Members

10.2.3. A member is a rigid steel component that retains its shape and dimensions during timed construction and in the completed bridge.

10.2.4. A member must not exceed overall dimensions of 3'6" x 6" x 6." That is, it must fit in a prismatic box of those dimensions.

10.2.5. A member must 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. Exception: Deformations caused by mechanical strain (e.g., bending, stretching) during load testing are not violations.

10.2.6. A member may consist of multiple parts rigidly joined together before timed construction begins. Those parts must remain rigidly joined throughout timed construction and in the completed bridge. Parts must be joined by welding or with steel connectors such as bolts, screws, and rivets. If nuts are used, their threads must be fully engaged (that is, the end of the bolt or threaded stud must be flush with or extend beyond the outer face of the nut).

Fasteners

10.2.7. A fastener is a steel bolt that is not part of a member, with at least one steel nut that is not part of a member. The specified bolts and nuts usually are available in hardware stores.

10.2.8. The bolt in a fastener must be no more than three-inch nominal length (bottom of head to end) with a hexagonal head, and it must have the configuration and dimensions of an A325 or A490 high-strength bolt or of a non-high-strength hex or heavy hex bolt as listed in Tables 7-15 and 7-20, respectively, of the *Steel Construction Manual* (AISC, thirteenth edition). Bolts shall not be mechanically altered or modified in any way but may be painted.

10.2.9. The nuts in a fastener must match the bolt. That is, the nominal size (inside diameter) must be the same as that of the bolt and the threads of the nuts must fully engage the threads on the bolt and permit the nuts to be turned onto the bolt. Nuts must be solid, hexagonal, and have the configuration and dimensions of an A563 nut or of a non-high-strength hex or heavy hex nut as listed in the tables cited in rule 10.2.8. Nuts must not be mechanically altered or modified in any way but may be painted.

10.2.10. Nuts and bolts that connect the parts of a member but do not connect a member to other members are not considered to be fasteners and are not governed by rules 10.2.7, 10.2.8, and 10.2.9.

11. CONSTRUCTION

11.1. Definitions

11.1.1. “River,” “floodway,” “staging yard,” “footing,” “moorage” and construction “site boundary” are defined by the “Site and Bridge” diagram. “Ground” is the entire floor, both inside and outside the site boundary, except for the river.

11.1.2. “Builders” are undergraduate or graduate student members of a competing student organization. See chapter 3 for eligibility requirements.

11.1.3. A “barge” is a builder who is designated to begin, remain, and end timed construction in the river. Builders cannot be designated as barges after the start of timed construction and builders so designated remain barges for the duration of timed construction. The use of barges is optional. Barges are counted as builders.

11.1.4. A “team” is all the builders from the competing organization who are in the construction site during timed construction. The team shall include no more than six builders. No more than three of those builders shall be designated as barges.

11.1.5. “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.

11.1.6. 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.

11.1.7. “Temporary piers” are optional devices that bear on the river or ground, and are used to support the constructed portion of the bridge during timed construction. They have no other purpose, are not tools, and are not part of the completed bridge. A team provides its own temporary piers. The construction cost, C_c, includes an increment for one temporary pier even if none is used, plus an increment for each additional temporary pier.

11.1.8. “Member” and “fastener” are defined in section 10.2. “Member-to-member connection” is defined in section 9.3.

11.1.9. To be “moored” means that a barge is in the river with one foot on a portion of the line marking the edge of the river that is designated as a moorage. Only one barge can be moored at each moorage.

11.1.10. The “constructed portion” is created during timed construction by placing members in essentially their final positions. The constructed portion is not required to be contiguous.

11.1.11. When a member is placed in essentially its final position it becomes part of the constructed portion and is no longer considered to be a member.

11.2. Safety

If any rule in this section (11.2) is violated during timed construction, the judge will stop the clock and explain the violation. Before the clock is restarted, builders, tools, members, fasteners, and temporary piers will be returned to the positions they occupied before the violation. Then the team will be asked to resume construction using safe procedures. A team will have the opportunity to construct its bridge safely. However, if the 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.

11.2.1. Builders, judges, volunteers, and spectators must not be exposed to risk of personal injury.

11.2.2. Only builders and judges are permitted within the boundaries of the construction site during timed construction and repair.

11.2.3. At all times during timed construction and repair every builder must wear personal protective equipment in the proper manner (e.g., hardhat with peak in front).

11.2.4. Welding machines and tools requiring external power connections must not be used during timed construction or repair.

11.2.5. A tool must not weigh more than twenty pounds and must not exceed 3’6” in any linear dimension when fully assembled and extended.

11.2.6. A temporary pier must not weigh more than twenty pounds and must not exceed 1’6” in any horizontal dimension.

11.2.7. A tool must not touch a temporary pier.

11.2.8. A temporary pier must not be moved while it is supporting the constructed portion.

11.2.9. A temporary pier must not collapse or fall over while in use.

11.2.10. A temporary pier must bear on the river or ground within the construction site and not be supported or stabilized by a builder while it is supporting the constructed portion.

11.2.11. Lubricant must not be applied during timed construction or within the construction site at any time. Lubricant must not drop on the floor within the construction site.

11.2.12. Throwing anything is prohibited.

11.2.13. A builder must not use the bridge, a portion of the bridge, a 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 a constructed portion if the builder is kneeling on the ground on both knees, kneeling on the ground on one knee with the other foot on the ground, or standing with the heels and toes of both feet on the ground.

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

11.2.15. A builder must not cross the floodway or the river.

11.2.16. A constructed portion must be created in, and remain in, essentially the same location, position, and configuration that it will have in the completed bridge. Exceptions

- A former member that is connected to the constructed portion by only one fastener may rotate relative to the constructed portion.
- Due to lack of support from members that have not yet been connected to the constructed portion, part of it may sag or sway.
- The constructed portion may slide from its final position on the ground as an unintended consequence of construction. However, intentional movement of the constructed portion from its final position is a violation.

For all three exceptions, one or more builders may move all or part of the constructed portion in order to make a connection or correct the position of the bridge on the footings. However, rule 11.7.3 applies.

11.2.17. A member must not contact another member except when it is in its final position and becomes part of the constructed portion.

11.2.18. A member that is not in its final position must not be supported by the constructed portion.

11.2.19. Surfaces of the constructed portion that bear on the ground must be the same surfaces that will bear on the ground in the completed bridge and, after being placed, must remain in contact with the ground for the remaining duration of timed construction and repair.

11.2.20. A builder must not support the constructed portion or a non-contiguous part of the constructed portion unless it also is supported by the ground or a temporary pier.

11.2.21. Outside the staging yard, a builder shall not contribute simultaneously to moving or supporting more than one of the following items: a member, a temporary pier, the constructed portion, or a non-contiguous part of the constructed portion. However, a builder may adjust the constructed portion as permitted by rule 11.2.16 while simultaneously supporting a member or temporary pier.

11.3. 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, including the one-foot by one-foot footings, 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 tape, not the centerlines, designate the lines shown on the "Site Plan."

Only builders and judges are permitted within the boundaries of the construction site during timed construction. Only judges are permitted near the construction site. Spectators, including faculty advisers, must observe from areas designated by the judges and host student organization.

11.4. Start

Before construction begins, all of the following items, and nothing else, are in the staging yard: members, fasteners, tools, and temporary piers. Every member, tool, temporary pier, and fastener must be in contact with the ground. Members must not be connected or touching one another. Tools and fasteners must not be in contact with members. Tools must not be in contact with fasteners. Temporary piers must not be in contact with one another or with members, tools, or fasteners. Builders who are not barges are in the staging yards. Every barge is moored at a different moorage. Barges start without tools and fasteners, which may be passed to them by other builders after timed construction begins. Builders, including barges, are wearing personal protective equipment as well as optional clothing such as pouches.

Immediately after a tool, member, fastener or temporary pier is placed in the staging yard, the judge may inspect it for compliance with the Rules and assess appropriate penalties.

After the beginning of inspection and throughout timed construction and repairs, additional members, 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.

Timing and construction begin when one of the builders signifies that the team is ready and the judge declares the start.

11.5. Time

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

11.5.1. if a builder or judge sees a condition that could cause injury, or

11.5.2. when a safety rule has been violated (see section 11.2), or

11.5.3. 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 section 11.7), or

11.5.4. if a builder or judge is injured.

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

11.6. Time Limit

11.6.1. If construction time exceeds thirty minutes, it will be counted as 180 minutes for scoring. “Accidents” (section 11.7) that occur after thirty minutes will not be penalized but safety rules (section 11.2) will still be enforced. Judges will inform the team when this time limit is approached and again when it is reached.

11.6.2. If construction time exceeds 45 minutes, judges may halt construction or may move the bridge off site if it can be constructed safely. The bridge will not be eligible for awards in any category.

11.7. Accidents

In general, the clock is not stopped when an “accident” occurs. If an accident is continuous (for example, a builder who is not a barge stands in the river) it will be counted as multiple incidents. Builders involved in accidents may continue to build, and items involved in accidents must 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, temporary piers, and fasteners will be returned to the positions they occupied before the accident. Exception: Construction may proceed if it is no longer possible to hold all four bearing surfaces within the footings simultaneously. In this situation, the team captain may request that the clock be stopped in order to demonstrate the difficulty to the judge. If the judge is convinced, no additional accidents will be cited for bearing surfaces touching the ground outside the footings (rule 11.7.3), the clock will be restarted, construction will resume, and a penalty will be assessed for a two-inch violation under rule 9.2.1 (even if the bearing surfaces fall within the footings when the bridge is completed).

Types of accidents and the corresponding time penalties, which will be added to the construction time, are

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

11.7.2. A barge or a barge’s clothing touches ground. Penalty is 1/2 minute (30 seconds) per incident. Exception: There is no penalty for stepping on ground to retrieve an object that has been dropped, such as a member, tool, nut, bolt, or personal protective equipment.

11.7.3. A member, constructed portion, tool, nut, bolt, or personal protective equipment touches the river or ground outside a staging yard. Penalty is 1/4 minute (15 seconds) per incident. Exceptions: (1) There is no penalty for the constructed portion touching the ground within the one-foot by one-foot footings. (2) There is no penalty if a tool used **exclusively** for measuring touches the ground during use while being held by a builder.

11.8. Finish

Construction ends and the clock is stopped when

- the bridge has been completed by connecting all the members that were in the staging yard, and
- temporary piers and builders who are not barges are back in the staging yard, and
- every barge is moored at a moorage, with no more than one barge at each moorage, and
- every tool is in the staging yard, is held by a barge, or is in clothing worn by a barge.

Installation of decking is not included in timed construction.

After construction is finished the bridge must not be modified except as provided by section “11.9 Repairs.”

11.9. Repairs

Before the judges inspect and measure the bridge, and before the bridge is moved from the construction site, two builders will be given five minutes to inspect the bridge for construction mistakes and to plan corrective action. They must not modify the bridge and they must not touch the bridge except as necessary to use measuring devices. Following this inspection, builders will be permitted, but not required, to repair construction mistakes found by their inspectors. Repairs are made with the clock restarted and must be completed in ten minutes or less. Safety precautions (section 11.2) apply and accidents (section 11.7) are counted. The time required to make repairs (including penalties) is multiplied by 1.5. This is added to the construction time to compute total time. Judges will not inspect the completed bridge for violations of rules until after the team captain is satisfied or the time limit for repairs is reached.

12. LOAD TESTS

12.1. Safety Precautions

The judge will halt any activity that he or she considers to be hazardous.

A bridge could suddenly collapse or sway in any direction during load tests. Therefore, the number of people near the bridge while it is being tested shall be minimized. Usually, the load should be placed on the bridge by only two members of the team. Team members who are not participating in loading, faculty, advisers, and other spectators must observe from an area designated by the judges and host student organization.

While participating in load testing, competitors must wear hardhats meeting ANSI standard Z89.1, protective eyewear or safety goggles meeting ANSI standard Z87.1, 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.

During testing, safety supports must be in place below the decking. The safety supports shall be of sufficient height, strength, number, and extent that none of the load will fall more than approximately six inches if the bridge collapses.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a portion of the decking that is cantilevered over its support.

When any portion of the load is on the bridge, no one is permitted to crawl, reach, or step under the bridge. If such an action is necessary, the load must first be removed.

12.2. Damage

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

If a nut falls off its bolt while the bridge is being transported or prepared for load testing, or if the threads of a nut are not fully engaged, the connection will be repaired, the nut will be installed, and a penalty of two minutes will be added to construction time.

A bridge with irreparable damage that would reduce its strength or stability (such as a missing or broken member or fastener) will not be approved for load testing and is not eligible for awards in any category.

12.3. Preparation

Temporary piers are not used during load testing.

The judge designates the “A” and “B” sides of each bridge by a random process. “Left” and “right” ends are determined by facing the “A” side.

Teams must accept imperfect field conditions such as bent decking and slightly sloping floors.

12.4. Lateral Load Test

The provisions of this section are illustrated by the “Lateral Load Test” plan on the “Bridge Loading” diagram. “Sway” is translation in any horizontal direction.

The lateral load test is conducted with one unit of decking 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 prevent the bearing surfaces of the bridge from lifting off the ground when lateral load is applied.

A sway target is established for measurement on the “A” side of the bridge, 9’6” from the left end of the decking support surface on that side. The sway target is located at the level of the decking support surface, which is the same as the bottom of the decking. See the “Lateral Load Test” plan on the “Bridge Loading” diagram.

The two bearing surfaces on the “B” side of the bridge are prevented from sliding by horizontal restraint applied from the inside of the abutments as close as possible to the ground. This horizontal restraint does not restrain rotation of the abutments and is identical for all bridges.

Apply a fifty-pound lateral pull at the sway target and measure the sway. To pass the lateral load test, the sway must not exceed one inch.

If the bridge did not pass the lateral load test it is not approved for further testing. **Do not conduct any other load test**. Add a penalty of 900 pounds to the weight of the bridge and a penalty of thirty minutes to the construction time. Record: Aggregate deflection = sixty inches.

If the bridge passed the lateral load test, remove the load and decking, and proceed with the vertical load test.

12.5. Vertical Load Test

The provisions of this section are illustrated by the three “Vertical Load Test” elevations on the “Bridge Loading” diagram.

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

Decking units are three feet long in the longitudinal (span) direction of the bridge. Place the two decking units at distances L1 and L2 measured from the left end of the decking support surface on the “A” side of the bridge to the left edges of the decking units, as shown in the “Location of Targets and Decking” plan on the “Bridge Loading” diagram. See item 4 in chapter 8 for determination of L1 and L2. Decking units are placed square with the bridge, with the main bars spanning laterally over the decking support surfaces, and centered on the designated nominal centerline (see section 9.4). Decking units must not be attached to the bridge and must not distort it (see rules 9.1.3 and 9.1.4).

Three targets are established for measuring vertical deflection. Two of the vertical deflection targets are located longitudinally at the center of the left unit of decking, on the “A” and “B” sides of the bridge, at the level of the decking. The other vertical deflection target is located longitudinally at the center of the right unit of decking, on the “A” side of the bridge, at the level of the decking. Targets may be on the decking or on the bridge.

At their discretion, judges may impose a penalty for a bridge that incorporates parts having the primary function of interfering with placement of targets or measuring devices.

Position measuring devices on the three vertical deflection targets.

Uniformly distribute 100 pounds of preload on the left decking unit and uniformly distribute100 pounds of preload on the right decking unit. Preloads are laterally centered on the decking units. Preloads are distributed and aligned identically for every bridge.

If a contestant disturbs a measuring device after it has been initialized and before the measurement is recorded, the judge will require the team to disassemble the bridge and repeat timed construction. Scoring will be based on the larger of the two construction times but will not exceed 125% of the initial construction time.

The two steps (increments) of vertical loading produce three measurements used in scoring

- D1A = value of downward vertical deflection at left target on the “A” side that occurs during step 1 (loading the left decking unit).
- D1B = value of downward vertical deflection at left target on the “B” side that occurs during step 1 (loading the left decking unit).
- D2 = absolute value of vertical deflection at right target that occurs from the beginning of step 1 to the end of step 2 (loading the right decking unit with load from step 1 remaining in place).

Step 1
Loading the left unit and measuring deflections at those targets

- The two 100-pound preloads remain in place.
- Initialize the sway measurement.
- Initialize the measuring devices on all three vertical deflection targets or record the initial readings.
- Team members place 1150 pounds of additional load on the left decking unit. The 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.
- As the load is being placed, observe sway and deflection. Stop loading if
  a. sway exceeds one inch, or
  b. deflection measurement at any of the three vertical deflection targets exceeds two inches downward from the beginning of step 1, or
  c. decking or any part of the bridge, other than the intended bearing points, 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 sway or deflection is excessive (situation a or b), the bridge is not approved for further load testing. Remove the load and **do not continue load testing**. Add an 800-pound penalty to the weight of the bridge and a penalty of thirty minutes to the construction time. Record: Aggregate deflection = sixty inches.

If the bridge fails (situation c, d, or e), it 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**.

If the bridge passes step 1, record the measured values D1A and D1B, which are the downward vertical deflections during step 1 of the two targets for the left decking unit.

Step 2
Loading the right unit and measuring deflection at that target

- The two preloads and the load from step 1 remain in place.
- Do **not** re-initialize the sway measurement.
- Do **not** re-initialize the measuring devices on the deflection targets.
- Team members place 1150 pounds of additional load on the right decking unit. The 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.
- As the load is being placed, observe sway and deflection. Stop loading if
  a. sway exceeds one inch, or
  b. deflection measurement at any of the three vertical deflection targets exceeds two inches downward from the beginning of step 1, or
  c. decking or any part of the bridge, other than the intended bearing points, 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 sway or deflection is excessive (situation a or b), the bridge is not approved for further load testing. Remove the load and **do not continue load testing**. Add a 700-pound penalty to the weight of the bridge and a penalty of thirty minutes to the construction time. Record: Aggregate deflection = sixty inches.

If the bridge fails (situation c, d, or e), it 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**.

If the bridge passes step 2, record the measured value D2 = absolute value of vertical deflection of the target for the right unit of decking.

12.6. Unloading

If the bridge collapses during unloading, it is not eligible for awards in any category.

13. EQUIPMENT PROVIDED BY HOST

The web site http://www.nssbc.info has detailed descriptions and illustrations of hosting equipment. The following partial list is intended to help competitors know what to expect. Competitors should acquire similar equipment for use in practice and testing before the competition.

13.1. Floor

The surfaces on which the bridges will bear shall be solid, stable and as nearly flat and level as possible, in both the construction site and loading area.

13.2. Lateral Load Device

Capable of applying a fifty-pound force in the horizontal direction.

13.3. Equipment for Measuring Sway

Sway is horizontal translation and is measured by any accurate method. A suggested method is to suspend a plumb bob from the sway target and measure sway from a point marked on the ground.

13.4. Equipment for Measuring Deflection

Deflection is vertical translation and is measured at three points by any accurate method.

13.5. 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 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 of the grating that are perpendicular to the length.

13.6. Safety Supports

The safety supports must be used during load testing and are intended to limit the consequences of a bridge collapsing. The 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, timbers, sand bags, or masonry units.

13.7. Load

2500 pounds total. The load 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.

13.8. String

A string is stretched between the holes specified in section 9.4 in order to identify the nominal centerline of the bridge, which guides checking dimensions (rules 9.2.5 and 9.2.6) and placing the decking and load (rule 12.5).

13.9. Official Scoring Spreadsheet and Data Forms

Results will not be official until the official scoring spreadsheet is submitted to aftbq@uaa.alaska.edu to report outcomes. It may be downloaded at http://www.nssbc.info. Judges' forms for recording data are accessed from the spreadsheet.

14. INTERPRETATION OF RULES

The web site http://www.aisc.org/steelbridge.html lists answers to questions about 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 and reread this *Rules* document carefully in its entirety**. Submitters' names and affiliations must accompany clarification requests and will be posted with the questions and answers. Questions must be submitted before 5:00 PM Eastern Daylight Saving Time, May 4, 2009.

15. 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, including the official scoring spreadsheet, is available at http://www.nssbc.info and http://www.aisc.org/steelbridge.html.

16. APPEALS

16.1. Regional Competitions

16.1.1. At the beginning of the competition each team will identify the team member who serves as captain. The host organization will identify the regional head judge (RHJ).

16.1.2. A penalty, decision, measurement, score, or condition of competition may be appealed only by a team captain and only to the RHJ. The appeal must be made as soon as possible after the situation becomes apparent. The RHJ will not hear the appeal if he or she is approached by students other than the team captain. The RHJ will hear the appeal as soon as possible and may interrupt the competition. Participants are reminded that civility and ethical behavior are expected during the competition and particularly concerning appeals.

16.1.3. After the regional competition, the team captain has the option to appeal the decision of the RHJ by sending an e-mail message to Ms. Shanna Quinn <quinn@aisc.org> followed by a letter mailed to Ms. Quinn (AISC, Suite 700, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to ASCE Student Services (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The e-mail message and letter shall include

- name of the college or university making the appeal,
- team captain's name, e-mail address, postal address, and telephone number,
- faculty adviser's name, e-mail address, postal address, and telephone number,
- brief description of the problem,
- action taken at the competition to deal with the problem,
- action that the appealing team feels should have been taken,
- data showing that the team should have qualified for national competition, and
- team captain's signature (letter only).

Appeals must be made by e-mail followed by letter. An appeal will be considered only if the e-mail is received and the letter is postmarked by 5:00 PM Eastern Daylight Saving Time on the Wednesday immediately after the regional competition. Ms. Quinn will forward the appeal to the ASCE/AISC SSBC Rules Committee for their evaluation. The Committee will not respond to an appeal until the official scoring spreadsheet for that region has been submitted by the host organization to aftbq@uaa.alaska.edu. 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 regional judges will not be overturned.

16.2. National Competition

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

16.2.2. 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.

16.2.3. 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 ASCE/AISC SSBC Rules Committee. The conditions at issue will not be changed during deliberation.

16.2.4. If the team has justification to contest the NHJ's ruling, the team captain has the option to appeal that decision directly to the ASCE/AISC 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.

16.2.5. The decision of the ASCE/AISC SSBC Rules Committee is final; there are no further appeals. However, AISC and ASCE welcome written suggestions for improving future competitions.

17. SUMMARY OF SCORING

This form summarizes chapter "7 Scoring." Official scoring data shall be recorded on the official scoring spreadsheet that is available at http://www.nssbc.info. The completed official scoring spreadsheet shall be submitted to aftbq@uaa.alaska.edu.

17.1. Display (see section 7.1 - Judges shall not declare ties in display.)

- Appearance: balance, proportion, elegance, finish.
- Name of college or university on bridge in letters at least one inch high.
- Poster describing design and fabrication, no larger than 2 x 3 feet.

DISPLAY SCORE = _____

17.2. Construction Speed and Time Penalties

Construction clock time, CT _____ minutes
If CT ≤ 30 minutes, enter CT
If 30 < CT ≤ 45, enter 180 (see 11.6) _____ minutes
Time penalties during construction (see 11.7)
11.7.1 and 2: violations _____ x 1/2 + _____ minutes
11.7.3: violations _____ x 1/4 + _____ minutes
Repair time (see 11.9) _____ x 1.5 + _____ minutes
Time penalties during repair (see 11.7, 11.9)
11.7.1 and 2: violations _____ x 1/2 x 1.5 + _____ minutes
11.7.3: violations _____ x 1/4 x 1.5 + _____ minutes
Time penalty, damage (see 12.2) + _____ minutes
Time penalty, load tests, 30 min (see 12.4 and 12.5) + _____ minutes

TOTAL TIME = _____ minutes
Lowest total wins.

17.3. Construction Economy

Number of builders, including barges (_____ builders
Total time (part 17.2) x _____ minutes
x 50)
Number or temporary piers: minimum of 1 (see 7.3) + (_____
x 50)

CONSTRUCTION COST: C_c = _____ thousand $
Lowest cost wins.

17.4. Lightness and Weight Penalties

Bridge weight			_____ pounds
Weight penalties,			
"7.1 Display" (30, 50, or 80)		+	_____ pounds
"9.2 Usability"			
Rules violated ≤ ½ inch	_____x 50	+	_____ pounds
Rules violated ½ - 1 inch	_____x 150	+	_____ pounds
Rules violated 1 - 2 inch	_____x 300	+	_____ pounds
"9.3 Member-to-member Connections"			
Number of violations	_____ x 25	+	_____ pounds
"9.4 Centerline" (100)		+	_____ pounds
"10.2 Durability & Constructability"			
Number of violations	_____ x 25	+	_____ pounds
"12.4 and .5 Lateral Load and Vertical Load" (900, 800 or 700)		+	_____ pounds
	TOTAL WEIGHT	=	_____ pounds

Lowest weight wins.

17.5. Stiffness

AGGREGATE DEFLECTION: D1A + D1B + D2 = _____ inches

Lowest deflection wins.

17.6. Structural Efficiency

Total weight (part 17.4)	(	_____ pounds
	x	5)
Aggregate deflection (part 17.5)	+ (	_____ inches
	x	700)

STRUCTURAL COST: C_s = _____ thousand $

Lowest cost wins.

17.7. Overall Performance

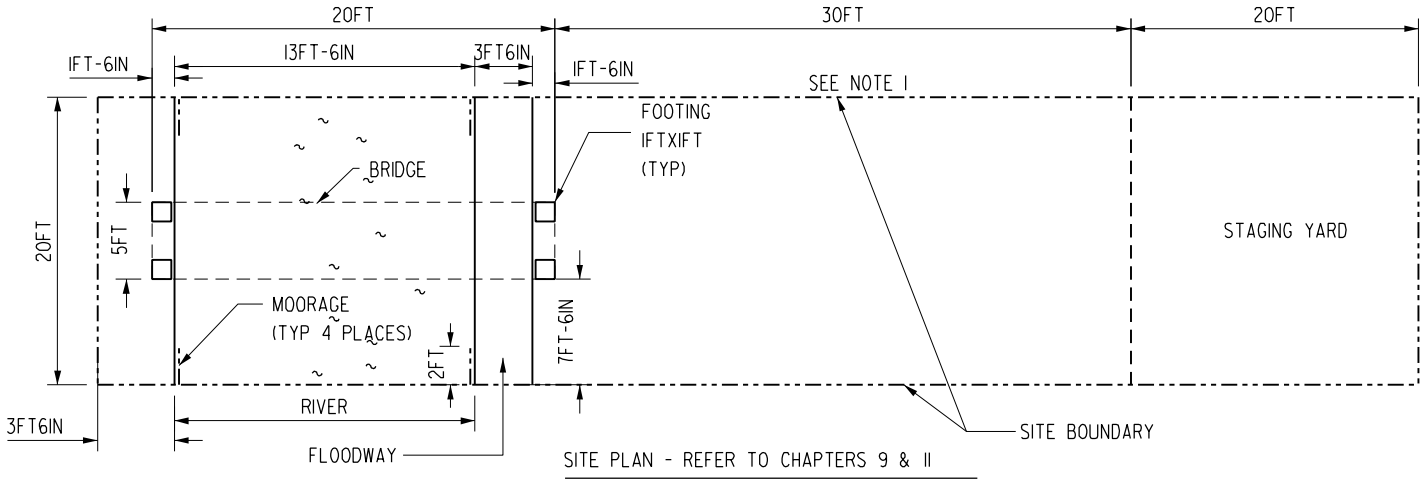
C_c (from part 17.3) _____ + C_s (from part 17.6) _____ = _____

Lowest total wins.

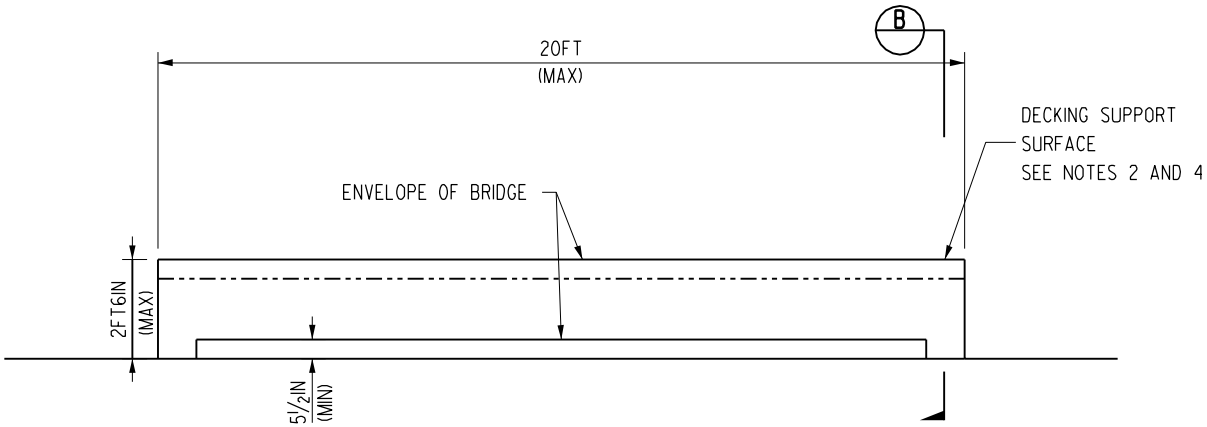
17.8. Ranks (Display is the tie-breaker for all categories)

A bridge will not be ranked if it was submitted by a student organization that is not in good standing with ASCE or is not assigned to this region, or if the bridge was not approved for construction or load testing, or failed in load testing.

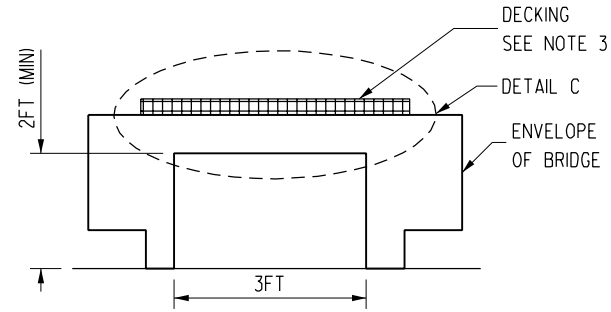
Display _____ Construction Speed _____ Lightness _____
Stiffness _____ Construction Economy _____ Structural Efficiency _____
Overall Performance _____



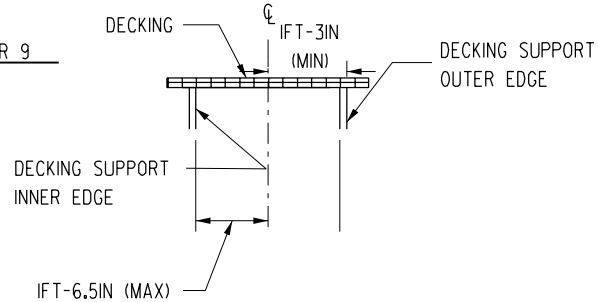
SITE PLAN - REFER TO CHAPTERS 9 & 11



ELEVATION - REFER TO CHAPTER 9



B END VIEW
NO SCALE



C DECKING SUPPORT
NO SCALE

NOTES:

1. LENGTH CAN BE ADJUSTED TO FIT SITE CONDITIONS.
2. NO PART OF THE BRIDGE SHALL EXTEND ABOVE DECKING SUPPORT SURFACES.
3. BRIDGE SHALL ACCOMODATE DECKING THROUGHOUT OVERALL LENGTH OF THE BRIDGE IN ACCORDANCE WITH RULE 9.2.4.
4. NO PART OF BRIDGE SHALL EXTEND BEYOND DECKING SUPPORT SURFACE (AT BOTH ENDS).

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION
A	6-27-08						2009 SSBC RULES

DESIGNED BY F. HATFIELD
DRAWN BY D. SEPULVEDA
CHECKED BY RULES COMM.
IN CHARGE F. ROSENBERG
DATE 6-27-2008

ASCE - AISC
STUDENT STEEL BRIDGE CONTEST

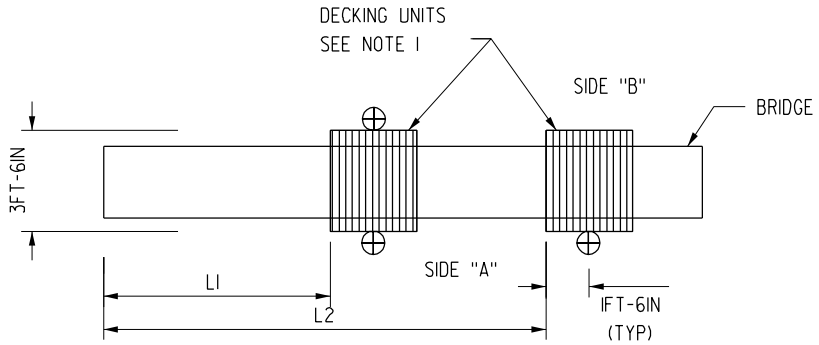
SUBMITTED
APPROVED

SITE AND BRIDGE

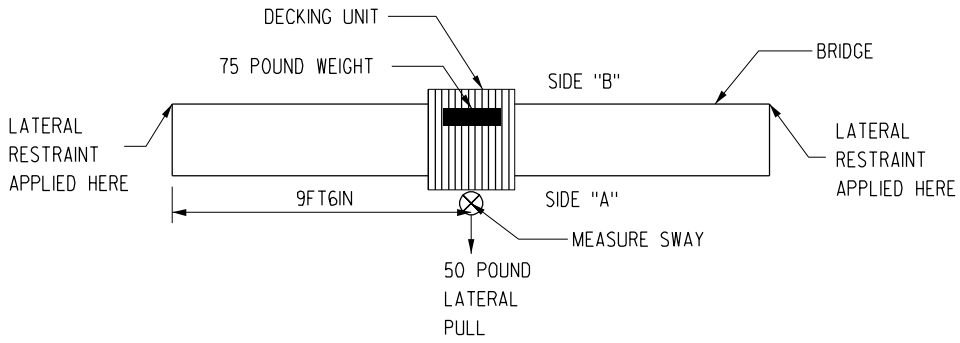
DIAGRAM

CONTRACT NO
DRAWING NO EXHIBIT 1 REV
SCALE AS SHOWN
SHEET NO

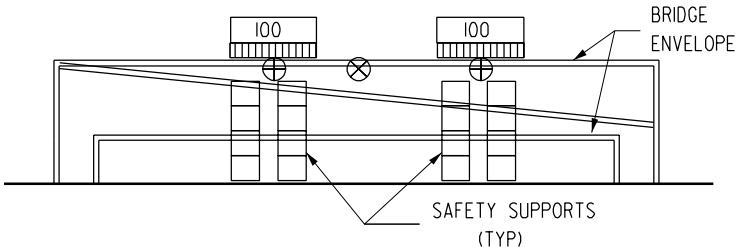
$FILE$
$DATE$
Plotted by:$USER$



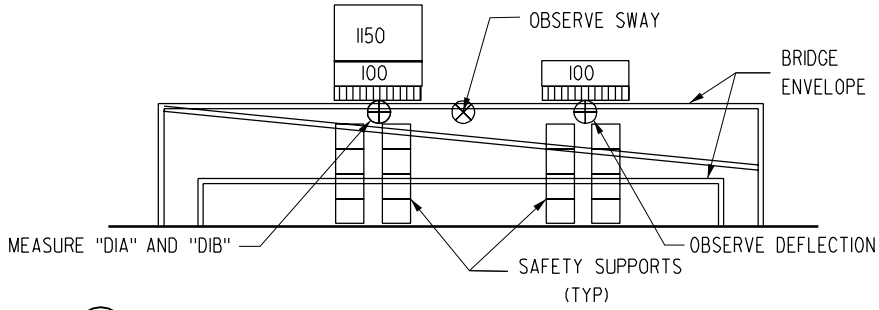
A LOCATIONS OF TARGETS AND DECKING - PLAN
REFER TO CHAPTER 12, SECTIONS 3 & 5



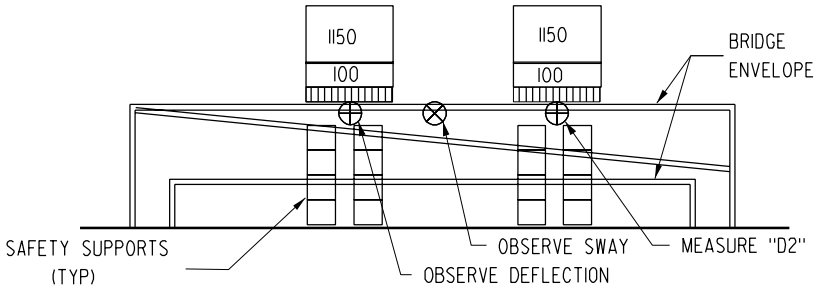
B LATERAL LOAD TEST - PLAN
CHAPTER 12, SECTIONS 3 & 4



0 VERTICAL LOAD TEST - PRELOAD
REFER TO NOTES DURING LOADING PROCESS



1 VERTICAL LOAD TEST - STEP 1
REFER TO NOTES DURING LOADING PROCESS



2 VERTICAL LOAD TEST - STEP 2
REFER TO NOTES DURING LOADING PROCESS

LEGEND

⊕ TARGETS FOR MEASURING VERTICAL DEFLECTION TO BE PLACED LONGITUDINALLY AT THE CENTER OF THE DECKING UNITS

⊗ TARGET FOR MEASURING SWAY

NOTES

1. THE LOAD IS LATERALLY CENTERED ON THE DECKING UNIT AND DISTRIBUTED OVER THE LENGTH OF THE DECKING UNIT AS UNIFORMLY AS POSSIBLE AT ALL TIMES DURING LOADING.
2. OBSERVE ALL VERTICAL TARGETS ON EACH SIDE OF THE BRIDGE FOR DEFLECTION.
3. LOADING TERMINATES IF DEFLECTION AT ANY OF THE VERTICAL DEFLECTION TARGETS EXCEEDS 2 INCHES DURING STEP 1 AND STEP 2.
4. LOADING TERMINATES IF SWAY AT SWAY TARGET EXCEEDS 1" DURING STEP 1 AND STEP 2.
5. SAFETY SUPPORT TO BE IN PLACE AT ALL TIMES DURING LOADING.
6. BRIDGE TO BE UNLOADED IN THE REVERSE ORDER OF LOADING.
7. ALL LOADING SAFETY PROCEDURES TO BE FOLLOWED.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION
A	6-27-08						2009 SSBC RULES

DESIGNED BY F. HATFIELD
DRAWN BY D. SEPULVEDA
CHECKED BY RULES COMM.
IN CHARGE F. ROSENBERG
DATE 6-27-2008

ASCE - AISC
STUDENT STEEL BRIDGE CONTEST

ASCE

SUBMITTED

APPROVED

BRIDGE LOADING

DIAGRAM

CONTRACT NO

DRAWING NO EXHIBIT 2 REV

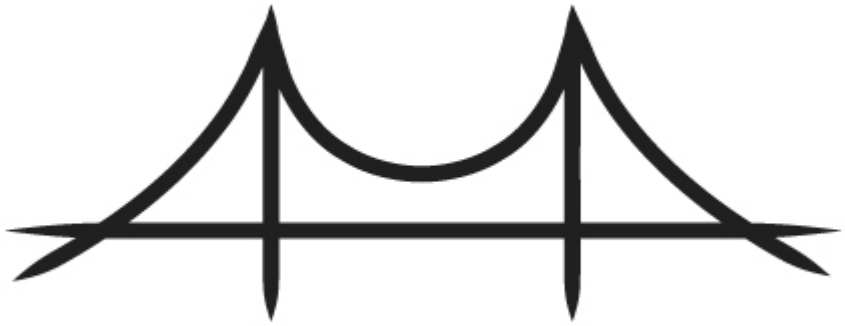
SCALE AS SHOWN

SHEET NO

Plotted by:&USER$ &DATE$ &FILE$

STUDENT STEEL BRIDGE COMPETITION

2008 RULES



The mission of the ASCE/AISC 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 issues such as spatial constraints, material properties, strength, serviceability, fabrication and erection processes, safety, esthetics and cost. Success in inter-collegiate competition requires effective team work and project management. Future engineers are stimulated to innovate, practice professionalism and use structural steel efficiently.

TABLE OF CONTENTS

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.html. Revisions and clarifications do not appear in this document but are considered formal addenda to the *Rules*.

1. INTRODUCTION

The Student Steel Bridge Competition is sponsored by the American Society of Civil Engineers (ASCE) and by the American Institute of Steel Construction (AISC), and co-sponsored by the American Iron and Steel Institute, the James F. Lincoln Arc Welding Foundation, the National Steel Bridge Alliance, and the Nucor Corporation.

Students design a steel bridge by themselves but may seek advice from faculty and student organization advisers. Students gain maximum benefit from the experience if they design and 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 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.

This document describes the competition and states the rules for this year. It is available at http://www.aisc.org/steelbridge.html, together with related information. These rules govern competition at both regional and national levels. Additional information is available at http://www.nssbc.info. Information and rules at http://www.aisc.org/steelbridge.html will govern if there is a conflict between the two sites.

The rules are changed every year to improve the competition and assure 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 chapter “14 Interpretation of Rules.” Revisions to the rules, if any, will be incorporated in the clarifications that appear on the web page cited in that chapter.

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 gain practical experience in structural design, fabrication processes, construction planning, organization, and teamwork.

The rules of the competition simulate a request for proposal that requires a scaled model to demonstrate the efficacy of competing designs. Chapter "6 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 regulations 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 (Department of Transportation) and have the authority to accept and reject entries.

The safety of competitors, judges, and spectators is paramount. Risky procedures are prohibited, and bridges that cannot be constructed and tested 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.

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

3. ELIGIBILITY

3.1. Regional Competition

There are two levels of competition: regional and national. Regional competitions are held in conjunction with ASCE student conferences. 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.

The ASCE student organizations entering regional competitions are required to be current with their national dues and annual reports. A team must consist only of undergraduate and graduate students in good standing with their ASCE student organization.

A student team which does not have an ASCE student organization that meets the requirements of the preceding paragraph may enter a steel bridge in a regional competition if invited by the conference host organization. Such teams are invited guests and will not be ranked in the competitions nor will they be invited to compete in the National Student Steel Bridge Competition.

An ASCE student organization will not be permitted to participate in the National Student Steel Bridge Competition unless it satisfies ASCE regulations regarding participation in its ASCE student conference. These regulations are stated at www.asce.org/students.

3.2. National Competition

Invitations to compete at the national level are extended only to the winner from an ASCE student conference in which two, three, or four ASCE student organizations participated in the Student Steel Bridge Competition, to the top two teams from a conference in which five to ten ASCE student organizations competed, and to the top three teams from a conference with eleven or more competing ASCE student organizations. Guest teams will not be invited to the national competition and will not be counted when determining how many teams will be invited from a conference. Only one bridge per college or university may be entered in the national competition.

4. RULE CHANGES

The following list covers some of the major changes from the 2007 rules. Not all changes are listed. Contestants, hosts, and judges are cautioned to **read this entire document carefully and disregard rules and clarifications from previous years**.

1. Scoring multipliers are different.
2. University name on the bridge and poster must match the name registered with ASCE.
3. Poster must give credit to consultants, technicians, and fabricators who helped.
4. Width of river and span of bridge are increased.
5. Clearance under the bridge is increased.
6. Height of the bridge is decreased.
7. Threads of nuts must be fully engaged.
8. One or two builders may be designated as “barges” and will operate in the river but not on land.
9. Touching the floodway on either side of the river is penalized as an accident.
10. “Superintendent” designation is eliminated. A builder or builders may supervise from inside the construction site while also constructing.
11. Builders must demonstrate stability of the constructed portion.

5. SAFETY

Safety has the highest priority. Judges are empowered to halt any activity that they deem hazardous. Judges will stop construction procedures that could cause personal injury. Judges will not allow additional load to be placed on a bridge that has collapsed, that is approaching a collapse that could be dangerous, or that has swayed or deflected in excess of specified limits. A bridge that cannot be safely constructed or load tested using the equipment provided by the host is not eligible for awards in any category and must be withdrawn from participation.

6. PROBLEM STATEMENT

A century-old bridge that spans a river and adjacent floodways must be replaced. The bridge carries traffic serving the residences, farms, and agricultural processing industries that are the economic base of this rural region. A quick replacement is necessary because no other crossing is available for miles.

The state Department of Transportation (DOT) has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered but the DOT has specified steel as the material because of its durability, fast erection, and high level of recycled content. Clearance under the bridge must be provided for passage of floods. The bridge must be able to carry specified patterns of loads without exceeding sway and deflection limits. Based on past experience with performance and maintenance, the DOT prefers bridges that are relatively light and stiff. The new bridge must accommodate modular decking that was salvaged from another structure.

Due to environmental concerns, construction of permanent piers is permitted only on the existing footings. However, temporary piers may be used. Construction barges are permitted in the river. Both sides of the river are bounded by floodways that are too shallow for barges and too wet for terrestrial construction machinery. Soil conditions limit the weight of loads that may be moved. Existing revetments protect steep slopes and must not be damaged by construction equipment.

Your company's design/build proposal is among those that the DOT has deemed responsive, and winning the contract would be a step toward becoming a leader in the bridge replacement market. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. A panel of DOT personnel will judge the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy, and display. The contract will be awarded to the company whose model best meets the DOT’s needs and requirements. 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 rejection of the model and termination of the company’s eligibility.

7. SCORING

A college or university may enter only one bridge in regional competition and may participate in only one regional competition.

Categories of competition are display, construction speed, lightness, stiffness, construction economy, and structural efficiency. In addition, overall performance is rated. A bridge that was not approved for load testing or that failed in load testing is not eligible for awards in any category.

7.1. Display

Display is the tie-breaker for all categories of competition. Judges should not declare ties in display. Display is judged by

7.1.1. Appearance of bridge, including balance, proportion, elegance, and finish. Quality of fabrication should not be considered because some bridges may be fabricated professionally while others are student work.

7.1.2. Permanent identification of the bridge consisting of the name of the college or university exactly as shown on the ASCE register available at www.asce.org/students. The name must appear on the bridge in letters at least one inch high and must be formed from steel or applied to steel with paint or decals. A 50-pound weight penalty will be imposed if the bridge lacks appropriate identification.

7.1.3. Poster describing design. The poster must 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. The poster must identify the college or university with the same name that appears on the bridge and must present a brief explanation of why the overall configuration of the bridge was selected, a brief computation demonstrating design for one limit state, a scaled, dimensioned side view of the bridge, and acknowledgment of companies, university technicians, faculty, and others who helped fabricate the bridge or provided advice. Additional information may be included. Electronic displays, decorated supports, lights, and sound are not permitted and will result in the worst possible rating for the poster. A fifty-pound weight penalty 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.

7.2. Construction Speed

The bridge with the lowest total time will win in this category. Total time is the time required for construction plus 150% of the time for repairs (see section 11.9), modified by penalties prescribed in sections 11.6, 11.7, 11.9, 12.2, 12.4, and 12.5. There is an upper limit on construction time.

7.3. Construction Economy

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

C_c = Total time (minutes) x Number of builders (including barges)
x 50 thousand dollars per person-minute
+ 20 thousand dollars for every move of a temporary pier
+ 30 thousand dollars for each barge.

Total time is defined in section "7.2 Scoring: Construction Speed" and includes penalties. The number of builders includes all members and associates of the competing organization who are within the construction site or physically assist the team at any time during timed construction.

7.4. Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in sections "7.1 Scoring: Display," "9.2 and 9.3 Dimensions and Support: Usability and Centerline," "10.2 Material and Components: Durability and Constructability" and "12.4 and 12.5 Load Tests: Lateral Load Test and Vertical Load Test." Decking, tools, temporary piers, and poster are not included in total weight.

7.5. Stiffness

The bridge with the lowest aggregate deflection will win in the stiffness category. Aggregate deflection is determined from measurements as prescribed in section "12.5 Load Tests: Vertical Load Test."

7.6. Structural Efficiency

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

C_s = Total weight (pounds) x 3 thousand dollars per pound
+ Aggregate deflection (inches) x 700 thousand dollars per inch.

Total weight is defined in section "7.4 Scoring: Lightness" and includes penalties. Aggregate deflection is defined in section "7.5 Scoring: Stiffness" and includes penalties.

7.7. 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.

8. SCHEDULE OF COMPETITION

In the months before the competition, students design their bridges, fabricate members, test load, practice construction, and select a member of the team to serve as its captain. The following events occur during the competition

1. 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, erection, and repairs as described in section "11.9 Construction: Repairs."
2. Bridges are disassembled.
3. The head judge clarifies rules and conditions of the competition and answers questions.
4. The head judge selects the locations of loads. See section "12.5 Load Tests: Vertical Load Test" and the "Locations of Targets and Decking" detail on the "Bridge Loading" diagram. Selection is done in the presence of the team captains by rolling a die twice. Let S1 and S2 be the spots from the two rolls and let L1 and L2 be dimensional locations of decking units in inches.

   L1 = 40 + 7 (S1) and L2 = 115 + 7 (S2)

   The same locations will be used for all bridges.
5. Bridge members, fasteners, tools, and temporary piers are staged for construction and inspected by the judges. See chapter "10 Material and Components" for details.
6. Timed construction. See chapter "11 Construction" for details.
7. Judges inspect assembled bridges. See chapter "9 Dimensions and Support" and rules 10.1.2, 10.1.3, 10.2.11, 10.2.12, and 10.2.13 for details.
8. Bridges are weighed (if it is impractical to weigh the entire bridge, its parts may be weighed prior to construction).
9. Load testing. See chapter "12 Load Tests" for details.
10. The host ASCE student organization must submit the completed official scoring spread sheet by e-mailing it to the address given on that spread sheet, which is aftbq@uaa.alaska.edu.

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

- bridges are not modified after selection of load locations,
- bridges are not modified between display judging and timed construction,
- no components or tools are added to or removed from the construction site after staging and inspection, and
- modifications between timed construction and load testing are limited to repairs as described in "11.9 Construction: Repairs."

9. DIMENSIONS AND SUPPORT

Dimensions and support will be checked with the bridge in its as-built condition after construction is completed 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 any applied load on the bridge.

9.1. Functionality and Safety

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

9.1.1. The bridge must span the river and floodways without touching them. See the "Site Plan" on the "Site and Bridge" diagram.

9.1.2. The bridge must provide support for the decking for the full overall length of the bridge along both of the edges that run in the span direction of the bridge. See the "Elevation" on the "Site and Bridge" diagram.

9.1.3. Decking support must be rigid. At their discretion, judges may test rigidity by applying a 25-pound load at selected points on the decking support. Deflection under that load exceeding one inch indicates lack of rigidity.

9.1.4. The bridge must provide access for placing the decking and load.

9.1.5. The decking must not be attached or anchored to the bridge, and it must not be used to distort the bridge from its as-built condition.

9.1.6. The bridge must not be anchored or tied to the ground.

9.1.7. It must be possible to construct and load the bridge safely using equipment provided by the host student organization. **Bridges must accommodate local conditions.**

9.2. Usability

A weight penalty will be assessed for each rule in this section (9.2) that is violated, rather than for every violation of that rule.

The penalty for violation of each of the following rules will be an addition to the weight of the bridge determined as follows: 50 pounds for a dimensional violation of ½ inch or less; 150 pounds for a dimensional violation greater than ½ inch but not exceeding 1.0 inch; 300 pounds for a dimensional violation greater than 1.0 inch but not exceeding 2.0 inches. If a dimensional violation exceeds 2.0 inches, the bridge will not be approved for load testing and will not be eligible for awards in any category.

9.2.1. The bridge must bear on the ground only within the one-foot by one-foot squares that are marked on the construction site to represent existing footings. See the “Site Plan” on the “Site and Bridge” diagram.

9.2.2. Decking support surfaces must not be more than 21’0” long and must extend for the overall length of the bridge.

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

9.2.4. The bridge must be able to accommodate solid decking that is 3½ inches thick and extends 1’10½” on both sides of the nominal centerline (described in section 9.3) at all points along the length of the bridge. This rule will be checked along the full overall end-to-end length of the decking support surfaces using a 3’9” wide template centered on the nominal centerline.

9.2.5. The lateral distance from the nominal centerline to the outer edge of the outermost decking support surface on each side of the bridge must not be less than 1’3”. See the “Decking Support” detail on the “Site and Bridge” diagram.

9.2.6. The lateral distance from the nominal centerline to the inner edge of the outermost decking support surface on each side of the bridge must not be more than 1’6½”. See the “Decking Support” detail on the “Site and Bridge” diagram.

9.2.7. The decking support surfaces must not have gaps exceeding ¼ inch wide in the span direction of the bridge. See the “Irregularities in Decking Support” detail on the “Site and Bridge” diagram.

9.2.8. The decking support surfaces must not have vertical protrusions exceeding ¼ inch high. See the “Irregularities in Decking Support” detail on the “Site and Bridge” diagram.

9.2.9. Elevation of the decking support surface must not change more than ¼ inch in any six inches of span length. See the “Irregularities in Decking Support” detail on the “Site and Bridge” diagram.

9.2.10. The decking support surface must be no less than 2’3” nor more than 2’6” above the surface of the ground or river at any point. See the “Elevation” on the “Site and Bridge” diagram.

9.2.11. The bridge must not extend more than 6'0" above the surface of the ground or river. See the “Elevation” on the “Site and Bridge” diagram.

9.2.12. Clearance must be provided under the bridge at all points directly over the river and floodways. The clearance must be at least 2’1” high, measured from the surface of the river and floodway. See the “Elevation” on the “Site and Bridge” diagram.

9.2.13. At all other points that are not directly over the river, floodways, or footings, there must be clearance of at least 6” under the bridge. See the “End View” on the “Site and Bridge” diagram.

9.2.14. A vehicle passageway must completely traverse the bridge from end to end. It must be at least 2’0” high, measured from the decking support surfaces, and must extend at least 1’6” on each side of the nominal centerline. See the “End View” on the “Site and Bridge” diagram.

9.3. Nominal Centerline

A weight penalty of 100 pounds will be assessed if any of the requirements in this section (9.3) is violated or if some feature of the bridge prevents the judge from stretching a string along a designated straight nominal centerline.

9.3.1. The bridge must have a designated straight nominal centerline extending from one end to the other. The centerline must be designated by two holes, one at each end of the bridge, drilled vertically through horizontal steel surfaces at the level of the decking support surfaces. Each hole must be approximately ¼ inch in diameter and must be located no more than 3’0” from the vertical plane defined by the ends of the decking support surfaces.

10. MATERIAL AND COMPONENTS

10.1. Safety

If any one of the following rules in this section (10.1) is violated, the bridge will not be approved for construction or load testing, and will not be eligible for awards in any category.

10.1.1. A member must not weigh more than twenty pounds. See section 10.2 for definition of "member."

10.1.2. A bridge must 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.

10.1.3. After completion of timed construction, energy must not be transmitted to or from a bridge (for example, by applying or releasing mechanical, magnetic, fluidic, or other force; by sound, light, radio, or other wave or ray; by conduction or convection of heat; or by electric current). The exceptions are forces necessary to the competition (for example, those associated with load testing and with moving the bridge from place to place), and changes in ambient conditions that are not controlled by contestants (such as wind, temperature, and lighting).

10.2. Durability and Constructability

Violation of the following rules in this section (10.2) will result in penalties being added to the weight of the bridge. The penalty for each violation is ten pounds plus five times the weight of the non-conforming member or fastener. If the non-conforming component weighs less than one pound, its weight will be assumed to be one pound for the purpose of computing the penalty.

10.2.1. A bridge must be constructed only of structural steel. For the purposes of this competition, structural steel is defined as an iron alloy that is strongly attracted to any magnet provided by the host organization. Solder, brazing, and structural adhesives are not permitted. Exceptions: Paint, decals, and other purely decorative items are permitted, and bridge parts may be labeled.

10.2.2. A bridge must be constructed only of members and fasteners. During timed construction, members are connected with fasteners to form assemblies and the constructed portion, which are defined and regulated by rules in chapter “11 Construction.”

Members

10.2.3. A member is a rigid steel component that retains its shape and dimensions during timed construction and in the completed bridge.

10.2.4. A member must not exceed overall dimensions of 3'6” x 6” x 6.” That is, it must fit in a prismatic box of those dimensions.

10.2.5. A member must 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. Exception: Deformations caused by mechanical strain (e.g., bending, stretching) during load testing are not violations of this rule.

10.2.6. A member may consist of multiple parts rigidly joined together before timed construction begins. Those parts must remain rigidly joined throughout timed construction and in the completed bridge. Parts must be joined by welding or with steel connectors such as bolts, screws, and rivets. If nuts are used their threads must be fully engaged (that is, the end of the bolt or threaded pin must be flush with or extend beyond the outer face of the nut).

Fasteners

10.2.7. A fastener is a steel bolt that is not part of a member, with at least one steel nut that is not part of a member. The specified bolts and nuts usually are available in hardware stores.

10.2.8. The bolt in a fastener must be no more than three-inch nominal length (bottom of head to end) with a hexagonal head, and it must have the configuration and dimensions of a “cap screw grade 2,” “cap screw grades 5 and 8,” “A307 bolt,” “A325 and A490 structural bolt”, or “hex tap bolt” illustrated on http://www.purchasepartners.com/fastenerspecs.htm. Bolts must not be mechanically altered or modified in any manner. They may be painted.

10.2.9. The nuts in a fastener must match the bolt. That is, the nominal size (inside diameter) must be the same as that of the bolt and the threads of the nuts must engage the threads on the bolt and permit the nuts to be turned onto the bolt. Nuts must be solid, hexagonal, and have the configuration and dimensions of “finished hex nut grade 2,” “finished hex nut grades 5 and 8,” or “heavy hex nut” as illustrated on the web site cited in rule 10.2.8. Nuts must not be mechanically altered or modified in any manner. They may be painted.

10.2.10. Nuts and bolts that connect the parts of a member but do not connect a member to other members are not considered to be fasteners and are not governed by rules 10.2.7, 10.2.8, and 10.2.9.

Member-to-member Connections

10.2.11. Each member must be connected directly to every member that it touches by at least one fastener installed during timed construction so that the connection cannot be taken apart without first turning and removing a nut from the bolt.

10.2.12. The bolt must penetrate completely through a hole in each of the members that it connects. Dimension(s) of the hole must be small enough so that neither the head of the bolt specified in rule 10.2.8 nor the nut specified in rule 10.2.9 can pass through the hole.

10.2.13 The bolt must fully engage the threads of its nuts. That is, the end of the bolt must extend beyond, or be flush with, the outer surface of the outermost nut.

11. CONSTRUCTION

11.1. Definitions

11.1.1. “River,” “floodway,” “staging yard,” “footing,” and construction “site boundary” are defined by the “Site and Bridge” diagram. “Ground” is the entire floor, both inside and outside the site boundary, except for the river.

11.1.2. “Builders” are undergraduate or graduate student members of a competing student organization. See chapter 3 for eligibility requirements.

11.1.3. Some builders may be designated to be “barges.” Builders cannot be designated as barges after the start of timed construction and builders so designated remain barges for the duration of timed construction. The use of barges is optional. Barges are counted as builders and, in addition, the construction cost, C_c, is incremented for each barge that is used.

11.1.4. A “team” is all the builders from the organization that is constructing the bridge. The team must include no more than six builders. No more than two of those builders may be designated as barges.

11.1.5. “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.

11.1.6. 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.

11.1.7. “Temporary piers” are optional devices that bear on the river or ground, including floodways, and are used to support the constructed portion of the bridge during timed construction. They have no other purpose, are not tools, and are not part of the completed bridge. A team provides its own temporary piers. The construction cost, C_c, is incremented for every time a temporary pier is moved, including moves from and to a staging yard. However, there is no cost for moving a temporary pier from one location in a staging yard to another location in the same staging yard.

11.1.8. “Moving a temporary pier” means changing the orientation or horizontal position of its bearing surfaces on the ground or river. A move is considered complete when the temporary pier is released by the builder or builders who were moving it.

11.1.9. “Member,” “fastener,” and “member-to-member connection” are defined in section 10.2.

11.1.10. To “connect” means to attach with a member-to-member connection except that bolts are not required to completely penetrate nuts until construction and repairs are completed.

11.1.11. An “assembly” consists of members that are connected together in a staging yard during timed construction.

11.1.12. The “constructed portion” is created during timed construction by connecting members and assemblies in essentially their final positions. The constructed portion is not required to be contiguous.

11.1.13. When a member or assembly is connected to the constructed portion by at least one fastener it becomes part of the constructed portion and is no longer considered to be a member or assembly.

11.1.14. The constructed portion or a non-contiguous part of the constructed portion is “stable” if, without being supported by builders or by tools held by builders, it stands without falling and does not touch the river or the ground outside the footings. Temporary piers and tools that are not held by builders may be used to achieve the stable condition.

11.1.15. To “modify“ includes, but is not limited to, making and taking apart connections, and installing, tightening, loosening and removing nuts and bolts.

11.2. Safety

If any rule in this section (11.2) is violated during timed construction, the judge will stop the clock and explain the violation. Before the clock is restarted, builders, tools, members, assemblies, fasteners, and temporary piers will be returned to the positions they occupied before the violation. Then the team will be asked to resume construction using safe procedures. A team will have the opportunity to construct its bridge safely. However, if the 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.

11.2.1. Builders, judges, and spectators must not be exposed to risk of personal injury.

11.2.2. Only builders and judges are permitted within the boundaries of the construction site during timed construction.

11.2.3. At all times during timed construction every builder must wear personal protective equipment in the proper manner (e.g., hardhat with peak in front).

11.2.4. Welding machines and tools requiring external power connections must not be used during timed construction.

11.2.5. A tool must not weigh more than twenty pounds and must not exceed 3’6” in any linear dimension when fully assembled and extended.

11.2.6. Tools, members, and assemblies may be supported on the constructed portion or on temporary piers. Rules 11.7.3 and 11.7.4 apply.

11.2.7. A temporary pier must not be moved while it is supporting the constructed portion, a member, an assembly, or a tool.

11.2.8. A temporary pier must not weigh more than twenty pounds and must not exceed 1’6” in any horizontal dimension.

11.2.9. A temporary pier must not collapse or fall over while in use.

11.2.10. A temporary pier must bear on the ground or river and not be supported or stabilized by builders or tools while it is supporting the constructed portion, a member, an assembly, or a tool.

11.2.11. Lubricant must not be applied during timed construction or within the construction site at any time. Lubricant must not drop on the floor within the construction site.

11.2.12. Throwing anything is prohibited.

11.2.13. A builder must not use the bridge, a portion of the bridge, a 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 a constructed portion if the builder is kneeling on the ground on both knees, kneeling on the ground on one knee with the other foot on the ground, or standing with the heels and toes of both feet on the ground.

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

11.2.15. A builder must not cross a floodway or the river.

11.2.16. An assembly must not consist of more than three members.

11.2.17. Modification of a member or assembly is not permitted outside the staging yard. Furthermore, outside the staging yard, a member or assembly must not contact another member or assembly.

11.2.18. The bridge must be constructed by first placing members or assemblies in their final positions. These become the initial constructed portion. Then additional members and assemblies are successively connected to the constructed portion and become part of it. Outside the staging yard, connections must be made only to the constructed portion.

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

11.2.20. A constructed portion must be created in, and remain in, essentially the same location, position, and configuration that it will have in the completed bridge. Exceptions

- A former member or assembly that is connected to the constructed portion by only one fastener may rotate relative to the constructed portion.
- Due to lack of support from members that have not yet been connected to the constructed portion, part of it may sag or sway.
- The constructed portion may slide from its final position on the ground as an unintended consequence of construction. However, intentional movement of the constructed portion from its final position is a violation.

For all three exceptions, one or more builders may move all or part of the constructed portion in order to make a connection or correct the position of the bridge on the footings. However, rule 11.7.3 applies.

11.2.21. A constructed portion may be modified as described by 11.1.15.

11.2.22. The constructed portion and every non-contiguous part of the constructed portion must be stable. After each member or assembly is connected to the constructed portion, the builders must demonstrate stability by releasing the constructed portion, including the newly-connected member or assembly and all members and assemblies that are in contact with the constructed portion, and then announcing “stable” loud enough for the judges to hear.

11.2.23. Outside the staging yard, moving or supporting an assembly requires the effort of at least two builders. “Moving” includes, but is not limited to lifting, carrying, lowering, rolling, turning, sliding, tipping, and rotating.

11.2.24. Outside the staging yard, a builder must not contribute to lifting, carrying, or supporting more than one member or assembly at a time.

11.2.25. A builder must not move or support a temporary pier while also moving or supporting a member, assembly, or another temporary pier.

11.2.26. A builder may support a member, assembly, or temporary pier while simultaneously adjusting the constructed portion as permitted by rule 11.2.20.

11.3. 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, including the one-foot by one-foot footings, before the competition.

Only builders and judges are permitted within the boundaries of the construction site during timed construction. Only judges are permitted near the construction site. Spectators, including faculty advisers, must observe from areas designated by the judges and host student organization.

11.4. Start

Before construction begins, all of the following items, and nothing else, are in the staging yards: members, fasteners, tools, and temporary piers (if used). Every member, tool, temporary pier, and fastener must be in contact with the ground. Members must not be connected or touching one another. Tools and fasteners must not be in contact with members. Tools must not be in contact with fasteners. Temporary piers must not be in contact with one another nor with members, tools, or fasteners. Builders who are not barges are in the staging yards, and the barge or barges (if used), but nothing else, are in the river. Barges start without tools and fasteners, which may be passed to them by other builders after timed construction begins. Builders, including barges, are wearing personal protective equipment as well as optional clothing such as pouches.

During timed construction, additional builders, members, tools, fasteners, temporary piers, or other items must not be brought into the construction site nor must anything be removed.

Timing and construction begin when one of the builders signifies that the team is ready and the judge declares the start.

11.5. Time

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

11.5.1. if a builder or judge sees a condition that could cause injury, or

11.5.2. when a safety rule has been violated (see section 11.2), or

11.5.3. 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 section 11.7).

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

11.6. Time Limit

11.6.1. If construction time exceeds 30 minutes but does not exceed 45 minutes, it will be multiplied by 1.50 for scoring. Judges will inform the team when this limit is reached.

11.6.2. If construction time exceeds 45 minutes, it will be counted as 180 minutes for scoring. “Accidents” (section 11.7) that occur after 45 minutes will not be penalized but safety rules (section 11.2) will still be enforced. Judges will inform the team when this limit is reached.

11.6.3. If construction time exceeds sixty minutes, judges may halt construction, or may move the bridge off site if it can be completed safely. The bridge will not be eligible for awards in any category.

11.7. Accidents

In general, the clock is not stopped when an “accident” occurs. If an accident is continuous (for example, a builder who is not a barge stands in the river) it will be counted as multiple incidents. Builders involved in accidents may continue to build, and items involved in accidents must 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, assemblies, temporary piers, and fasteners will be returned to the positions they occupied before the accident. Exception: Construction may proceed if it is no longer possible to hold all four bearing surfaces within the footings simultaneously. In this situation, the team captain may request that the clock be stopped in order to demonstrate the difficulty to the judge. If the judge is convinced, no additional accidents will be cited for bearing surfaces touching the ground outside the footings (rule 11.7.3), the clock will be restarted, construction will resume, and a penalty will be assessed for a dimensional violation under rule 9.2.1 (even if the bearing surfaces fall within the footings when the bridge is completed).

Types of accidents and the corresponding time penalties, which will be added to the construction time, are

11.7.1. A builder who is not a barge or that builder’s clothing touches the river or floodway. Penalty is 1/2 minute (thirty seconds) per incident. Exception: There is no penalty for entering the river or floodway to retrieve an object that has been dropped, such as a member, tool, nut, bolt, or hardhat.

11.7.2. A barge or a barge’s clothing touches ground (which includes the floodways). Penalty is 1/2 minute (thirty seconds) per incident. Exception: There is no penalty for stepping on ground to retrieve an object that has been dropped, such as a member, tool, nut, bolt, or hardhat.

11.7.3. A member, assembly, or constructed portion touches the river or ground outside a staging yard. Penalty is 1/4 minute (fifteen seconds) per incident. Exception: There is no penalty for members, assemblies, and the constructed portion touching the ground within the one-foot by one-foot footings.

11.7.4. A tool, nut, bolt, hardhat, goggles, or protective eyewear touches the river or ground outside a staging yard. Penalty is 1/4 minute (fifteen seconds) per incident. Exception: There is no penalty if a tool used exclusively for measuring touches the ground during use while being held by a builder.

11.7.5. A member, assembly, or tool touches a revetment. Penalty is 1/4 minute (fifteen seconds) per incident.

11.7.6. A builder steps or jumps on or over a revetment. Penalty is 1/4 minute (fifteen seconds) per incident. However, a builder may go around the end of a revetment, reach over a revetment, and pass members, assemblies, temporary piers, tools, and fasteners over a revetment without penalty.

11.7.7. A barge crosses over or under any part of a constructed portion. Penalty is 1/4 minute (fifteen seconds) per incident. However, a barge may reach and pass objects under, over, or through the constructed portion without penalty.

11.7.8. A builder steps outside the boundary of the construction site. Penalty is 1/4 minute (fifteen seconds) per incident. Exception: There is no penalty for stepping outside the construction site to retrieve an object that has been dropped such as a member, tool, nut, bolt, or hardhat.

11.8. Finish

Construction ends and the clock is stopped when

- the bridge has been completed by connecting all the members, and
- all tools, temporary piers (if used), and builders who are not barges are back in the staging yards, and
- the barges are in the river and not in contact with the bridge, and
- one of the builders signifies that they are finished.

Installation of decking is not included in timed construction.

After construction is finished the bridge must not be modified except as provided by section “11.9 Construction: Repairs.”

11.9. Repairs

Before the judges inspect and measure the bridge, and before the bridge is moved from the construction site, two builders will be given five minutes to inspect the bridge for construction mistakes and to plan corrective action. They must not modify the bridge and they must not touch the bridge except as necessary to use measuring devices. Following this inspection, builders will be permitted, but not required, to repair construction mistakes found by their inspectors. Repairs are made with the clock restarted and must be completed in ten minutes or less. Safety precautions (section 11.2) apply and accidents (section 11.7) are counted. The time required to make repairs (including penalties) is multiplied by 1.5 and added to the construction time. Judges will not inspect the completed bridge for violations of rules until after the team captain is satisfied or the time limit for repairs is reached.

12. LOAD TESTS

12.1. Safety Precautions

The judge will halt any activity that is hazardous.

A bridge could suddenly collapse or sway in any direction during load tests. Therefore, minimize the number of people near the bridge while it is being tested. Usually, the load should be placed on the bridge by only two members of the team. Team members who are not participating in loading, faculty advisers, and other spectators must observe from an area designated by the judges and host student organization.

While participating in load testing, competitors must wear hardhats meeting ANSI standard Z89.1, protective eyewear or safety goggles meeting ANSI standard Z87.1, 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.

During testing, safety supports must be in place below the decking. The safety supports should be of sufficient height, strength, number, and extent that none of the load will fall more than approximately six inches if the bridge collapses.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a portion of the decking that is cantilevered over its support.

When any portion of the load is on the bridge, no one is permitted to crawl, reach, or step under the bridge. If such an action is necessary, the load must first be removed.

12.2. Damage

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

If a nut falls off its bolt while the bridge is being transported or prepared for load testing, or if the threads of a nut are not fully engaged, the connection will be repaired, the nut will be installed, and a penalty of two minutes will be added to construction time.

A bridge with irreparable damage that would reduce its strength or stability (such as a missing or broken member or fastener) will not be approved for load testing and is not eligible for awards in any category.

12.3. Preparation

Temporary piers are not used during load testing.

The judge designates the “A” and “B” sides of each bridge by a random process. “Left” and “right” ends are determined by facing the “A” side.

“Sway” is translation in any horizontal direction. A target is established for sway measurement on the “A” side of the bridge, ten feet from the left end of the decking support surface on that side. The sway target is located at the level of the decking support surface, which is the same as the bottom of the decking. See the “Lateral Load Test” plan on the “Bridge Loading” diagram.

Three targets are established for measuring vertical deflection. Two of the vertical deflection targets are located longitudinally at the center of the left unit of decking, on the “A” and “B” sides of the bridge, at the level of the decking support surface, which is the same as the bottom of the decking. The other vertical deflection target is located longitudinally at the center of the right unit of decking, on the “A” side of the bridge, at the level of the decking support surface. Targets may be on the decking or on the bridge. For location of decking units, see section 12.5 and the “Location of Targets and Decking” plan on the “Bridge Loading” diagram.

At their discretion, judges may impose a penalty for a bridge that incorporates parts having the primary function of interfering with placement of targets or measuring equipment.

Teams must accept imperfect field conditions such as bent decking and slightly sloping floors.

12.4. Lateral Load Test

The provisions of this section are illustrated by the “Lateral Load Test” plan on the “Bridge Loading” diagram.

The lateral load test is conducted with one unit of decking 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 prevent the bearing surfaces of the bridge from lifting off the ground when lateral load is applied.

The two bearing surfaces on the “B” side of the bridge are prevented from sliding by horizontal restraint applied from the inside of the abutments as close as possible to the ground. This horizontal restraint does not restrain rotation of the abutments and is identical for all bridges.

Apply a fifty-pound lateral pull at the sway target and measure the sway. To pass the lateral load test, the sway must not exceed one inch.

If the bridge did not pass the lateral load test it is not approved for further testing. **Do not conduct any other load test**. Add a penalty of 900 pounds to the weight of the bridge and a penalty of thirty minutes to the construction time. Record: Aggregate deflection = sixty inches.

If the bridge passed the lateral load test, remove the load and decking, and proceed with the vertical load test.

12.5. Vertical Load Test

The provisions of this section are illustrated by the three "Vertical Load Test" elevations on the "Bridge Loading" diagram.

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

Decking units are three feet long in the longitudinal (span) direction of the bridge. Place the two decking units at distances L1 and L2 measured from the left end of the decking support surface on the "A" side of the bridge to the left edges of the decking units. See item 4 in chapter 8 for determination of L1 and L2, and section 12.3 for location of targets. Decking units are placed square with the bridge, with the main bars spanning laterally over the decking support surfaces, and centered on the designated nominal centerline (see section 9.3). Decking units must not be attached to the bridge and must not distort it (see rules 9.1.4 and 9.1.5).

Position measuring devices on the three vertical deflection targets.

Uniformly distribute 100 pounds of preload on the left decking unit and uniformly distribute100 pounds of preload on the right decking unit. Preloads are laterally centered on the decking units. Preloads are distributed and aligned identically for every bridge.

If a contestant disturbs a measuring device after it has been initialized and before the measurement is recorded, the judge will require the team to disassemble the bridge and repeat timed construction. Scoring will be based on the larger of the two construction times but will not exceed 125% of the initial construction time.

The two steps (increments) of vertical loading produce three measurements used in scoring

- D1A = value of downward vertical deflection at left target on the “A” side that occurs during step 1 (loading on left decking unit).
- D1B = value of downward vertical deflection at left target on the “B” side that occurs during step 1 (loading on left decking unit).
- D2 = value of downward vertical deflection at right target that occurs during step 2 (loading on right decking unit with load from step 1 remaining in place).

Step 1
Loading the left unit and measuring deflections at those targets

- The two 100-pound preloads remain in place.
- Initialize the sway measurement.
- Initialize the measuring devices on all three vertical deflection targets or record the initial readings.
- Team members place 1150 pounds of additional load on the left decking unit. The 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 should be placed at a steady pace, without hesitation.
- As the load is being placed, observe sway and deflection. Stop loading if
    a. sway exceeds one inch, or
    b. deflection measurement at any of the three vertical deflection targets exceeds two inches downward, or
    c. decking or any part of the bridge, other than the intended bearing points, comes to bear on a safety support or the floor, or
    d. a decking unit falls off the bridge, or
    e. a dangerous collapse is imminent, in the opinion of the judge.

If sway or deflection is excessive (situation a or b), the bridge is not approved for further load testing. Remove the load and **do not continue load testing**. Add an 800-pound penalty to the weight of the bridge and a penalty of thirty minutes to the construction time. Record: Aggregate deflection = sixty inches.

If the bridge fails (situation c, d, or e), it 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**.

If the bridge passes step 1, record the measured values D1A and D1B, which are the downward vertical deflections during step 1 of the two targets for the left decking unit.

Step 2
Loading the right unit and measuring deflection at that target

- The two preloads and the load from step 1 remain in place.
- Do **not** re-initialize the sway measurement.
- Do **not** re-initialize the measuring devices on the left deflection targets.
- Initialize the measuring device on the right vertical deflection target or record the reading.
- Team members place 1150 pounds of additional load on the right decking unit. The 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 should be placed at a steady pace, without hesitation.
- As the load is being placed, observe sway and deflection. Stop loading if
    a. sway exceeds one inch, or
    b. deflection measurement at any of the three vertical deflection targets exceeds two inches downward, or
    c. decking or any part of the bridge, other than the intended bearing points, comes to bear on a safety support or the floor, or
    d. a decking unit falls off the bridge, or
    e. a dangerous collapse is imminent, in the opinion of the judge.

If sway or deflection is excessive (situation a or b), the bridge is not approved for further load testing. Remove the load and **do not continue load testing**. Add a 700-pound penalty to the weight of the bridge and a penalty of thirty minutes to the construction time. Record: Aggregate deflection = sixty inches.

If the bridge fails (situation c, d, or e), it 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**.

If the bridge passes step 2, record the measured value D2 = value of downward vertical deflection during step 2 of the target for the right unit of decking. Compute and record: Aggregate deflection = D1A + D1B + D2.

12.6. Unloading

If the bridge collapses during unloading, it is not eligible for awards in any category.

13. EQUIPMENT PROVIDED BY HOST

The web site http://www.nssbc.info has detailed descriptions and illustrations of hosting equipment. The following partial list is intended to help competitors know what to expect. Competitors should acquire similar equipment for use in practice and testing before the competition.

13.1. Lateral Load Device

Capable of applying a 50-pound force in the horizontal direction.

13.2. Equipment for Measuring Sway

Sway is horizontal translation and is measured by any accurate method. A suggested method is to suspend a plumb bob from the sway target and measure sway from a point marked on the ground.

13.3. Equipment for Measuring Deflection

Deflection is vertical translation and is measured at three points by any accurate method.

13.4. 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 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 of the grating that are perpendicular to the length.

13.5. Load

2500 pounds total. The load 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.

13.6. Safety Supports

The safety supports must be used during load testing and are intended to limit the consequences of a bridge collapsing. The safety supports should 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, timbers, sand bags, or masonry units.

13.7. Floor

The surfaces on which the bridges will bear should be as nearly flat and level as possible, in both the construction site and loading area.

13.8. Revetments

Revetments should be 1'6" to 2'6" high, ten feet long, and no thicker than one foot. Examples of adequate revetments include caution tape stretched between supports, mesh fencing, wood-framed knee walls, or insulation panels.

13.9. String

A string is stretched between the holes specified in section 9.3 in order to identify the nominal centerline of the bridge, which guides checking dimensions (rules 9.2.4, 9.2.5, 9.2.6, and 9.2.14) and placing the decking and load (rule 12.5).

14. INTERPRETATION OF RULES

The web site http://www.aisc.org/steelbridge.html lists answers to questions about 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 and reread this *Rules* document carefully in its entirety**. The names of submitters and their affiliations will be posted with their questions. Questions must be submitted before 5:00 PM Eastern Daylight Saving Time, 12 May 2008.

15. 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, including the official scoring spread sheet, is available at http://www.nssbc.info and http://www.aisc.org/steelbridge.html.

16. APPEALS

16.1. Regional Competitions

16.1.1. At the beginning of the competition each team will identify the team member who serves as captain. The host organization will identify the regional head judge (RHJ).

16.1.2. A penalty, decision, measurement, score, or condition of competition may be appealed only by a team captain and only to the RHJ. The appeal must be made as soon as possible after the situation becomes apparent. The RHJ will not hear the appeal if he or she is approached by students other than the team captain. The RHJ will hear the appeal as soon as possible and may interrupt the competition. Participants are reminded that civility and ethical behavior are expected during the competition and particularly concerning appeals.

16.1.3. After the regional competition, the team captain has the option to appeal the decision of the RHJ by sending an e-mail message to Mr. Fromy Rosenberg <rosenberg@aisc.org> followed by a letter mailed to Mr. Rosenberg (AISC, Suite 700, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to ASCE Student Services (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The e-mail message and letter should include

- name of the college or university making the appeal,
- team captain's name, e-mail address, postal address, and telephone number,
- faculty adviser's name, e-mail address, postal address, and telephone number,
- brief description of the problem,
- action taken at the competition to deal with the problem,
- action that the appealing team feels should have been taken,
- data showing that the team should have qualified for national competition, and
- team captain's signature (letter only).

Appeals must be made by e-mail followed by letter. An appeal will be considered only if the e-mail is received and the letter is postmarked within **one week** after the regional competition. Mr. Rosenberg will forward the appeal to the ASCE/AISC Rules Committee for their evaluation. The only redress that may be made is an invitation to participate in the national competition if the Rules 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 regional judges will not be overturned.

16.2. National Competition

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

16.2.2. 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.

16.2.3. 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 ASCE/AISC Rules Committee. The conditions at issue will not be changed during deliberation.

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

16.2.5. The decision of the ASCE/AISC Rules Committee is final; there are no further appeals. However, AISC and ASCE welcome written suggestions for improving future competitions.

17. SUMMARY OF SCORING

This form summarizes chapter "7 Scoring." Official scoring data should be recorded on the official scoring spreadsheet that is available at http://www.nssbc.info. The completed official scoring spread sheet should be submitted to aftbq@uaa.alaska.edu.

17.1. Display (see section 7.1 - Judges should not declare ties in display.)

- o Appearance: balance, proportion, elegance, finish.
- o Name of college or university on bridge in letters at least one inch high.
- o Poster describing design and fabrication, no larger than 2 x 3 feet.

DISPLAY SCORE = _____

17.2. Construction Speed and Time Penalties

Construction clock time, CT			_____ minutes
If CT ≤ 30 minutes, enter CT			
If 30 < CT ≤ 45, multiply CT by 1.5 (see 11.6)			
If 45 < CT ≤ 60, enter 180 (see 11.6)			_____ minutes
Time penalties during construction (see 11.7)			
11.7.1,2: violations _____	x 1/2	+	_____ minutes
11.7.3,4,5,6,7,8: violations _____	x 1/4	+	_____ minutes
Repair time (see 11.9) _____	x 1.5	+	_____ minutes
Time penalties during repair (see 11.7, 11.9)			
11.7.1,2: violations _____	x 1/2 x 1.5	+	_____ minutes
11.7.3,4,5,6,7,8: violations _____	x 1/4 x 1.5	+	_____ minutes
Time penalty, damage (see 12.2)		+	_____ minutes
Time penalty, load tests, 30 min (see 12.4 and 12.5)		+	_____ minutes

TOTAL TIME = _____ minutes
Lowest total wins.

17.3. Construction Economy

Number of builders, including barges		(_____ persons
Total time (part 17.2)	x	_____ minutes
	x	50)
Number of moves of temporary piers (see 11.1.8)	+	(_____
	x	20)
Number of barges (0, 1 or 2)	+	(_____
	x	30)

CONSTRUCTION COST: C_c = _____ thousand $
Lowest cost wins.

17.4. Lightness and Weight Penalties

Bridge weight _____ pounds
Weight penalties,
"7.1 Display" (50 or 100) + _____ pounds
"9.2 Dimensions and Support: Usability"
Rules violated ≤ ½ inch _____x 50 + _____ pounds
Rules violated ½ - 1 inch _____x 150 + _____ pounds
Rules violated 1 - 2 inch _____x 300 + _____ pounds
"9.3 Dimensions and Support: Centerline" (100) + _____ pounds
"10.2 Material & Components: Durability & Constructability"
Number of violations _____ x 10 pounds + _____ pounds
Wt. of parts in violation _____ pounds x 5 + _____ pounds
"12.4 and .5 Load Tests: Lateral Load and Vertical Load"
(900, 800 or 700) + _____ pounds

TOTAL WEIGHT = _____ pounds
Lowest weight wins.

17.5. Stiffness

AGGREGATE DEFLECTION: D1A + D1B + D2 = _____ inches
Lowest deflection wins.

17.6. Structural Efficiency

Total weight (part 17.4) (_____ pounds
x 3)
Aggregate deflection (part 17.5) + (_____ inches
x 700)

STRUCTURAL COST: C_s = _____ thousand $
Lowest cost wins.

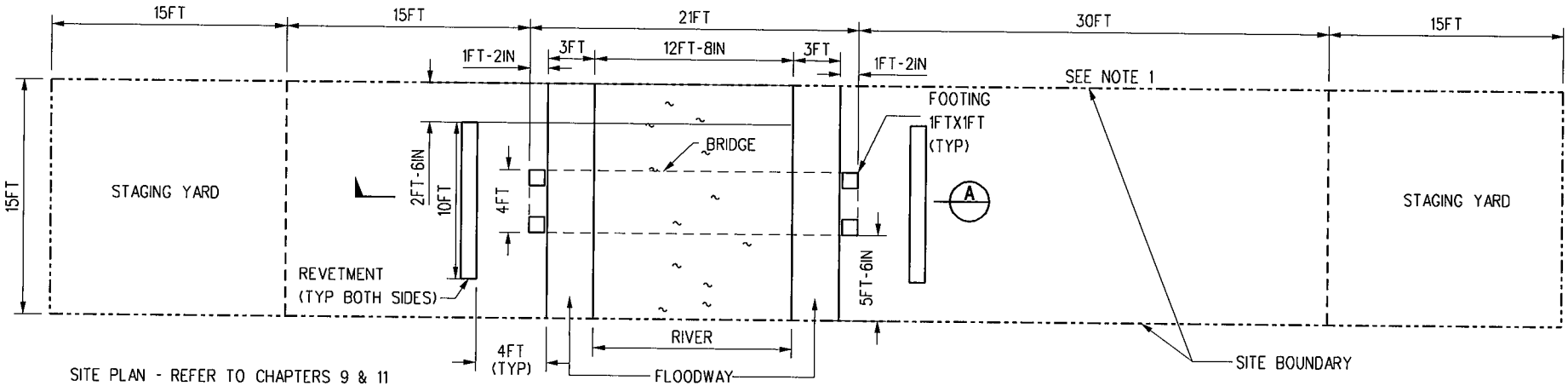
17.7. Overall Performance

C_c (from part 17.3) _____ + C_s (from part 17.6) _____ = _____
Lowest total wins.

17.8. Ranks (Display is the tie-breaker for all categories)

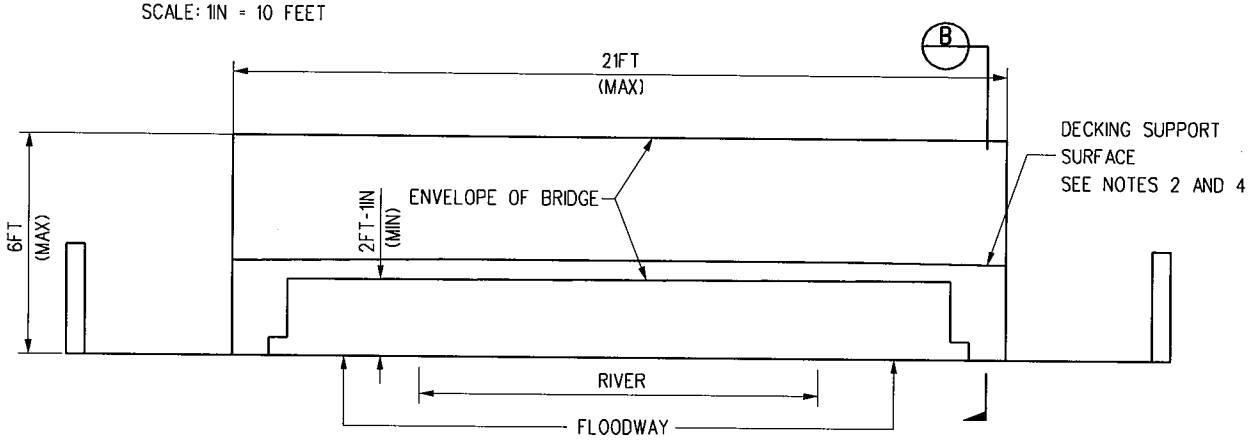
A bridge will not be ranked if it was not approved for construction or load testing, or if it failed in load testing.

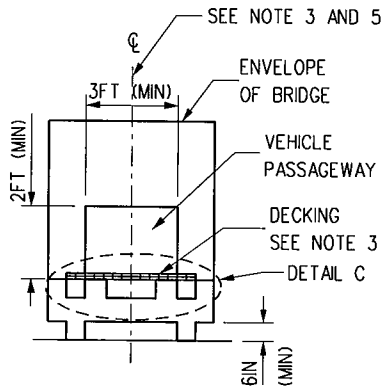
Display _____ Construction Speed _____ Lightness _____
Stiffness _____ Construction Economy _____ Structural Efficiency _____
Overall Performance _____



SITE PLAN - REFER TO CHAPTERS 9 & 11

SCALE: 1IN = 10 FEET



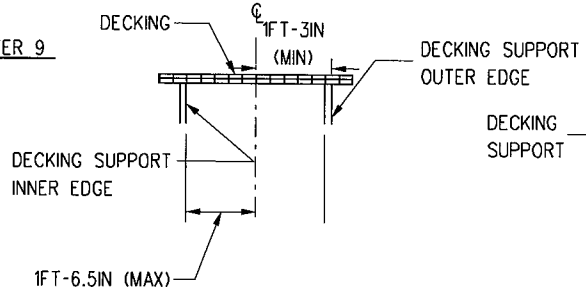


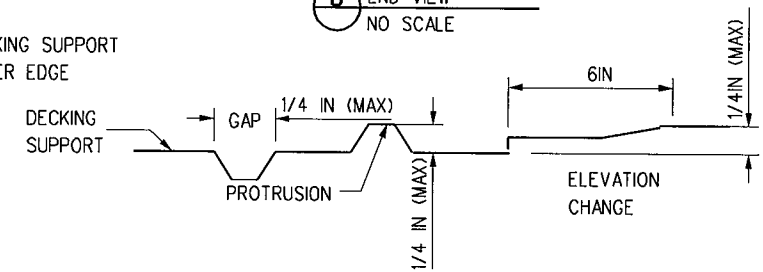
(A) ELEVATION - REFER TO CHAPTER 9

SCALE: 1 IN = 5 FT

(B) END VIEW

NO SCALE





(C) DECKING SUPPORT

NO SCALE

IRREGULARITIES IN DECKING SUPPORT - REFER TO CHAPTER 9

SCALE: NONE

NOTES:

1. LENGTH CAN BE ADJUSTED TO FIT SITE CONDITIONS.
2. TOP OF THE DECKING SUPPORT SHALL BE BETWEEN 2FT-3IN AND 2FT - 6IN ABOVE GRADE.
3. BRIDGE SHALL ACCOMODATE 3FT - 9IN DECKING THROUGHOUT OVERALL LENGTH OF THE BRIDGE IN ACCORDANCE WITH RULE 9.2.4.
4. NO PART OF BRIDGE SHALL EXTEND BEYOND DECKING SUPPORT SURFACE (AT BOTH ENDS).
5. DIMENSIONS ARE CENTERED ON BRIDGE CENTERLINE.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION
A	6-12-07						2008 SSBC RULES

DESIGNED BY: F. HATFIELD
DRAWN BY: D. SEPULVEDA
CHECKED BY: RULES COMM.
IN CHARGE: F. ROSENBERG
DATE: 6-11-2007

ASCE - AISC
STUDENT STEEL BRIDGE CONTEST

ASCE American Society of Civil Engineers

SUBMITTED

APPROVED

SITE AND BRIDGE DIAGRAM

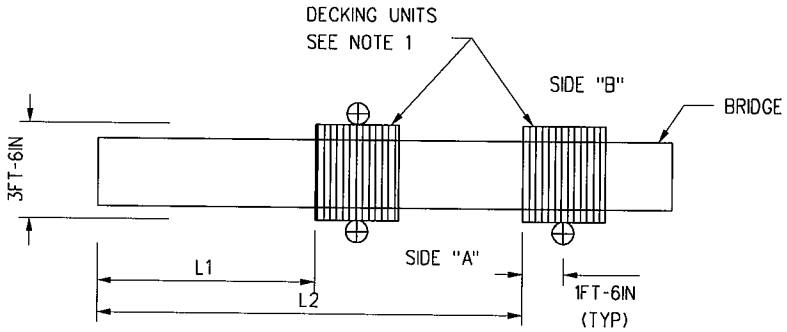
CONTRACT NO

DRAWING NO: EXHIBIT 1 REV

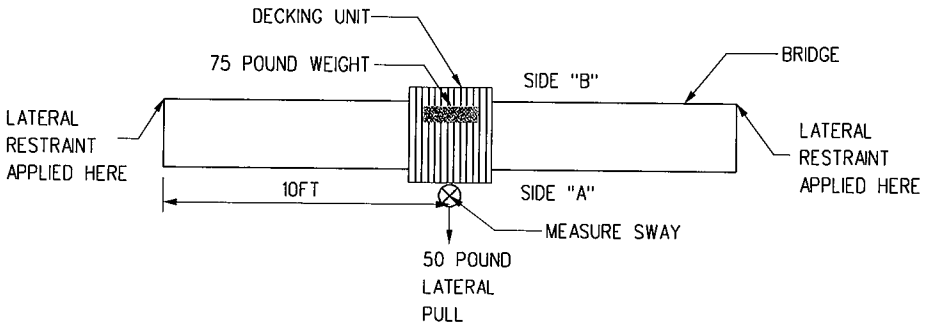
SCALE: AS SHOWN

SHEET NO

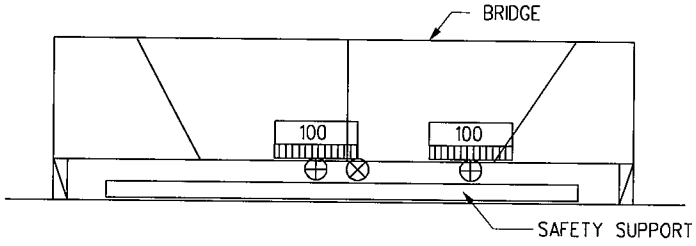
Plotted by:



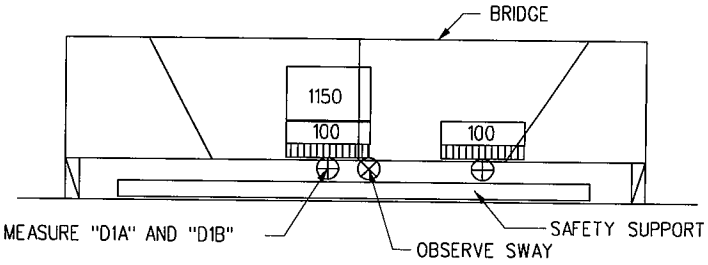
A LOCATIONS OF TARGETS AND DECKING - PLAN
REFER TO CHAPTER 12, SECTIONS 3 & 5



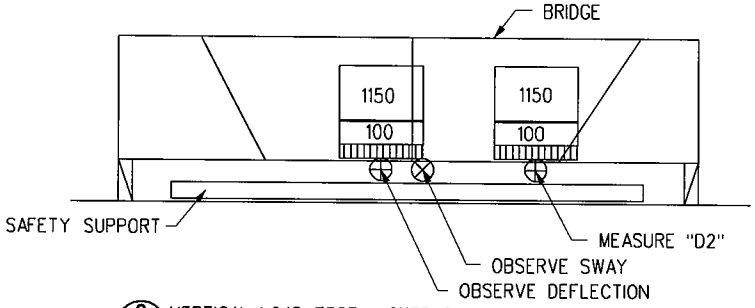
B LATERAL LOAD TEST - PLAN
CHAPTER 12, SECTIONS 3 & 4



0 VERTICAL LOAD TEST - PRELOAD
REFER TO NOTES DURING LOADING PROCESS



1 VERTICAL LOAD TEST - STEP 1
REFER TO NOTES DURING LOADING PROCESS



2 VERTICAL LOAD TEST - STEP 2
REFER TO NOTES DURING LOADING PROCESS

LEGEND

⊕ TARGETS FOR MEASURING VERTICAL DEFLECTION TO BE PLACED LONGITUDINALLY AT THE CENTER OF THE DECKING UNITS

⊗ TARGET FOR MEASURING SWAY

NOTES

1. THE LOAD IS LATERALLY CENTERED ON THE DECKING UNIT AND DISTRIBUTED OVER THE LENGTH OF THE DECKING UNIT AS UNIFORMLY AS POSSIBLE AT ALL TIMES DURING LOADING.
2. OBSERVE ALL VERTICAL TARGETS ON EACH SIDE OF THE BRIDGE FOR DEFLECTION.
3. LOADING TERMINATES IF DEFLECTION AT ANY OF THE VERTICAL DEFLECTION TARGETS EXCEEDS 2 INCHES DURING STEP 1 AND STEP 2.
4. LOADING TERMINATES IF SWAY AT SWAY TARGET EXCEEDS 1" DURING STEP 1 AND STEP 2.
5. SAFETY SUPPORT TO BE IN PLACE AT ALL TIMES DURING LOADING.
6. BRIDGE TO BE UNLOADED IN THE REVERSE ORDER OF LOADING.
7. ALL LOADING SAFETY PROCEDURES TO BE FOLLOWED.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION
A	6-12-07						2008 SSBC RULES

DESIGNED BY: F. HATFIELD
DRAWN BY: D. SEPULVEDA
CHECKED BY: RULES COMM.
IN CHARGE: F. ROSENBERG
DATE: 6-11-2007

ASCE - AISC
STUDENT STEEL BRIDGE CONTEST

ASCE American Society of Civil Engineers

SUBMITTED
APPROVED

BRIDGE LOADING

DIAGRAM

CONTRACT NO
DRAWING NO: EXHIBIT 2
REV
SCALE: AS SHOWN
SHEET NO

STUDENT STEEL BRIDGE COMPETITION

2007 RULES

The mission of the ASCE/AISC 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 issues such as spatial constraints, material properties, strength, serviceability, fabrication and erection processes, safety, esthetics and cost. Success in inter-collegiate competition requires effective team work and project management. Future engineers are stimulated to innovate, practice professionalism and use structural steel efficiently.

TABLE OF CONTENTS

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

1. INTRODUCTION

The Student Steel Bridge Competition is sponsored by the American Institute of Steel Construction (AISC) and by the American Society of Civil Engineers (ASCE), and co-sponsored by the American Iron and Steel Institute, the James F. Lincoln Arc Welding Foundation, the National Steel Bridge Alliance, and the Nucor Corporation.

Students design a steel bridge by themselves but may seek advice from faculty and other consultants. Students gain maximum benefit from the competition if they fabricate the entire bridge themselves. However, because appropriate shop facilities and supervision are not available at all universities, the services of a commercial fabricator may be used provided that students develop the work orders 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.

This booklet describes the competition and states the rules for this year. It is available at http://www.aisc.org/steelbridge.html, together with related information. These rules govern competition at both regional and national levels.

The rules are changed every year to improve the competition and assure 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 chapter "14 Interpretation of Rules." Revisions to the rules, if any, are incorporated in the clarifications that appear on the web page cited in that chapter.

2. EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication, and construction. Participating students gain practical experience in structural design, fabrication processes, construction planning, organization, and teamwork.

The rules of the competition simulate a request for proposal that requires a scaled model to demonstrate the efficacy of competing designs. Chapter "5 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 regulations 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 (Department of Transportation) and have the authority to accept and reject entries.

The safety of competitors, judges, and spectators is paramount. Risky procedures are prohibited, and bridges that cannot be constructed and tested 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.

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

3. ELIGIBILITY

3.1. Regional Competition

There are two levels of competition: regional and national. Regional competitions are held in conjunction with ASCE regional student conferences. Only one bridge per college or university may compete in a regional competition, and a college or university may compete in only one region.

The ASCE student chapters, ASCE student clubs, and ASCE international student groups entering the competition are required to be current with their national dues and annual reports. A team must consist only of undergraduate and graduate students in good standing with their ASCE student group.

A student team which does not have an ASCE student group that meets the requirements of the preceding paragraph may enter a steel bridge in a regional competition if invited by the regional host group. Such teams are invited guests and will not be ranked in regional competitions nor will they be invited to compete in the National SSBC.

In order to facilitate broader participation by ASCE student groups in regional conference activities, the ASCE Committee on Student Activities (CSA) wishes to stress the importance of the conference as an event that is much more than a qualifying round for national competitions and to highlight the required events at a conference. Therefore, an ASCE student group is permitted to participate in the National SSBC only if it is in good standing with ASCE (annual report and annual dues submitted and received by ASCE prior to the start of a regional conference) and is a qualified regional conference participant as shown by

- good faith participation in the regional conference business meeting (i.e., attendance by representatives of the student group),
- good faith participation in the regional conference paper competition (i.e., submission and presentation by at least one member of the student group),
- meeting any additional requirements of regional conference participation set by the regional conference at the previous year's business meeting or in its written and approved by-laws, standing rules, or constitution.

3.2. National Competition

Invitations to compete at the national level are extended only to the winner from a region in which two, three, or four ASCE student groups competed, to the top two teams from a region in which five to ten ASCE student groups competed, and to the top three teams from a region with eleven or more competing ASCE student groups. Guest teams will not be invited to the national competition and will not be counted when determining how many teams will be invited from a region. Only one bridge per college or university may be entered in the national competition.

4. RULE CHANGES

The following list covers some of the major changes from the 2006 rules. Not all changes are listed. Contestants, hosts, and judges are cautioned to **read this entire booklet carefully and disregard rules and clarifications from previous years**.

1. Eligibility requirements are stricter.
2. Dimensional limits and load patterns are different.
3. Height of the vehicle passageway is from the decking support surface.
4. Footings are not skewed.
5. A bridge must have a designated nominal centerline that will be used to check vehicle clearance and to position loads.
6. Fasteners are not limited to a single diameter.
7. "Superintendent" replaces "coach."
8. There may be multiple temporary piers and they may be moved, at a cost.
9. Builders cannot support a constructed portion.
10. Restrictions on movement of the constructed portion are more liberal.
11. Movement of builders is restricted by revetments.
12. The structural efficiency score, C_s, is computed by a different formula.

5. PROBLEM STATEMENT

A century-old bridge that spans a river and adjacent floodway must be replaced. The bridge carries traffic serving the residences, farms, and agricultural processing industries that are the economic base of this rural region. A quick replacement is necessary because no other crossing is available for miles.

The state Department of Transportation (DOT) has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered but the DOT has specified steel as the material because of its durability, fast erection, and high level of recycled content. Clearance under the bridge must be provided for passage of floods. The bridge must be able to carry specified patterns of loads without exceeding sway and deflection limits. Based on past experience with performance and maintenance, the DOT prefers bridges that are relatively light and stiff. The new bridge must accommodate modular decking that was salvaged from another structure.

Due to environmental concerns, construction of permanent piers is permitted only on the existing footings. Temporary piers may be used. Construction barges and other equipment are not permitted in the river. Soil conditions limit the weight of loads that may be moved. Existing revetments protect steep slopes and must not be damaged by construction equipment.

Your company's design/build proposal is among those that the DOT has deemed responsive, and winning the contract would be a step toward becoming a leader in the bridge replacement market. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. A panel of DOT personnel will judge the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy, and display. The contract will be awarded to the company whose model best meets the DOT's needs and requirements. 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 rejection of the model and termination of the company's eligibility.

6. SAFETY

Safety has the highest priority. Judges are empowered to halt any activity that they deem hazardous. Judges will stop construction procedures that could cause personal injury. Judges will not allow additional load to be placed on a bridge that has collapsed, that is approaching a collapse that could be dangerous, or that has swayed or deflected in excess of specified limits. A bridge that cannot be safely constructed or load tested using the equipment provided by the host is not eligible for awards in any category and must be withdrawn from participation.

7. SCORING

A college or university may enter only one bridge in regional competition and may compete in only one region.

Categories of competition are display, construction speed, lightness, stiffness, construction economy, and structural efficiency. In addition, overall performance is rated. A bridge that was not approved for load testing or that failed in load testing is not eligible for awards in any category.

7.1. Display

Display is the tie-breaker for all categories of competition. Judges should not declare ties in display. Display is judged by

7.1.1. Appearance of bridge, including balance, proportion, elegance, and finish. Quality of fabrication should not be considered because some bridges may be fabricated professionally while others are student work.

7.1.2. Permanent identification of the bridge consisting of the full name or unique commonly accepted name of the college or university (not initials or name of mascot). The name must appear on the bridge in letters at least one inch high and must be formed from steel or applied to steel with paint or decals. The name on the bridge must be the same as the name on the poster. A 50-pound weight penalty will be imposed if the bridge lacks appropriate identification.

7.1.3. Poster describing design. The poster must be flat with maximum dimensions of 2 feet by 3 feet and must present all information on one side without attached pages that must be lifted or turned. The poster must identify the college or university with the same name that appears on the bridge and must present a brief explanation of why the overall configuration of the bridge was selected, a brief computation demonstrating design for one limit state, and a scaled, dimensioned side view of the bridge. Additional information may be included. Electronic displays, decorated poster supports, lights, and sound are not permitted and will result in the worst possible rating for the poster. A 50-pound weight penalty will be imposed if there is no poster or if the content is grossly inadequate. The poster is not part of the bridge but must be in place whenever the bridge is on display.

7.2. Construction Speed

The bridge with the lowest total time will win in this category. Total time is the time required for construction plus 150% of the time for repairs (see section 11.10), modified by penalties prescribed in sections 11.6, 11.8, 11.10, 12.2, 12.4, and 12.5. There is an upper limit on construction time.

7.3. Construction Economy

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

C_c = Total time (minutes) x Number of builders (persons)
x 50 thousand dollars per person-minute
+ 20 thousand dollars for every move of a temporary pier.

Total time is defined in section "7.2 Scoring: Construction Speed" and includes penalties. The number of builders includes all members and associates of the competing group who are within the construction site at any time during timed construction.

7.4. Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in sections "7.1 Scoring: Display," "9.2 and 9.3 Dimensions and Support: Usability and Centerline," "10.2 Material and Components: Durability and Constructability" and "12.4 and 12.5 Load Tests: Lateral Load Test and Vertical Load Test." Decking, tools, temporary piers, and poster are not included in total weight.

7.5. Stiffness

The bridge with the lowest aggregate deflection will win in the stiffness category. Aggregate deflection is determined from measurements as prescribed in section "12.5 Load Tests: Vertical Load Test."

7.6. Structural Efficiency

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

C_s = Total weight (pounds) x 5 thousand dollars per pound
+ Aggregate deflection (inches) x 500 thousand dollars per inch.

Total weight is defined in section "7.4 Scoring: Lightness" and includes penalties. Aggregate deflection is defined in section "7.5 Scoring: Stiffness" and includes penalties.

7.7. 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.

8. SCHEDULE OF COMPETITION

In the months before the competition, students design their bridges, fabricate members, test load, practice construction, and select a member of the team to serve as its captain. The following events occur during the competition

1. Bridges are erected for public viewing and are judged for display. After this, bridges must not be altered, modified, or enhanced in any way except for disassembly, erection, and repairs as described in section "11.10 Construction: Repairs."

2. Judges clarify rules and conditions of the competition and answer questions.

3. Bridges are disassembled.

4. The head judge selects the locations of loads. See section "12.5 Load Tests: Vertical Load Test" and the "Locations of Targets and Decking" detail on the "Bridge Loading" diagram. Selection is done in the presence of the team captains by rolling a die twice. Let S1 and S2 be the spots from the two rolls and let L1 and L2 be dimensional locations of decking units in inches.

$$L1 = 40 + 6\,(S1) \quad \text{and} \quad L2 = 110 + 6\,(S2)$$

The same locations will be used for all bridges.

5. Bridge members, fasteners, tools, and temporary piers are staged for construction and inspected by the judges. See chapter "10 Material and Components" for details.

6. Timed construction. See chapter "11 Construction" for details.

7. Judges inspect assembled bridges. See chapter "9 Dimensions and Support" and rules 10.1.2, 10.1.3, 10.2.11, and 10.2.12 for details.

8. Bridges are weighed (if it is impractical to weigh the entire bridge, its parts may be weighed prior to construction).

9. Load testing. See chapter "12 Load Tests" for details.

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

- bridges are not modified after selection of load locations, and
- bridges are not modified between display judging and timed construction,
- no components or tools are added to or removed from the construction site after staging and inspection, and
- modifications between timed construction and load testing are limited to repairs as described in "11.10 Construction: Repairs."

9. DIMENSIONS AND SUPPORT

Dimensions and support will be checked with the bridge in its as-built condition after construction is completed 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 any applied load on the bridge.

9.1. Functionality and Safety

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

9.1.1. The bridge must span the river and floodway without touching them. See the "Site Plan" on the "Site and Bridge" diagram.

9.1.2. The bridge must provide support for the decking for the full overall length of the bridge along both of the edges that run in the span direction of the bridge. See the "Elevation" on the "Site and Bridge" diagram.

9.1.3. Decking support must be rigid. At their discretion, judges may test rigidity by applying a 25-pound load at selected points on the decking support. Deflection under that load exceeding 1.0 inch indicates lack of rigidity.

9.1.4. The bridge must provide access for placing the decking and load.

9.1.5. The decking must not be attached or anchored to the bridge, and it must not be used to distort the bridge from its as-built condition.

9.1.6. The bridge must not be anchored or tied to the ground.

9.1.7. It must be possible to construct and load the bridge safely using equipment provided by the host student group. **Bridges must accommodate local conditions.**

9.2. Usability

A weight penalty will be assessed for each rule in this section (9.2) that is violated, rather than for every violation of that rule.

The penalty for violation for each of the following rules will be an addition to the weight of the bridge determined as follows: 50 pounds for a dimensional violation of ½ inch or less; 150 pounds for a dimensional violation greater than ½ inch but not exceeding 1.0 inch; 300 pounds for a dimensional violation greater than 1.0 inch but not exceeding 2.0 inches. If a dimensional violation exceeds 2.0 inches, the bridge will not be approved for load testing and will not be eligible for awards in any category.

9.2.1. The bridge must bear on the ground only within the 1-foot by 1-foot squares that are marked on the construction site to represent existing footings. See the "Site Plan" on the "Site and Bridge" diagram.

9.2.2 Decking support surfaces must not be more than 20'0" long and must extend for the overall length of the bridge.

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

9.2.4. The bridge must be able to accommodate solid decking that is 3½ inches thick and 3'9" wide at all points along the length of the bridge. This rule will be checked by sliding a template along the full overall end-to-end length of the decking support surfaces.

9.2.5. Clear span of the decking between decking support surfaces must not exceed 3'2" at any point along the length. This dimension is measured between points of contact of the decking with the support surfaces. See the "Decking Support" detail on the "Site and Bridge" diagram.

9.2.6. The transverse dimension over the decking support surfaces must not be less than 2'6" at any point along the length. This dimension is measured between points of contact of the decking with the support surfaces. See the "Decking Support" detail on the "Site and Bridge" diagram.

9.2.7. The decking support surfaces must not have gaps exceeding ¼ inch wide in the span direction of the bridge. See the "Irregularities in Decking Support" detail on the "Site and Bridge" diagram.

9.2.8. The decking support surfaces must not have vertical protrusions exceeding ¼ inch high. See the "Irregularities in Decking Support" detail on the "Site and Bridge" diagram.

9.2.9. Elevation of the decking support surface must not change more than ¼ inch in any 6 inches of span length. See the “Irregularities in Decking Support” detail on the “Site and Bridge” diagram.

9.2.10. The decking support surface must be no less than 2’3” nor more than 2’6” above the surface of the ground or river at any point. See the “Elevation” on the “Site and Bridge” diagram.

9.2.11. The bridge must not extend more than 7'0" above the surface of the ground or river. See the “Elevation” on the “Site and Bridge” diagram.

9.2.12. Clearance must be provided under the bridge at all points directly over the river and floodway. The clearance must be at least 1’9” high, measured from the surface of the river and floodway. See the “Elevation” on the “Site and Bridge” diagram.

9.2.13. At all other points that are not directly over the river, floodway, or footings, there must be clearance of at least 6 inches under the bridge. See the “End View” on the “Site and Bridge” diagram.

9.2.14. A vehicle passageway must completely traverse the bridge from end to end. It must be at least 2’0” high, measured from the decking support surfaces, and must extend at least 1’6” on both sides of the nominal centerline (described in section 9.3). See the “End View” on the “Site and Bridge” diagram.

9.3. Centerline

A weight penalty of 100 pounds will be assessed if any of the requirements in this section (9.3) is violated or if some feature of the bridge prevents the judge from determining a straight centerline.

9.3.1. The bridge must have a designated straight nominal centerline extending from one end to the other. The centerline must be designated by two holes, one at each end of the bridge, drilled through horizontal steel surfaces at the level of the decking support surfaces. Each hole must be ¼ inch in diameter and must be located no more than 3 feet from the vertical plane defined by the ends of the decking support surfaces.

10. MATERIAL AND COMPONENTS

10.1. Safety

If any one of the following rules in this section (10.1) is violated, the bridge will not be approved for construction or load testing, and will not be eligible for awards in any category.

10.1.1. A member must not weigh more than 20 pounds. See section 10.2 for definition of “member.”

10.1.2. A bridge must 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.

10.1.3. After completion of timed construction, energy must not be transmitted to or from a bridge (for example, by applying mechanical, magnetic, fluidic, or other force; by sound, light, radio, or other wave or ray; by conduction or convection of heat; or by electric current). The exceptions are forces necessary to the competition (for example, those associated with load testing and with moving the bridge from place to place), and changes in ambient conditions that are not controlled by contestants (such as wind, temperature, and lighting).

10.2. Durability and Constructability

Violation of the following rules in this section (10.2) will result in penalties being added to the weight of the bridge. The penalty for each violation is 10 pounds plus 5 times the weight of the non-conforming member or fastener. If the non-conforming component weighs less than one pound, its weight will be assumed to be one pound for the purpose of computing the penalty.

10.2.1. A bridge must be constructed only of structural steel. For the purposes of this competition, structural steel is defined as an iron alloy that is strongly attracted to a magnet. Solder, brazing, and adhesives are not permitted. Exceptions: Paint, decals, and other purely decorative items are permitted.

10.2.2. A bridge must be constructed only of members and fasteners. During timed construction, members are connected with fasteners to form assemblies and the constructed portion, which are defined and regulated by rules in chapter “11 Construction.”

Members

10.2.3. A member is a rigid steel component that retains its shape and dimensions during timed construction and in the completed bridge.

10.2.4. A member must not exceed overall dimensions of 3'6” x 6” x 6.” That is, it must fit in a prismatic box of those dimensions.

10.2.5. A member must 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. Exception: Deformations caused by mechanical strain (e.g., bending, stretching) during load testing are not violations of this rule.

10.2.6. A member may consist of multiple parts rigidly joined together before timed construction begins. Those parts must remain rigidly joined throughout timed construction and in the completed bridge. Parts must be joined by welding or with steel connectors such as bolts, screws, and rivets.

Fasteners

10.2.7. A fastener is a steel bolt that is not part of a member, with at least one steel nut that is not part of a member. The specified bolts and nuts usually are available in hardware stores.

10.2.8. The bolt in a fastener must be no more than 3" nominal length (bottom of head to end) with a hexagonal head, and it must have the configuration and dimensions of a "cap screw grade 2," "cap screw grades 5 and 8," "A307 bolt," "A325 and A390 structural bolt", or "hex tap bolt" illustrated on http://www.purchasepartners.com/fastenerspecs.htm. Bolts must not be mechanically altered or modified in any manner. They may be painted.

10.2.9. The nuts in a fastener must match the bolt. That is, the nominal size (inside diameter) must be the same as that of the bolt and the threads of the nuts must engage the threads on the bolt and permit the nuts to be turned onto the bolt. Nuts must be solid, hexagonal, and have the configuration and dimensions of "finished hex nut grade 2," "finished hex nut grades 5 and 8," or "heavy hex nut" as illustrated on the web site cited in rule 10.2.8. Nuts must not be mechanically altered or modified in any manner. They may be painted.

10.2.10. Nuts and bolts that connect the parts of a member but do not connect a member to other members are not considered to be fasteners and are not governed by rules 10.2.7, 10.2.8, and 10.2.9.

Member-to-member Connections

10.2.11. Each member must be connected directly to every member that it touches by at least one fastener installed during timed construction so that the connection cannot be taken apart without first removing a nut from the bolt.

10.2.12. The bolt must penetrate completely through a hole in each of the members that it connects. Dimension(s) of the hole must be small enough so that neither the head of the bolt specified in rule 10.2.8 nor the nut as specified in rule 10.2.9 can pass through the hole.

11. CONSTRUCTION

11.1. Definitions

11.1.1. “Builders” and “superintendent” are undergraduate or graduate student members of a competing student group. See chapter 3 for eligibility requirements.

11.1.2. A “team” is all the builders and the superintendent from the group that is constructing the bridge. The team must include no more than six builders and one superintendent.

11.1.3. “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.

11.1.4. A “tool” is a device used during construction that is not part of the completed bridge. A team provides its own tools.

11.1.5. “Temporary piers” may be used to support the bridge during timed construction. A team provides its own temporary piers.

11.1.6. “Member,” “fastener,” and “member-to-member connection” are defined in section 10.2.

11.1.7. An “assembly” consists of members that are connected together in a staging yard during timed construction.

11.1.8. “River,” “floodway,” “staging yard,” “footing,” and construction “site boundary” are defined by the “Site and Bridge” diagram. “Ground” is all parts of the construction site except the river.

11.1.9. A “constructed portion” is created in essentially its final position by connecting together members and assemblies during timed construction. A constructed portion is not required to be contiguous.

11.1.10. “Connected” means that every member in the assembly or constructed portion is fastened to that assembly or constructed portion by a member-to-member connection.

11.1.11. A member or assembly becomes part of a constructed portion when it is released by the builder or builders who were supporting it.

11.2. Safety

If any of the rules in this section (11.2) is violated during timed construction, the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools, members, assemblies, fasteners, and temporary piers will be returned to the positions they occupied before the violation. Then the team will be asked to resume construction using safe procedures. A team will have the opportunity to construct its bridge safely but if this is not possible, construction will cease and the bridge will not be approved for load testing and will not be eligible for awards in any category.

11.2.1. Builders must not be exposed to risk of personal injury.

11.2.2. Only builders and judges are permitted within the boundaries of the construction site during timed construction.

11.2.3. The superintendent may observe and direct the builders from outside the boundaries of the construction site but must not physically assist builders or interfere with judges.

11.2.4. At all times during timed construction every builder and the superintendent must wear personal protective equipment in the proper manner (e.g., hardhat with peak in front).

11.2.5. Welding machines and tools requiring external power connections must not be used during timed construction.

11.2.6. A tool must not weigh more than 20 pounds and must not exceed 3’6” in any linear dimension when fully assembled and extended.

11.2.7. A temporary pier must not exceed 20 pounds in weight.

11.2.8. A temporary pier must not exceed 1’6” in any horizontal dimension.

11.2.9. A temporary pier must not collapse or fall over while in use.

11.2.10. A temporary pier must bear on the ground or river and not be supported or stabilized by builders or tools while it is supporting the constructed portion, a member, an assembly, or a tool.

11.2.11. Lubricant must not be applied during timed construction or within the construction site at any time. Lubricant must not drop on the floor within the construction site.

11.2.12. Throwing is prohibited.

11.2.13. A builder must not use the bridge, a portion of the bridge, a 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 a constructed portion if the builder is kneeling on the ground on both knees, kneeling on the ground on one knee with the other foot on the ground, or standing with the heels and toes of both feet on the ground.

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

11.2.15. A builder must not cross the river by jumping, by temporary scaffolding, or by any other means.

11.2.16. An assembly must not consist of more than three members.

11.2.17. An assembly must not be modified between leaving the staging yard and becoming all or part of a constructed portion.

11.2.18. The surfaces of the constructed portion that bear on the ground must be the same surfaces that will bear on the ground in the completed bridge.

11.2.19. A constructed portion must be created in, and remain in, the same location, position, and configuration that it will have in the completed bridge.
Exceptions

- A member or assembly that is connected to the constructed portion by only one fastener may rotate with respect to the constructed portion.
- Due to lack of support from members that have not yet been connected to the constructed portion, part of it may sag or sway.
- The constructed portion may slide from its final position on the ground as an unintended consequence of construction. However, intentional movement of the constructed portion from its final position is a violation.

For all three exceptions, a builder may move all or part of the constructed portion in order to make a connection or correct the position of the bridge on the footings. However, rule 11.8.2 applies.

11.2.20. A constructed portion may be modified by connecting and removing members and assemblies, tightening connections, adding nuts to connections, making new connections and taking apart existing connections.

11.2.21. A builder or builders must not support a constructed portion or hold a tool that is supporting a constructed portion. The constructed portion must either support itself or be supported by temporary piers and/or by tools that are not held by builders. Also see rule 11.8.3.

11.2.22. Outside the staging yard, an assembly must not be moved or supported by only one builder. The word “moved” includes, but is not limited to: lifted, carried, lowered, rolled, turned, slid, tipped, and rotated.

11.2.23. Outside the staging yard, a builder must not contribute to lifting, carrying, or supporting more than one member or assembly at a time.

11.2.24. Tools, members and assemblies may be supported on the constructed portion or on temporary piers. Rules 11.8.2 and 11.8.3 apply.

11.2.25. A builder must not move or support a temporary pier while also moving or supporting a member, assembly, or another temporary pier.

11.2.26. A builder may support a member, assembly, or temporary pier while simultaneously adjusting the constructed portion as permitted by rule 11.2.19.

11.3. Construction Site

See the “Site Plan” on the “Site and Bridge” diagram for layout of the construction site. The host student group lays out the site, including the 1-foot by 1-foot footings, before the competition.

Only builders and judges are permitted within the boundaries of the construction site during timed construction. Only judges and the superintendent are permitted near the construction site. Spectators, including faculty advisers, must observe from areas designated by the judges and host student group.

11.4. Start

Before construction begins, all of the following items, and nothing else, are in the staging yards: members, fasteners, tools, temporary piers (if used), and builders. Builders and superintendent will be wearing hardhats and protective eyewear or safety goggles, as well as optional clothing such as pouches. Every member, tool, temporary pier, and fastener must be in contact with the ground. Members must not be connected or touching one another. Tools and fasteners must not be in contact with members. Tools must not be in contact with fasteners. Temporary piers must not be in contact with one another nor with members, tools, or fasteners.

During timed construction, additional members, tools, fasteners, temporary piers, builders, or other items must not be brought into the construction site nor must anything be removed.

Timing and construction begin when the superintendent or one of the builders signify that they are ready and the judge declares the start.

11.5. Time

Time is kept from start to finish of construction. The clock will be stopped

11.5.1. if a builder, superintendent, or judge sees a condition that could cause injury, or

11.5.2. when a safety rule has been violated (see section 11.2), or

11.5.3 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 section 11.8).

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

11.6. Time Limit

11.6.1. If construction time exceeds 30 minutes but does not exceed 45 minutes, it will be multiplied by 1.50 for scoring. Judges will inform the team when this limit is reached.

11.6.2. If construction time exceeds 45 minutes, it will be counted as 180 minutes for scoring. "Accidents" (section 11.8) that occur after 45 minutes will not be penalized but safety rules (section 11.2) will still be enforced. Judges will inform the team when this limit is reached.

11.6.3. If construction time exceeds 60 minutes, judges will halt construction. The bridge will not be approved for load testing and will not be eligible for awards in any category.

11.7. Use of Temporary Piers

Temporary piers may be placed anywhere within the construction site, including in the river. However, a penalty will be assessed under rule 11.8.1 if a builder steps into the river to place, move, or remove a temporary pier.

The construction economy score, C_c, is incremented by $20,000 for every time a temporary pier is moved, including moves from and to a staging yard. However, there is no cost for moving a temporary pier from one location in a staging yard to another location in the same staging yard.

"Moving a temporary pier" means changing the orientation or horizontal position of its bearing surfaces on the ground or river.

11.8. Accidents

In general, the clock is not stopped when an “accident” occurs. If an accident is continuous (for example, a builder stands in the river) it will be counted as multiple incidents. Builders involved in accidents may continue to build, and items involved in accidents must 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 resuming timed construction, builders, tools, members, assemblies, temporary piers, and fasteners will be returned to the positions they occupied before the accident. Exception: Construction may proceed if it is no longer possible to hold all four bearing surfaces within the footings simultaneously. In this situation, the team captain may request that the clock be stopped in order to demonstrate the difficulty to the judge. If the judge is convinced, no additional accidents will be cited for bearing surfaces touching the ground outside the footings (rule 11.8.2), the clock will be restarted, construction will resume, and a penalty will be assessed for a dimensional violation under rule 9.2.1 (even if the bearing surfaces fall within the footings when the bridge is completed).

Types of accidents and the corresponding time penalties, which will be added to the construction time, are

11.8.1. A builder or a builder’s clothing touches the river. Penalty is 1/2 minute (30 seconds) per incident. Exception: There is no penalty for entering the river to retrieve an object such as a member, tool, nut, bolt, or hardhat.

11.8.2. A member, assembly, or constructed portion touches the river or ground outside a staging yard. Penalty is 1/4 minute (15 seconds) per incident. Exception: There is no penalty for members, assemblies, and the constructed portion touching the ground within the 1-foot by 1-foot footings.

11.8.3. A tool, nut, bolt, hardhat, goggles, or protective eyewear touches the river or ground outside a staging yard. Penalty is 1/4 minute (15 seconds) per incident. Exception: There is no penalty if a tool used exclusively for measuring touches the ground during use while being held by a builder.

11.8.4. A builder steps or jumps on or over a revetment. Penalty is 1/4 minute (15 seconds) per incident. However, builders may go around the end of a revetment, reach over a revetment, and pass members, assemblies, temporary piers, tools, and fasteners over a revetment without penalty.

11.8.5. A member, assembly, or tool touches a revetment. Penalty is 1/4 minute (15 seconds) per incident.

11.8.6. A builder steps outside the boundary of the construction site. Penalty is 1/4 minute (15 seconds) per incident. Exception: There is no penalty for stepping outside the construction site to retrieve an object such as a member, tool, nut, bolt, or hardhat.

11.9. Finish

Construction ends and the clock is stopped when

- the bridge has been completed by connecting all the members, and
- all tools, builders, and temporary piers (if used) are back in the staging yards, and
- the superintendent or one of the builders signifies that they are finished.

Installation of decking is not included in timed construction.

After construction is finished the bridge must not be modified except as provided by section “11.10 Construction: Repairs.”

11.10. Repairs

Before the judges inspect and measure the bridge, and before the bridge is moved from the construction site, two builders will be given five minutes to inspect the bridge for construction mistakes and plan corrective action. They must not modify the bridge and they must not touch the bridge except as necessary to use measuring devices. Following this inspection, builders will be permitted, but not required, to repair construction mistakes found by their inspectors. Repairs are made with the clock restarted and must be completed in ten minutes or less. Safety precautions (section 11.2) apply and accidents (section 11.8) are counted. The time required to make repairs (including penalties) is multiplied by 1.5 and added to the construction time. Judges will not examine the bridge for violation of rules until after the repair period.

12. LOAD TESTS

12.1. Safety Precautions

The judge will halt any activity that is hazardous.

A bridge could suddenly collapse or sway in any direction during load tests. Therefore, minimize the number of people near the bridge while it is being tested. Usually, the load should be placed on the bridge by only two members of the team. Team members who are not participating in loading, faculty advisers, and other spectators must observe from an area designated by the judges and host student group.

While participating in load testing, competitors must wear hardhats meeting ANSI standard Z89.1, protective eyewear or safety goggles meeting ANSI standard Z87.1, 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.

During testing, safety supports must be in place below the decking. The safety supports should be of sufficient height, strength, number, and extent that none of the load will fall more than approximately 6 inches if the bridge collapses.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a portion of the decking that is cantilevered over its support.

When any portion of the load is on the bridge, no one is permitted to crawl, reach, or step under the bridge. If such an action is necessary, the load must first be removed.

12.2. Damage

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

If a nut falls off its bolt while the bridge is being transported or prepared for load testing, the connection will be repaired, the nut will be replaced (finger tight) and a penalty of 2 minutes will be added to construction time.

A bridge with irreparable damage that would reduce its strength or stability (such as a missing or broken member or fastener) will not be approved for load testing and is not eligible for awards in any category.

12.3. Preparation

Temporary piers are not used during load testing.

The judge designates the “A” and “B” sides of each bridge by a random process. “Left” and “right” ends are determined by facing the “A” side.

“Sway” is translation in any horizontal direction. A target is established for sway measurement on the “A” side of the bridge, 9’6” from the left end of the decking support surface on that side. The sway target is located at the level of the decking support surface which is the same as the bottom of the decking. See the “Lateral Load Test” plan on the “Bridge Loading” diagram.

Three targets are established for measuring vertical deflection. Two of the vertical deflection targets are located longitudinally at the center of the left unit of decking, on the “A” and “B” sides of the bridge, at the level of the decking support surface which is the same as the bottom of the decking. The other vertical deflection target is located longitudinally at the center of the right unit of decking, on the “A” side of the bridge, at the level of the decking support surface. Targets may be on the decking or on the bridge. For location of decking units, see section 12.5 and the “Location of Targets and Decking” plan on the “Bridge Loading” diagram.

At their discretion, judges may impose a penalty for a bridge that incorporates parts having the primary function of interfering with placement of targets or measuring equipment.

Teams must accept imperfect field conditions such as bent decking and slightly sloping floors.

12.4. Lateral Load Test

The provisions of this section are illustrated by the “Lateral Load Test” plan on the “Bridge Loading” diagram.

The lateral load test is conducted with one unit of decking 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 prevent the bearing surfaces of the bridge from lifting off the ground when lateral load is applied.

The two bearing surfaces on the “B” side of the bridge are prevented from sliding by horizontal restraint applied from the inside of the abutments as close as possible to the ground. This horizontal restraint does not restrain rotation of the abutments and is identical for all bridges.

Apply a 50-pound lateral pull at the sway target and measure the sway. To pass the lateral load test, the sway must not exceed 1.0 inch.

If the bridge did not pass the lateral load test it is not approved for further testing. **Do not conduct any other load test**. Add a penalty of 900 pounds to the weight of the bridge and a penalty of 30 minutes to the construction time. Record: Aggregate deflection = 60 inches.

If the bridge passed the lateral load test, remove the load and decking, and proceed with the vertical load test.

12.5. Vertical Load Test

The provisions of this section are illustrated by the three "Vertical Load Test" elevations on the "Bridge Loading" diagram.

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

Decking units are three feet long in the longitudinal (span) direction of the bridge. Place the two decking units at distances L1 and L2 measured from the left end of the decking support surface on the "A" side of the bridge to the left edges of the decking units. See item 4 in chapter 8 for determination of L1 and L2, and section 12.3 for location of targets. Decking units are placed square with the bridge and centered on the designated nominal centerline (see section 9.3). Decking units must not be attached to the bridge and must not distort it (see rules 9.1.4 and 9.1.5).

Position measuring devices on the three vertical deflection targets.

Uniformly distribute 100 pounds of preload on the left decking unit and uniformly distribute100 pounds of preload on the right decking unit. Preloads are laterally centered on the decking units. Preloads are distributed and aligned identically for every bridge.

If a contestant disturbs a measuring device after it has been initialized and before the measurement is recorded, the judge will require the team to disassemble the bridge and repeat timed construction. Scoring will be based on the larger of the two construction times but will not exceed 125% of the initial construction time.

The two steps (increments) of vertical loading produce three measurements used in scoring

- D1A = value of downward vertical deflection at left target on the “A” side that occurs during step 1 (loading on left decking unit).
- D1B = value of downward vertical deflection at left target on the “B” side that occurs during step 1 (loading on left decking unit).
- D2 = value of downward vertical deflection at right target that occurs during step 2 (loading on right decking unit with load from step 1 remaining in place).

Step 1
Loading the left unit and measuring deflections at those targets

- The two 100-pound preloads remain in place.
- Initialize the sway measurement.
- Initialize the measuring devices on all three vertical deflection targets or record the initial readings.
- Team members place 1150 pounds of additional load on the left decking unit. The 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 should be placed at a steady pace, without hesitation.
- As the load is being placed, observe sway and deflection. Stop loading if
    a. sway exceeds one inch, or
    b. deflection measurement at any of the three vertical deflection targets exceeds 2 inches downward, or
    c. any part of the bridge, other than the intended bearing points, comes to bear on a safety support or the floor, or
    d. a decking unit falls off the bridge, or
    e. a dangerous collapse is imminent, in the opinion of the judge.

If sway or deflection is excessive (situation a or b), the bridge is not approved for further load testing. Remove the load and **do not continue load testing**. Add an 800-pound penalty to the weight of the bridge and a penalty of 30 minutes to the construction time. Record: Aggregate deflection = 60 inches.

If the bridge fails (situation c, d, or e), it 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**.

If the bridge passes step 1, record the measured values D1A and D1B, which are the downward vertical deflections during step 1 of the two targets for the left decking unit.

Step 2
Loading the right unit and measuring deflection at that target

- The two preloads and the load from step 1 remain in place.
- Do **not** re-initialize the sway measurement.
- Do **not** re-initialize the measuring devices on the left deflection targets.
- Initialize the measuring device on the right vertical deflection target or record the reading.
- Team members place 1150 pounds of additional load on the right decking unit. The 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 should be placed at a steady pace, without hesitation.
- As the load is being placed, observe sway and deflection. Stop loading if
    a. sway exceeds one inch, or
    b. deflection measurement at any of the three vertical deflection targets exceeds 2 inches downward, or
    c. any part of the bridge, other than the intended bearing points, comes to bear on a safety support or the floor, or
    d. a decking unit falls off the bridge, or
    e. a dangerous collapse is imminent, in the opinion of the judge.

If sway or deflection is excessive (situation a or b), the bridge is not approved for further load testing. Remove the load and **do not continue load testing**. Add a 700-pound penalty to the weight of the bridge and a penalty of 30 minutes to the construction time. Record: Aggregate deflection = 60 inches.

If the bridge fails (situation c, d, or e), it 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**.

If the bridge passes step 2, record the measured value D2 = value of downward vertical deflection during step 2 of the target for the right unit of decking. Compute and record: Aggregate deflection = D1A + D1B + D2.

12.6. Unloading

If the bridge collapses during unloading, it is not eligible for awards in any category.

13. EQUIPMENT PROVIDED BY HOST

The web site http://www.aisc.org/steelbridge.html has detailed descriptions and illustrations of hosting equipment. The following partial list is intended to help competitors know what to expect. Competitors should acquire similar equipment for use in practice and testing before the competition.

13.1. Lateral Load Device

Capable of applying a 50-pound force in the horizontal direction.

13.2. Equipment for Measuring Sway

Sway is horizontal translation and is measured by any accurate method. A suggested method is to suspend a plumb bob from the sway target and measure sway from a point marked on the ground.

13.3. Equipment for Measuring Deflection

Deflection is vertical translation and is measured at three points by any accurate method.

13.4. 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 of the grating that are perpendicular to the length.

13.5. Load

2500 pounds total. The load 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.

13.6. Safety Supports

The safety supports must be used during load testing and are intended to limit the consequences of a bridge collapsing. The safety supports should 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, timbers, sand bags, or masonry units.

13.7. Floor

The surfaces on which the bridges will bear should be as nearly flat and level as possible, in both the construction site and loading area.

13.8. Revetments

Revetments should be 1'6" to 2'6" high, ten feet long, and no thicker than one foot. Examples of adequate revetments include caution tape stretched between supports, mesh fencing, wood-framed knee walls, or insulation panels.

13.9. String

A string is stretched between the holes specified in section 9.3 in order to identify the nominal centerline of the bridge, which guides checking the width of the vehicle passageway (rule 9.2.14) and placing the decking and load (rule 12.5).

14. INTERPRETATION OF RULES

The web site http://www.aisc.org/steelbridge.html lists answers to questions about 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 and reread this *Rules* booklet carefully in its entirety**. The names of students and their universities will be posted with their questions. Questions must be submitted before 5:00 PM Eastern Daylight Saving Time, 14 May 2007.

15. JUDGING

The host 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 group will assure that the judges are fully informed of the rules and procedures, and fully equipped for their tasks. More information for host groups and judges, including a spread sheet for scoring, is available at http://www.aisc.org/steelbridge.html.

16. APPEALS

16.1. Regional Competitions

16.1.1. At the beginning of the competition each team will identify the team member who serves as captain. The host university will identify the regional head judge (RHJ).

16.1.2. A penalty, decision, measurement, score, or condition of competition may be appealed only by a team captain and only to the RHJ. The appeal must be made as soon as possible after the situation becomes apparent. The RHJ will not hear the appeal if he or she is approached by students other than the team captain. The RHJ will hear the appeal as soon as possible and may interrupt the competition. Participants are reminded that civility and ethical behavior are expected during the competition and particularly concerning appeals.

16.1.3. After the regional competition, the team captain has the option to appeal the decision of the RHJ by sending an e-mail message to Mr. Fromy Rosenberg <rosenberg@aisc.org> followed by a letter mailed to Mr. Rosenberg (AISC, Suite 3100, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to ASCE Student Services (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The e-mail message and letter should include

- name of the college or university making the appeal,
- team captain's name, e-mail address, postal address, and telephone number,
- faculty adviser's name, e-mail address, postal address, and telephone number,
- brief description of the problem,
- action taken at the competition to deal with the problem,
- action that the appealing team feels should have been taken,
- data showing that the team should have qualified for national competition, and
- team captain's signature (letter only).

Appeals must be made by e-mail followed by letter. An appeal will be considered only if the e-mail is received and the letter is postmarked within **one week** after the regional competition. Mr. Rosenberg will disseminate the appeal to the ASCE/AISC Rules Committee for their evaluation. The only redress that may be made is an invitation to participate in the national competition if the Rules 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 regional judges will not be overturned.

16.2. National Competition

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

16.2.2. 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.

16.2.3. 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 ASCE/AISC Rules Committee. The conditions at issue will not be changed during deliberation.

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

16.2.5. The decision of the ASCE/AISC Rules Committee is final; there are no further appeals. However, AISC and ASCE welcome written suggestions for improving future competitions.

17. SUMMARY OF SCORING

This form summarizes chapter "7 Scoring." A comparable spreadsheet is available at http://www.aisc.org/steelbridge.html.

17.1. Display (see section 7.1 for criteria)

- Appearance: balance, proportion, elegance, finish.
- Name of college or university on bridge in letters at least one inch high.
- Poster describing design and fabrication, no larger than 2 x 3 feet.

Judges should not declare ties in display.

DISPLAY SCORE = _____

17.2. Construction Speed and Time Penalties

Construction clock time, CT _____ minutes
If CT ≤ 30 minutes, enter CT
If 30 < CT ≤ 45, multiply CT by 1.5 (see 11.6)
If 45 < CT ≤ 60, enter 180 (see 11.6) _____ minutes
Time penalties during construction (see 11.8)
11.8.1: violations _____ x 1/2 + _____ minutes
11.8.2,3,4,5,6: violations _____ x 1/4 + _____ minutes
Repair time (see 11.10) _____ x 1.5 + _____ minutes
Time penalties during repair (see 11.8, 11.10)
11.8.1: violations _____ x 1/2 x 1.5 + _____ minutes
11.8.2,3,4,5,6: violations _____ x 1/4 x 1.5 + _____ minutes
Time penalty, damage (see 12.2) + _____ minutes
Time penalty, load tests, 30 min (see 12.4 and 12.5) + _____ minutes

TOTAL TIME = _____ minutes
Lowest total wins.

17.3. Construction Economy

Number of builders (_____ persons
Total time (part 17.2) x _____ minutes
x 50)
Number of moves of temporary piers (see 11.7) + (_____
x 20)

CONSTRUCTION COST: C_c = _____ thousand $
Lowest cost wins.

17.4. Lightness and Weight Penalties

Bridge weight _____ pounds
Weight penalties,
"7.1 Display" (50 or 100) + _____ pounds
"9.2 Dimensions and Support: Usability"
Rules violated ≤ ½ inch _____x 50 + _____ pounds
Rules violated ½ - 1 inch _____x 150 + _____ pounds
Rules violated 1 - 2 inch _____x 300 + _____ pounds
"9.3 Dimensions and Support: Centerline" (100) + _____ pounds
"10.2 Material & Components: Durability & Constructability"
Number of violations _____ x 10 pounds + _____ pounds
Wt. of parts in violation _____ pounds x 5 + _____ pounds
"12.4 and .5 Load Tests: Lateral Load and Vertical Load"
(900, 800 or 700) + _____ pounds

TOTAL WEIGHT = _____ pounds
Lowest weight wins.

17.5. Stiffness

AGGREGATE DEFLECTION: D1A + D1B + D2 = _____ inches
Lowest deflection wins.

17.6. Structural Efficiency

Total weight (part 17.4) (_____ pounds
x 5)
Aggregate deflection (part 17.5) + (_____ inches
x 500)

STRUCTURAL COST: C_s = _____ thousand $
Lowest cost wins.

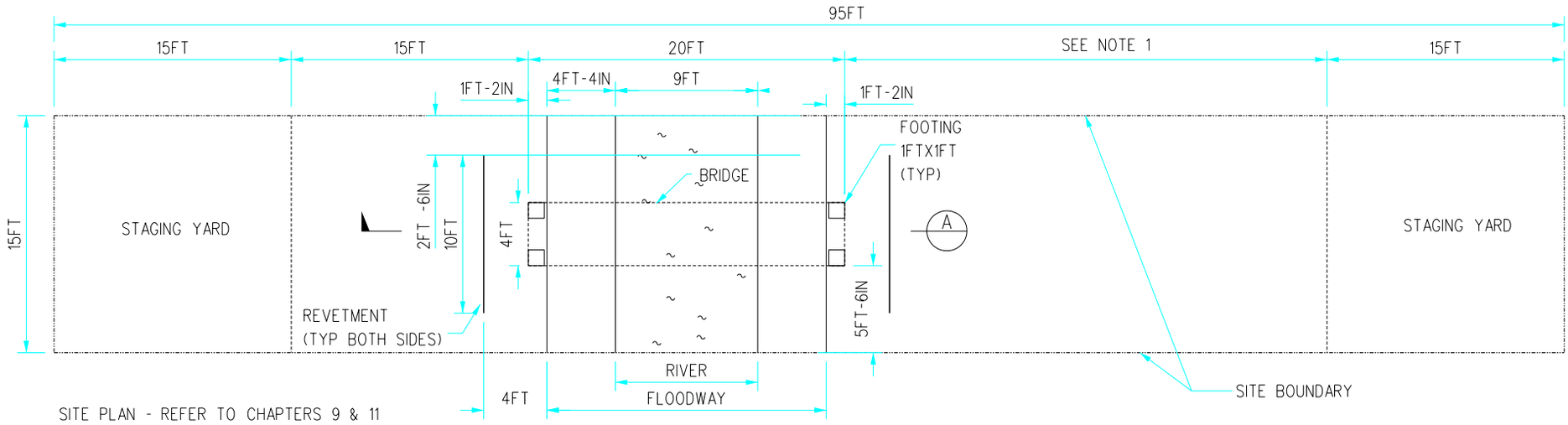
17.7. Overall Performance

C_c (from part 17.3) _____ + C_s (from part 17.6) _____ = _____
Lowest total wins.

17.8. Ranks (Display is the tie-breaker for all categories)

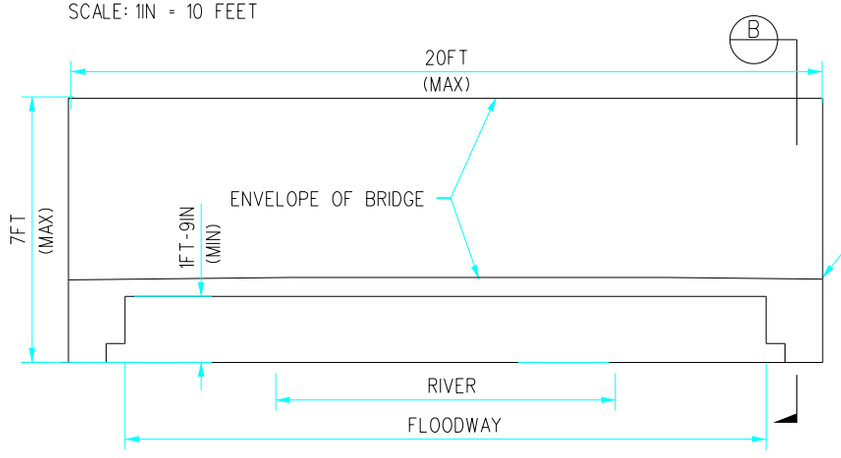
A bridge will not be ranked if it was not approved for construction or load testing, or if it failed in load testing.

Display _____ Construction Speed _____ Lightness _____
Stiffness _____ Construction Economy _____ Structural Efficiency _____
Overall Performance _____



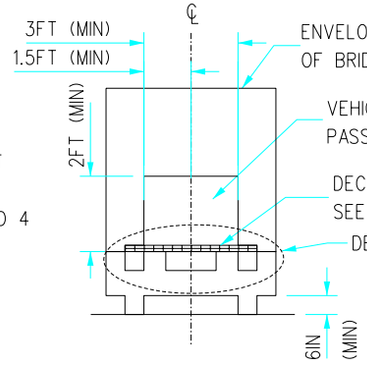
SITE PLAN - REFER TO CHAPTERS 9 & 11

SCALE: 1IN = 10 FEET



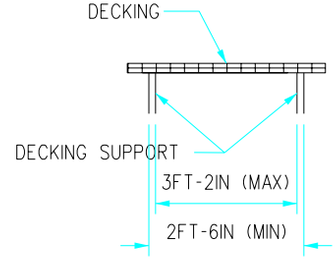
A ELEVATION - REFER TO CHAPTER 9

SCALE: 1 IN = 5 FT



B END VIEW

NO SCALE

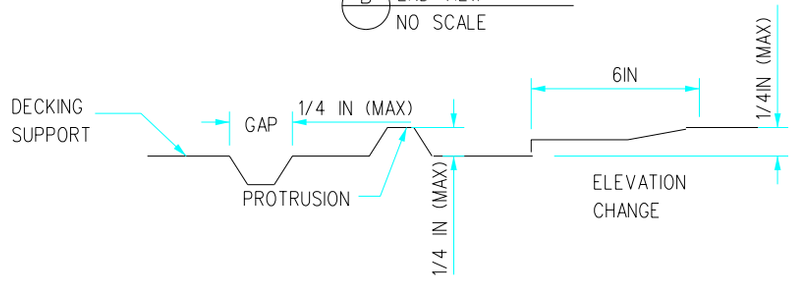


C DECKING SUPPORT

NO SCALE

NOTES:

1. LENGTH CAN BE ADJUSTED TO FIT SITE CONDITIONS.
2. TOP OF THE DECKING SUPPORT SHALL BE BETWEEN 2FT-3IN AND 2FT - 6IN ABOVE GRADE.
3. BRIDGE SHALL ACCOMODATE 3FT- 9IN DECKING THROUGHOUT OVERALL LENGTH OF THE BRIDGE.
4. NO PART OF BRIDGE SHALL EXTEND BEYOND DECKING SUPPORT SURFACE (AT BOTH ENDS).



IRREGULARITIES IN DECKING SUPPORT - REFER TO CHAPTER 9

SCALE: NONE

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION
A	7-01-06						2007 SSBC RULES

DESIGNED BY F. HATFIELD
DRAWN BY D. SEPULVEDA
CHECKED BY RULES COMM.
IN CHARGE F. ROSENBERG
DATE 7-01-2006

ASCE - AISC
STUDENT STEEL BRIDGE CONTEST

ASCE American Society of Civil Engineers

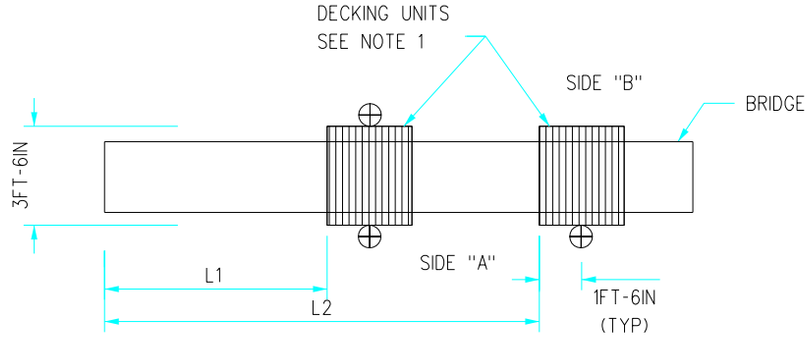
SUBMITTED

APPROVED

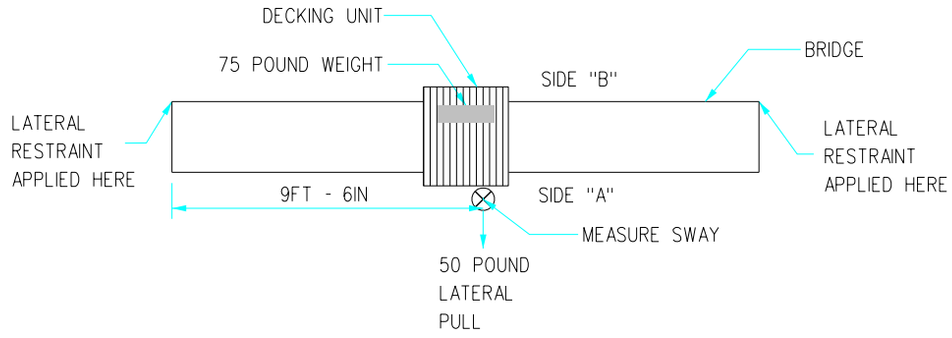
SITE AND BRIDGE
DIAGRAM

CONTRACT NO 2007
DRAWING NO EXHIBIT 1
REV
SCALE AS SHOWN
SHEET NO

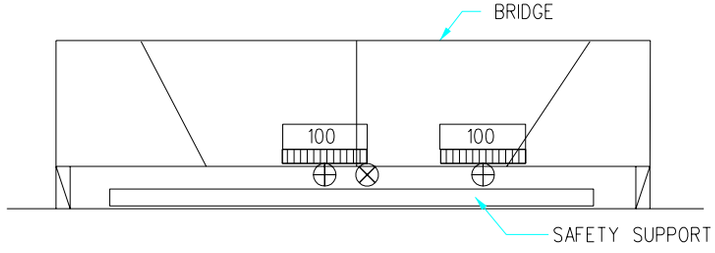
Plotted by: ortegas 7/19/2006 C:\Documents and Settings\Ortegas\Desktop\don\NSSBC-Site 2007.dgn



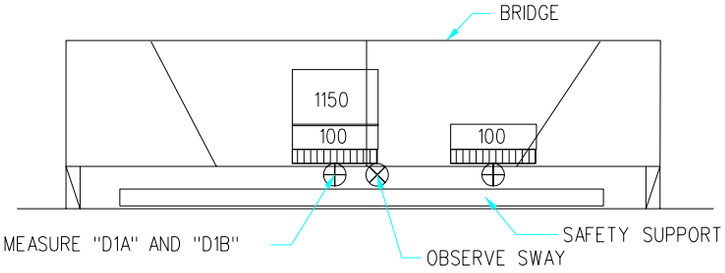
A LOCATIONS OF TARGETS AND DECKING - PLAN
REFER TO CHAPTER 12, SECTIONS 3 & 5



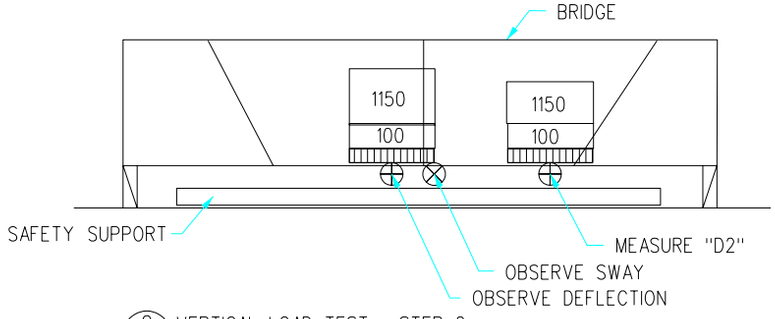
B LATERAL LOAD TEST - PLAN
CHAPTER 12, SECTIONS 3 & 4



0 VERTICAL LOAD TEST - PRELOAD
REFER TO NOTES DURING LOADING PROCESS



1 VERTICAL LOAD TEST - STEP 1
REFER TO NOTES DURING LOADING PROCESS



2 VERTICAL LOAD TEST - STEP 2
REFER TO NOTES DURING LOADING PROCESS

LEGEND

⊕ TARGETS FOR MEASURING VERTICAL DEFLECTION TO BE PLACED LONGITUDINALLY AT THE CENTER OF THE DECKING UNITS

⊗ TARGET FOR MEASURING SWAY

NOTES

1. THE LOAD IS LATERALLY CENTERED ON THE DECKING UNIT AND DISTRIBUTED OVER THE LENGTH OF THE DECKING UNIT AS UNIFORMLY AS POSSIBLE AT ALL TIMES DURING LOADING.
2. OBSERVE ALL VERTICAL TARGETS ON EACH SIDE OF THE BRIDGE FOR DEFLECTION.
3. LOADING TERMINATES IF DEFLECTION AT ANY OF THE VERTICAL DEFLECTION TARGETS EXCEEDS 2 INCHES DURING STEP 1 AND STEP 2.
4. LOADING TERMINATES IF SWAY AT SWAY TARGET EXCEEDS 1" DURING STEP 1 AND STEP 2.
5. SAFETY SUPPORT TO BE IN PLACE AT ALL TIMES DURING LOADING.
6. BRIDGE TO BE UNLOADED IN THE REVERSE ORDER OF LOADING.
7. ALL LOADING SAFETY PROCEDURES TO BE FOLLOWED.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION
A	7-01-06						2007 SSBC RULES

DESIGNED BY F. HATFIELD
DRAWN BY D. SEPULVEDA
CHECKED BY RULES COMM.
IN CHARGE F. ROSENBERG
DATE 7-01-07

ASCE - AISC
STUDENT STEEL BRIDGE CONTEST

ASCE American Society of Civil Engineers

SUBMITTED

APPROVED

BRIDGE LOADING

DIAGRAM

CONTRACT NO 2006
DRAWING NO EXHIBIT 2 REV
SCALE AS SHOWN
SHEET NO

Plotted by: ortegas 7/18/2006 C:\Documents and Settings\Ortegas\Desktop\don\NSSBC-loading 2007.dgn

STUDENT STEEL BRIDGE COMPETITION

2006 RULES

http://www.aisc.org/steelbridge.html

TABLE OF CONTENTS

1. INTRODUCTION

The Student Steel Bridge Competition is sponsored by the American Institute of Steel Construction (AISC) and by the American Society of Civil Engineers (ASCE), and co-sponsored by the American Iron and Steel Institute, the James F. Lincoln Arc Welding Foundation, the National Steel Bridge Alliance, Nucor Corporation, and Walter P. Moore and Associates, Inc.

This document describes the contest and states the rules for this year. It is available at http://www.aisc.org/steelbridge.html, together with related information.

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

Students design a steel bridge by themselves but may seek advice from faculty and other consultants. Ideally, students fabricate the entire bridge themselves. However, appropriate shop facilities and supervision are not available at every university. Therefore, the services of a commercial fabricator may be used provided that students develop the work orders and observe the operations. Students are encouraged to maximize their involvement in fabrication.

The rules are changed every year to improve the contest and assure 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 chapter "13 Interpretation of Rules."

There are two levels of competition: regional and national. These *Rules* govern competition at both levels. Regional competitions are held in conjunction with ASCE regional student conferences. Only one bridge per university may compete in a regional competition, and a university may compete in only one region. Invitations to compete at the national level are extended only to the winner from a region in which two, three or four bridges competed, to the top two teams from a region in which five to ten bridges competed, and to the top three teams from a region with eleven or more competing bridges. Only one bridge per university may be entered in the national competition.

A student team which does not have an ASCE chapter, ASCE club, or ASCE international group meeting the requirements of the following paragraph may enter a steel bridge in a regional contest if invited by the regional host. Such team will be an invited guest and will not be ranked in the regional contest nor will it be invited to compete in the National Student Steel Bridge contest.

The ASCE student chapters, ASCE student clubs, and ASCE international student groups entering the contest are required to be current with their national dues and annual reports. A team must consist only of undergraduate and graduate students in good standing with their ASCE student organization.

2. EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication, and construction. Participating students gain practical experience in structural design, fabrication processes, construction planning, organization, and teamwork.

Chapter "4 Problem Statement" describes challenges encountered in a representative structural engineering project. The competition is a scaled simulation of that project.

Standards for strength, durability, constructability, usability, functionality, and safety reflect the volumes of regulations that govern the design and construction of full-scale bridges. Criteria for excellence are represented by the award categories of stiffness, lightness, construction speed, aesthetics, efficiency and economy. Contest judges and the Rules Committee take the role of the owner (Department of Transportation) and have the authority to accept and reject entries. As with any full-scale construction project, safety is the primary concern.

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.

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

3. RULE CHANGES

The following list covers some of the major changes from the 2005 rules. Not all changes are listed. Contestants and judges are cautioned to **read this entire *Rules* document carefully and disregard rules and clarifications from previous years**.

1. Clearances under the bridge are unsymmetrical.
2. The construction site, skew, and several dimensional limits are different.
3. There is a time limit for construction.
4. An assembly may be moved by as few as two builders.
5. The use of lubricants is limited.
6. There is a cost for using a temporary pier.
7. Load patterns are less symmetrical.
8. The structural efficiency cost constant is larger.
9. Teams entering the national contest must meet ASCE requirements.

4. PROBLEM STATEMENT

A century-old bridge that spans a river and parkway must be replaced. The bridge carries traffic serving the residences, farms, and agricultural processing industries that are the economic base of this rural region. A quick replacement is necessary because no other crossing is available for miles.

The state Department of Transportation (DOT) has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered but the DOT has specified steel as the material because of its durability, fast erection, and high level of recycled content. Clearance under the bridge must be provided for navigation on the river and vehicle traffic on the parkway. The bridge must be able to carry specified patterns of loads without exceeding sway and deflection limits. Based on past experience with performance and maintenance, the DOT prefers bridges that are relatively light and stiff. The new bridge must accommodate modular decking that was salvaged from another structure. Decking units will not be modified.

Due to environmental concerns, construction of permanent piers is permitted only on the existing footings. A temporary pier may be placed on land. Construction barges and other equipment are not permitted in the river. Soil conditions limit the weight of loads that may be moved.

Your company's design/build proposal is among those that the DOT has deemed responsive, and winning the contract would be a step toward becoming a leader in the bridge replacement market. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. A panel of DOT personnel will judge the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy, and aesthetics. The contract will be awarded to the company whose model best meets the DOT's needs and requirements. 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 rejection of the model and termination of the company's eligibility.

5. SAFETY

Safety has the highest priority. Judges are empowered to halt any activity that they deem hazardous. Judges will stop construction procedures that could cause personal injury. Judges will not allow additional load to be placed on a bridge that has collapsed, that is approaching a collapse that could be dangerous, or that has swayed or deflected in excess of specified limits. A bridge that cannot be safely constructed or load tested using the equipment provided by the host is not eligible for awards in any category and must be withdrawn from participation.

6. SCORING

A university may enter only one bridge in regional competition and may compete in only one region.

Categories of competition are aesthetics, construction speed, lightness, stiffness, construction economy, and structural efficiency. In addition, overall performance is rated. A bridge that was not approved for load testing or that failed in load testing is not eligible for awards in any category.

6.1. Aesthetics

Aesthetics is the tie-breaker for all categories of competition. Judges should not declare ties in aesthetics. Aesthetics is judged by

6.1.1. Appearance of bridge, including balance, proportion, elegance, and finish. Quality of fabrication should not be considered because some bridges may be fabricated professionally while others are student work.

6.1.2. Permanent identification of the bridge consisting of the full name or unique commonly accepted name of the college or university (not initials or name of mascot). The name must appear on the bridge in letters at least one inch high and must be formed from steel or applied to steel with paint or decals. A 50-pound weight penalty will be imposed if the bridge lacks appropriate identification.

6.1.3. Poster describing design. The poster must be flat with maximum dimensions of 2 feet by 3 feet and must present all information on one side without attached pages that must be lifted or turned. The poster must identify the college or university with the same name that appears on the bridge and must present a brief explanation of why the overall configuration of the bridge was selected, a brief computation demonstrating design for one limit state, and a scaled, dimensioned side view of the bridge. Additional information may be included. Electronic displays, decorated poster supports, lights, and sound are not permitted and will result in the worst possible rating for the poster. A 50-pound weight penalty will be imposed if there is no poster or if the content is grossly inadequate. The poster is not part of the bridge but must be in place during aesthetics judging and at other times when the bridge is on display.

6.2. Construction Speed

The bridge with the lowest total time will win in this category. Total time is the time required for construction plus 150% of the time for repairs (see section 10.11), modified by penalties prescribed in sections 10.8, 10.9, 11.2, 11.4, and 11.5. There is an upper limit on construction time.

6.3. Construction Economy

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

C_C = Total time (minutes) x Number of builders (persons)
x 50 thousand dollars per person-minute
+ 100 thousand dollars if a temporary pier is used.

Total time is defined in section "6.2 Scoring: Construction Speed" and includes penalties. The number of builders includes all participants who are within the construction site at any time during timed construction.

6.4. Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in sections "6.1 Scoring: Aesthetics," "8.2 Dimensions and Support: Usability," "9.2 Material and Components: Durability and Constructability" and "11.4 and 11.5 Load Tests: Lateral Load Test and Vertical Load Test." Decking, tools, temporary pier, and poster are not included in total weight.

6.5. Stiffness

The bridge with the lowest aggregate deflection will win in the stiffness category. Aggregate deflection is determined from measurements as prescribed in section "11.5 Load Tests: Vertical Load Test."

6.6. Structural Efficiency

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

C_S = Total weight (pounds) x Aggregate deflection (inches)
x 20 thousand dollars per pound-inch

Total weight is defined in section "6.4 Scoring: Lightness" and includes penalties. Aggregate deflection is defined in section "6.5 Scoring: Stiffness" and includes penalties.

6.7. 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.

7. SCHEDULE OF COMPETITION

In the months before the contest, students design their bridges, fabricate members, test load, and practice construction. The following events occur during the competition

1. Bridges are erected for public display and are judged for aesthetics. After this, bridges must not be altered, modified, or enhanced in any way except for disassembly, erection, and repairs as described in section "10.11 Construction: Repairs."

2. Judges clarify rules and conditions of the contest and answer questions.

3. Bridges are disassembled.

4. The head judge selects the locations of loads. See section "11.5 Load Tests: Vertical Load Test" and the "Locations of Targets and Decking" detail on the "Bridge Loading" diagram. Selection is done in the presence of the team captains by rolling a die twice. Let S1 and S2 be the spots from the two rolls and let LC and LR be dimensional locations of decking units in inches.

$$LC = 92 + 6\,(S1)$$
$$LR = 160 + 6\,(S2)$$

The same locations will be used for all bridges.

5. Judges inspect components of the bridges. See chapter "9 Material and Components" for details.

6. Timed construction. See chapter "10 Construction" for details.

7. Judges inspect assembled bridges. See chapter "8 Dimensions and Support" and rules 9.1.3, 9.2.11, and 9.2.12 for details.

8. Bridges are weighed (alternatively, bridge parts may be weighed prior to construction).

9. Load testing. See chapter "11 Load Tests" for details.

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

- bridges are not modified after selection of load locations, and
- bridges are not modified between aesthetics judging and timed construction, and
- modifications between timed construction and load testing are limited to repairs as described in "10.11 Construction: Repairs."

8. DIMENSIONS AND SUPPORT

Dimensions and support will be checked with the bridge in its as-built condition after construction is completed 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 any applied load on the bridge.

8.1. Functionality and Safety

If any of the following rules in this section (8.1) is violated, the bridge will not be approved for load testing and will not be eligible for awards in any category.

8.1.1. The bridge must span the river and parkway without touching them. See the "Site Plan" on the "Site and Bridge" diagram.

8.1.2. The bridge must provide support for the decking for the full overall length of the bridge along both of the edges that run in the span direction of the bridge. See the "Elevation" on the "Site and Bridge" diagram.

8.1.3. Decking support must be rigid. At their discretion, judges may test rigidity by applying a 25-pound load at selected points on the decking support. Deflection under that load exceeding 1.0 inch indicates lack of rigidity.

8.1.4. The bridge must provide access for placing the decking and load.

8.1.5. The decking must not be attached or anchored to the bridge, and it must not be used to distort the bridge from its as-built condition.

8.1.6. The bridge must not be anchored or tied to the ground.

8.1.7. It must be possible to construct and load the bridge safely using equipment provided by the host university. **Bridges must accommodate local conditions.**

8.2. Usability

A weight penalty will be assessed for each rule in this section (8.2) that is violated, rather than for every violation of that rule.

The penalty for violation for each of the following rules will be an addition to the weight of the bridge determined as follows: 150 pounds for a dimensional violation of 1.0 inch or less; 300 pounds for a dimensional violation greater than 1.0 inch but not exceeding 2.0 inches. If a dimensional violation exceeds 2.0 inches, the bridge will not be approved for load testing and will not be eligible for awards in any category.

8.2.1. The bridge must bear on the ground only within the 6-inch by 6-inch squares that are marked on the construction site to represent existing footings. Note that the footing locations are skewed. See the "Site Plan" on the "Site and Bridge" diagram.

8.2.2 The decking support must be at least 21'0" and not more than 21'9" long on each side and extend for the overall length of the bridge.

8.2.3. Parts of the bridge (including fasteners and parts that bear on the ground) must not extend beyond the vertical plane defined by the ends of the decking supports at each end of the bridge.

8.2.4. The bridge must be able to accommodate solid decking that is 3½ inches thick and 3'9" wide at all points along the length of the bridge. This rule will be checked by sliding a template along the full overall end-to-end length of the decking supports.

8.2.5. Clear span of the decking between decking supports must not exceed 3'2". See the "Decking Support" detail on the "Site and Bridge" diagram.

8.2.6. The edges of the decking that run in the span direction of the bridge must not be cantilevered laterally more than 6 inches on each side. See the "Decking Support" detail on the "Site and Bridge" diagram.

8.2.7. The decking support must not have gaps exceeding ¼ inch wide in the span direction of the bridge. See the "Irregularities in Decking Support" detail on the "Site and Bridge" diagram.

8.2.8. The decking support must not have vertical protrusions exceeding ¼ inch high. See the "Irregularities in Decking Support" detail on the "Site and Bridge" diagram.

8.2.9. Elevation of the decking support must not change more than ¼ inch in any 6 inches of span length. See the “Irregularities in Decking Support” detail on the “Site and Bridge” diagram.

8.2.10. The decking support surface must be no less than 2’3” nor more than 2’6” above the surface of the ground or river at any point. See the “Elevation” on the “Site and Bridge” diagram.

8.2.11. The bridge must not extend more than 6'0" above the surface of the ground or river. See the “Elevation” on the “Site and Bridge” diagram.

8.2.12. Navigation clearance must be provided under the bridge at all points over the river. The clearance must be at least 2’0” high, measured from the surface of the river. See the “Elevation” on the “Site and Bridge” diagram.

8.2.13. Vehicle clearance must be provided under the bridge at all points over the parkway. The clearance must be at least 1’2” high, measured from the ground. See the “Elevation” on the “Site and Bridge” diagram.

8.2.14. A vehicle passageway at least 3’0” wide and 2’0” high must completely traverse the bridge from end to end. That is, a vehicle that is 3’0” wide and 2’0” high must be able to cross the bridge. See the “End View” on the “Site and Bridge” diagram.

9. MATERIAL AND COMPONENTS

9.1. Safety

If any one of the following rules in this 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 must not weigh more than 20 pounds. See section 9.2 for definition of “member.”

9.1.2. A bridge must 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 pre-stressed member with triggering device.

9.1.3. After completion of timed construction, energy must not be transmitted to or from a bridge (for example, by applying mechanical, magnetic, fluidic, or other force; by sound, light, radio, or other wave or ray; by conduction or convection of heat; or by electric current). The exceptions are forces necessary to the competition (for example, those associated with load testing and with moving the bridge from place to place), and changes in ambient conditions that are not controlled by contestants (such as wind, temperature, and lighting).

9.2. Durability and Constructability

Violation of the following rules in this section (9.2) will result in penalties being added to the weight of the bridge. The penalty for each violation is 10 pounds plus 5 times the weight of the non-conforming member or fastener. If the non-conforming component weighs less than one pound, its weight will be assumed to be one pound for the purpose of computing the penalty.

9.2.1. A bridge must be constructed only of structural steel. For the purposes of this contest, structural steel is defined as an iron alloy that is strongly attracted to a magnet. Solder, brazing, and adhesives are not permitted. Exceptions: Paint, decals, and other purely decorative items are permitted.

9.2.2. A bridge must be constructed only of members and fasteners. During timed construction, members are connected with fasteners to form assemblies and the constructed portion, which are defined and regulated by rules in section “10.2 Construction: Safety.”

Members

9.2.3. A member is a rigid steel component that retains its shape and dimensions during timed construction and in the completed bridge.

9.2.4. A member must not exceed overall dimensions of 3'6” x 6” x 6.” That is, it must fit in a prismatic box of those dimensions.

9.2.5. A member must 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. Exception: Deformations caused by mechanical strain (e.g., bending, stretching) during load testing are not violations of this rule.

9.2.6. A member may consist of multiple parts rigidly joined together before timed construction begins. Those parts must remain rigidly joined throughout timed construction and in the completed bridge. Parts must be joined by welding or with steel connectors such as bolts, screws, and rivets.

Fasteners

9.2.7. A fastener is a steel bolt that is not part of a member, with at least one steel nut that is not part of a member. The specified bolts and nuts are available in hardware stores.

9.2.8. The bolt in a fastener must be 3/8" nominal diameter and no more than 3" nominal length (bottom of head to end) with a hexagonal head, and it must have the configuration and dimensions of a "cap screw grade 2," "cap screw grades 5 and 8," or "hex tap bolt" illustrated on http://www.purchasepartners.com/fastenerspecs.htm. Bolts must not be mechanically altered or modified in any manner. They may be painted.

9.2.9. The nuts in a fastener must match the bolt. That is, the nominal size (inside diameter) must be 3/8" and the threads of the nuts must engage the threads on the bolt and permit the nuts to be turned onto the bolt. Nuts must be solid, hexagonal, and have the configuration and dimensions of "finished hex nut grade 2," "finished hex nut grades 5 and 8," or "heavy hex nut" as illustrated on the web site cited in rule 9.2.8. Nuts must not be mechanically altered or modified in any manner. They may be painted.

9.2.10. Nuts and bolts that connect the parts of a member but do not connect a member to other members are not considered to be fasteners and are not governed by rules 9.2.7, 9.2.8, and 9.2.9.

Member-to-member Connections

9.2.11. Each member must be connected directly to every member that it touches by at least one fastener installed during timed construction so that the connection cannot be taken apart without first removing a nut from the bolt.

9.2.12. The bolt must penetrate completely through a hole in each of the members that it connects. Dimension(s) of the hole must be small enough so that the head of the bolt specified in 9.2.8 cannot pass through the hole.

10. CONSTRUCTION

10.1. Safety Equipment and Tools

Competitors are required to provide their own tools, hardhats, and protective eyewear or safety goggles.

10.1.1. A team will not be permitted to construct its bridge unless every builder is outfitted with a hardhat meeting ANSI standard Z89.1 and protective eyewear or safety goggles meeting ANSI standard Z87.1.

10.1.2. The following items must not be used during timed construction

- welding machine,
- tool requiring external power connection,
- tool exceeding 3’6” in any linear dimension when fully assembled and extended,
- tool weighing more than 20 pounds,
- temporary pier that at any time exceeds 2’6” in height or width in the span direction of the bridge,
- temporary pier weighing more than 20 pounds,
- more than one temporary pier.

10.2. Safety

If any of rules in this section (10.2) is violated during timed construction, the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools, and bridge components will be returned to the positions they occupied before the violation. Then the builders will be asked to resume construction using safe procedures. Builders will have the opportunity to construct their bridge safely but if this is not possible, construction will cease and the bridge will not be approved for load testing and will not be eligible for awards in any category.

10.2.1. Builders must not be exposed to risk of personal injury.

10.2.2. At all times during construction all builders must wear hardhats and protective eyewear or safety goggles specified in rule 10.1.1. Safety equipment must be worn properly (e.g., hardhats with peak in front).

10.2.3. Under no circumstance will throwing be permitted.

10.2.4. A builder must not use the bridge, a portion of the bridge, 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 bridge if the builder is kneeling on one or both knees, or if the builder is standing on the heels and toes of both feet.

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

10.2.6. A builder must not cross the river by jumping, by temporary scaffolding, by crossing the bridge, or by any other means.

10.2.7. The temporary pier must not collapse while it is supporting part of the bridge.

10.2.8. An “assembly” consists of no more than three members that are connected together with fasteners in the staging yards during timed construction. An assembly must not be modified after it leaves the staging yard. Exception: After an assembly is in its final position, the nuts on the fasteners may be tightened, additional nuts may be added to fasteners, and fasteners may be removed temporarily and reinstalled in the same holes.

10.2.9. A “constructed portion” consists of connected members and assemblies. A constructed portion may consist of several entities that are not contiguous. A bridge must be constructed by first placing members or assemblies in their final positions on the footings or on the temporary pier (if one is used). These become the initial constructed portion. Then additional members and assemblies are successively connected to the constructed portion to enlarge it. Outside the staging yards connections must be made only to the constructed portion.

10.2.10. A constructed portion must be created in its final position and must not be moved. Exception: small movement (maximum 3 inches) of a constructed portion by as few as one builder will be allowed as necessary to facilitate connections, placement on the footings, and removal of the temporary pier.

10.2.11. A constructed portion is considered to be self-supporting if all of its parts retain essentially their final positions without support by builders. A constructed portion that is not self-supporting must be supported by at least one builder.

10.2.12. Outside the staging yard, moving or supporting an assembly requires the effort of at least two builders. The word “moving” includes, but is not limited to, lifting, carrying, lowering, rolling, turning, sliding, tipping, and rotating.

10.2.13. Outside the staging yard, a builder must not contribute to lifting, carrying, or supporting more than one member or assembly at a time.

10.2.14 A builder who is supporting the constructed portion must not simultaneously contribute to moving or supporting a member or assembly.

10.2.15. A builder must not move or support the temporary pier while also moving or supporting a member, assembly, or constructed portion.

10.2.16. Lubricant must not be applied during timed construction or within the construction site at any time. Lubricant must not drop on the floor within the construction site.

10.3. Team

The construction team, also referred to as builders, consists of all participants who are within the construction site at any time during timed construction. There must be no more than six builders.

Participation is limited to undergraduate and graduate student members of ASCE student chapters, ASCE student clubs, and ASCE international student groups.

10.4. Temporary Pier

A temporary pier is a support placed on the ground. The use of a temporary pier is optional but adds to construction cost (see section 6.3). Each team provides its own temporary pier. Only one is permitted and it must be used in only one place.

10.5. Construction Site

See the “Site Plan” on the “Site and Bridge” diagram for layout of the construction site. The host university lays out the site, including the 6-inch by 6-inch footings, before the contest. All of the site outside of the river is “ground,” including the parkway.

Only builders and judges are permitted in the construction site during timed construction. Only judges are permitted near the construction site; coaches, managers, and spectators must observe from a safe distance that does not obstruct judges.

10.6. Start

Before construction begins, all of the following items, and nothing else, are in the staging yards: members, fasteners, tools, temporary pier (if used), and builders. Builders will be wearing hardhats and protective eyewear or safety goggles, as well as optional clothing such as pouches. Every member, tool, and fastener must be in contact with the ground. Members must not be connected or touching one another. Tools and fasteners must not be in contact with members.

During timed construction, additional members, tools, fasteners, temporary piers, builders, or other items must not be brought into the construction site nor must anything be removed.

Timing and construction begin when the builders signify that they are ready and the judge declares the start.

10.7. Time

Time is kept from start to finish of construction. The clock will be stopped

10.7.1. if a builder or judge sees a condition that could cause injury, or

10.7.2. when a safety rule has been violated (see section 10.2), or

10.7.3 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 section 10.9).

Construction ceases while the clock is stopped. After the situation has been corrected, builders, 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 exceeds 30 minutes but does not exceed 45 minutes, it will be multiplied by 1.50 for scoring. Judges will inform the team when this limit is reached.

10.8.2. If construction time exceeds 45 minutes, it will be counted as 180 minutes for scoring. "Accidents" (section 10.9) that occur after 45 minutes will not be penalized but safety rules (section 10.2) will still be enforced. Judges will inform the team when this limit is reached.

10.8.3. If construction time exceeds 60 minutes, judges will halt construction. The bridge will not be approved for load testing and will not be eligible for awards in any category.

10.9. Accidents

In general, the clock is not stopped when an “accident” occurs. If an accident is continuous (for example, a builder stands in the river) it will be counted as multiple incidents. Builders involved in accidents may continue to build, and items involved in accidents must 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 resuming timed construction, builders, tools, members, temporary pier, and fasteners will be returned to the positions they occupied before the accident. Exception: Construction may proceed if it is no longer possible to hold all four bearing surfaces within the footings simultaneously. In this situation, the team captain may request that the clock be stopped in order to demonstrate the difficulty to the judge. If the judge is convinced, no additional accidents will be cited for bearing surfaces touching the ground outside the footings (rule 10.9.2), the clock will be restarted, construction will resume, and a penalty will be assessed for a dimensional violation under rule 8.2.1 (even if the bearing surfaces fall within the footings when the bridge is completed).

Types of accidents and the corresponding time penalties, which will be added to the construction time, are

10.9.1. A builder or a builder’s clothing touches the river. Penalty is 1/2 minute (30 seconds) per incident. Exception: There is no penalty for entering the river to retrieve an object such as a member, tool, nut, bolt, or hardhat.

10.9.2. A member, assembly, or constructed portion touches the river or ground outside a staging yard. Penalty is 1/4 minute (15 seconds) per incident. Exception: members, assemblies, and the constructed portion may touch the ground within the 6-inch by 6-inch footings.

10.9.3. A tool, nut, bolt, hardhat, protective eyewear, or goggles touches the river or ground outside a staging yard. Penalty is 1/4 minute (15 seconds) per incident. Exception: a tool used exclusively for measuring may touch the ground during use while being held by a builder.

10.9.4. The temporary pier touches the river. Penalty is 1/4 minute (15 seconds) per incident.

10.9.5. The temporary pier is moved from one location outside the staging yards to another location outside the staging yards. Penalty is 1/4 minute (15 seconds) per incident.

10.9.6. A builder steps outside the boundary of the construction site. Penalty is 1/4 minute (15 seconds) per incident.

10.10. Finish

Construction ends and the clock is stopped when

- the bridge has been completed by connecting all the members, and
- all tools, builders, and the temporary pier (if used) are back in the staging yards, and
- the builders signify that they are finished.

Installation of decking is not included in timed construction.

After construction is finished the bridge must not be modified except as provided by section "10.11 Construction: Repairs."

10.11. Repairs

Before the judges inspect and measure the bridge, and before the bridge is moved from the construction site, two members of the team will be given five minutes to inspect the bridge for construction mistakes. They must not modify the bridge and they must not touch the bridge except as necessary to use measuring devices. The team will be permitted, but not required, to repair construction mistakes found by their inspectors. Repairs are made with the clock restarted, and must be completed in ten minutes or less. Judges will not examine the bridge for violation of rules until after the repair period. Safety precautions (sections 10.1 and 10.2) apply and accidents (section 10.9) are counted. The time required to make repairs (including penalties) is multiplied by 1.5 and added to the construction time.

11. LOAD TESTS

11.1. Safety Precautions

The judge will halt any activity that is hazardous.

A bridge could suddenly collapse or sway in any direction during load tests. Therefore, minimize the number of people near the bridge while it is being tested. Usually, the load should be placed on the bridge by only two competitors.

While participating in load testing, competitors must wear hardhats meeting ANSI standard Z89.1, protective eyewear or safety goggles meeting ANSI standard Z87.1, 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.

During testing, safety supports must be in place below the decking. The safety supports should be of sufficient height, strength, number, and extent that none of the load will fall more than approximately 6 inches if the bridge collapses.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a portion of the decking that is cantilevered laterally over its support.

When any portion of the load is on the bridge, no one is permitted to crawl, reach or step under the bridge. If such an action is necessary the load must first be removed.

11.2. Damage

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

If a nut falls off its bolt while the bridge is being transported or prepared for load testing, the connection will be repaired, the nut will be replaced (finger tight) and a penalty of 2 minutes will be added to construction time.

A bridge with irreparable damage that would reduce its strength or stability (such as a missing or broken member or fastener) will not be approved for load testing and is not eligible for awards in any category.

11.3. Preparation

The temporary pier is not used during load testing.

The judge designates the “A” and “B” sides of each bridge by a random process. “Left” and “right” ends are determined by facing the “A” side.

Sway is translation in any horizontal direction. A target is established for sway measurement on the “A” side of the bridge, 10’9” from the left end of the decking support on that side. The sway target is located at the level of the decking support which is the same as the bottom of the decking. See the “Lateral Load Test” plan on the “Bridge Loading” diagram.

Three targets are established for measuring vertical deflection. Two of the vertical deflection targets are located longitudinally at the center of the centermost unit of decking, on the "A" and "B" sides of the bridge, at the level of the decking support which is the same as the bottom of the decking. The other vertical deflection target is located longitudinally at the center of the unit of decking nearest the right end of the bridge, on the "A" side of the bridge, at the level of the decking support. Targets may be on the decking or on the bridge. For location of decking units, see section 11.5 and the "Location of Targets and Decking" plan on the "Bridge Loading" diagram.

At their discretion, judges may impose a penalty for a bridge that incorporates parts having the primary function of interfering with placement of targets or measuring equipment.

Teams must accept imperfect field conditions such as bent decking and slightly sloping floors.

11.4. Lateral Load Test

The provisions of this section are illustrated by the "Lateral Load Test" plan on the "Bridge Loading" diagram.

The lateral load test is conducted with one unit of decking 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 prevent the bearing surfaces of the bridge from lifting off the ground when lateral load is applied.

The two bearing surfaces on the "B" side of the bridge are prevented from sliding by horizontal restraint applied from the inside of the abutments as close as possible to the ground. This horizontal restraint does not restrain rotation of the abutments and is identical for all bridges.

Apply a 50-pound lateral pull at the sway target and measure the sway. To pass the lateral load test, the sway must not exceed 1.0 inch.

If the bridge did not pass the lateral load test it is not approved for further testing. **Do not conduct any other load test**. Add a penalty of 900 pounds to the weight of the bridge and a penalty of 30 minutes to the construction time. Record: Aggregate deflection = 60 inches.

If the bridge passed the lateral load test, remove the load and decking, and proceed with the vertical load test.

11.5. Vertical Load Test

The provisions of this section are illustrated by the three “Vertical Load Test” elevations on the “Bridge Loading” diagram.

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

Decking units are three feet long in the longitudinal (span) direction of the bridge. Place the two decking units at distances LC and LR measured from the left end of the decking support on the “A” side of the bridge to the left edges of the decking units. See item 4 in chapter 7 for determination of LC and LR, and section 11.3 for location of targets. Decking units are square with the bridge, not skewed. Decking units must not be attached to the bridge and must not distort it (see rules 8.1.4 and 8.1.5).

Position measuring devices on the three vertical deflection targets.

Uniformly distribute 100 pounds of preload on the right decking unit and uniformly distribute100 pounds of preload on the center decking unit. Preloads are distributed and aligned identically for every bridge.

If a contestant disturbs a measuring device after it has been initialized and before the measurement is recorded, the judge will require the team to disassemble the bridge and repeat timed construction. Scoring will be based on the larger of the two construction times but will not exceed 125% of the initial construction time.

The two steps (increments) of vertical loading produce three measurements used in scoring

- DCA = value of downward vertical deflection at center target on “A” side that occurs during step 1 (loading on center decking unit).
- DCB = value of downward vertical deflection at center target on “B” side that occurs during step 1 (loading on center decking unit).
- DR = value of downward vertical deflection at right target that occurs during step 2 (loading on right decking unit with load from step 1 remaining in place).

Step 1

Loading the center unit and measuring deflections at those targets

- The two 100-pound preloads remain in place.
- Initialize the sway measurement.
- Initialize the measuring devices on all three vertical deflection targets or record the initial readings.
- Team members place 1400 pounds of additional load on the center decking unit. The 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 should be placed at a steady pace, without hesitation.
- As the load is being placed, observe sway and deflection. Stop loading if
    a. sway exceeds one inch, or
    b. deflection measurement at any of the three vertical deflection targets exceeds 2 inches, or
    c. any part of the bridge, other than the intended bearing points, comes to bear on the safety support or floor, or
    d. a decking unit falls off the bridge, or
    e. a dangerous collapse is imminent, in the opinion of the judge.

If sway or deflection is excessive (situation a or b), the bridge is not approved for further load testing. Remove the load and **do not continue load testing**. Add an 800-pound penalty to the weight of the bridge and a penalty of 30 minutes to the construction time. Record: Aggregate deflection = 60 inches.

If the bridge fails (situation c, d, or e), it 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**.

If the bridge passes step 1, record the measured values DCA and DCB, which are the downward vertical deflections during step 1 of the two targets for the center decking unit.

Step 2
Loading the right unit and measuring deflection at that target

- The two preloads and the load from step 1 remain in place.
- Do **not** re-initialize the sway measurement.
- Do **not** re-initialize the measuring devices on the center deflection targets.
- Initialize the measuring device on the right vertical deflection target or record the reading.
- Team members place 900 pounds of additional load on the right decking unit. The 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 should be placed at a steady pace, without hesitation.
- As the load is being placed, observe sway and deflection. Stop loading if
    a. sway exceeds one inch, or
    b. deflection measurement at any of the three vertical deflection targets exceeds 2 inches downward, or
    c. any part of the bridge, other than the intended bearing points, comes to bear on the safety support or floor, or
    d. a decking unit falls off the bridge, or
    e. a dangerous collapse is imminent, in the opinion of the judge.

If sway or deflection is excessive (situation a or b), the bridge is not approved for further load testing. Remove the load and **do not continue load testing**. Add a 700-pound penalty to the weight of the bridge and a penalty of 30 minutes to the construction time. Record: Aggregate deflection = 60 inches.

If the bridge fails (situation c, d, or e), it 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**.

If the bridge passes step 2, record the measured value DR = value of downward vertical deflection during step 2 of the target for the right unit of decking. Compute and record: Aggregate deflection = DCA + DCB + DR.

11.6. Unloading

If the bridge collapses during unloading, it is not eligible for awards in any category.

12. EQUIPMENT PROVIDED BY HOST

The web site http://www.aisc.org/steelbridge.html has detailed descriptions and illustrations of hosting equipment. The following partial list is intended to help competitors know what to expect. Competitors should acquire similar equipment for use in practice and testing before the competition.

12.1. Lateral Load Device

Capable of applying a 50-pound force in the horizontal direction.

12.2. Equipment for Measuring Sway

Sway is horizontal translation and is measured by any accurate method. A suggested method is to suspend a plumb bob from the sway target and measure sway from a point marked on the ground.

12.3. Equipment for Measuring Deflection

Deflection is vertical translation and is measured at three points by any accurate method.

12.4. 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 of the grating that are perpendicular to the length.

12.5. Load

2500 pounds total. The load 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.

12.6. Safety Supports

The safety supports must be used during load testing and are intended to limit the consequences of a bridge collapsing. The safety supports should 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, plastic buckets, timbers, sand bags, or masonry units.

12.7. Floor

The surfaces on which the bridges will bear should be as nearly flat and level as possible, in both the construction site and loading area.

13. INTERPRETATION OF RULES

The web site http://www.aisc.org/steelbridge.html lists answers to questions about 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 and reread this *Rules* document carefully in its entirety**. The names of students and their universities will be posted with their questions. Questions must be submitted before 5:00 PM Eastern Daylight Saving Time, 15 May 2006.

14. JUDGING

The host 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 will assure that the judges are fully informed of the rules and procedures, and fully equipped for their tasks. More information for hosts and judges, including a spread sheet for scoring, is available at http://www.aisc.org/steelbridge.html.

15. APPEALS

15.1. Regional Competitions

15.1.1. At the beginning of the competition each team will designate a student as team captain. The host university will identify the regional head judge (RHJ).

15.1.2. A penalty, decision, measurement, score, or condition of competition may be appealed only by a team captain and only to the RHJ. The appeal must be made as soon as possible after the situation becomes apparent. The RHJ will not hear the appeal if he or she is approached by students other than the team captain. The RHJ will hear the appeal as soon as possible and may interrupt the contest. Participants are reminded that civility and ethical behavior are expected during the contest and particularly concerning appeals.

15.1.3. After the regional competition, the team captain has the option to appeal the decision of the RHJ by sending an e-mail message to Mr. Fromy Rosenberg <rosenberg@aisc.org> followed by a letter mailed to Mr. Rosenberg (AISC, Suite 3100, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to ASCE Student Services (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The e-mail message and letter should include

- name of the college or university making the appeal,
- team captain's name, e-mail address, postal address, and telephone number,
- faculty adviser's name, e-mail address, postal address, and telephone number,
- brief description of the problem,
- action taken at the contest to deal with the problem,
- action that the appealing team feels should have been taken,
- data showing that the team should have qualified for national competition, and
- team captain's signature (letter only).

Appeals must be made by e-mail followed by letter. An appeal will be considered only if the e-mail is received and the letter is postmarked within **one week** after the regional contest. Mr. Rosenberg will disseminate the appeal to the ASCE/AISC Rules Committee for their evaluation. The only redress that may be made is an invitation to participate in the national competition if the Rules 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 regional 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 contest 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 ASCE/AISC 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 ASCE/AISC Rules Committee within fifteen minutes after hearing the NHJ's ruling. The Rules 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 ASCE/AISC Rules Committee is final; there are no further appeals. However, AISC and ASCE welcome written suggestions for improving future competitions.

16. SCORE SHEET

16.1. Aesthetics (see section 6.1 for criteria)

- o Appearance: balance, proportion, elegance, finish.
- o Name of college or university on bridge in letters at least one inch high.
- o Poster describing design and fabrication, no larger than 2 x 3 feet.

Judges should not declare ties in aesthetics

AESTHETICS SCORE = _____

16.2. Construction Speed and Time Penalties

Construction clock time, CT			_____ minutes
If CT ≤ 30 minutes, enter CT			
If 30 < CT ≤ 45, multiply CT by 1.5 (see 10.8)			
If 45 < CT ≤ 60, enter 180 (see 10.8)			_____ minutes
Time penalties during construction (see 10.9)			
10.9.1: violations _____	x 1/2	+	_____ minutes
10.9.2,.3,4,.5,6: violations _____	x 1/4	+	_____ minutes
Repair time (see 10.11) _____	x 1.5	+	_____ minutes
Time penalties during repair (see 10.9, 10.11)			
10.9.1: violations _____	x 1/2 x 1.5	+	_____ minutes
10.9.2,.3,4,.5,6: violations _____	x 1/4 x 1.5	+	_____ minutes
Time penalty, damage (see 11.2)		+	_____ minutes
Time penalty, load tests, 30 min (see 11.4 and 11.5)		+	_____ minutes

TOTAL TIME = _____ minutes
Lowest total wins.

16.3. Construction Economy

Number of builders		_____
Total time (part 16.2)	x	_____ minutes
	x	50
+ 100 if a temporary pier is used	+	_____

CONSTRUCTION COST: C_C = _____ thousand $
Lowest cost wins.

16.4. Lightness and Weight Penalties

Bridge weight _____ pounds
Weight penalties,
"6.1 Aesthetics" (50 or 100) + _____ pounds
"8.2 Dimensions and Support: Usability"
Rules violated ≤ 1 inch _____x 150 + _____ pounds
Rules violated 1 - 2 inch _____x 300 + _____ pounds
"9.2 Material & Components: Durability & Constructability"
Number of violations _____ x 10 pounds + _____ pounds
Wt. of parts in violation _____ pounds x 5 + _____ pounds
"11.4 and .5 Load Tests: Lateral Load and Vertical Load"
(900, 800 or 700) + _____ pounds

TOTAL WEIGHT = _____ pounds
Lowest weight wins.

16.5. Stiffness

AGGREGATE DEFLECTION: DCA + DCB + DR = _____ inches
Lowest deflection wins.

16.6. Structural Efficiency

Total weight (part 16.4) _____ pounds
Aggregate deflection (part 16.5) x _____ inches
x 20

STRUCTURAL COST: C_S = _____ thousand $
Lowest cost wins.

16.7. Overall Performance

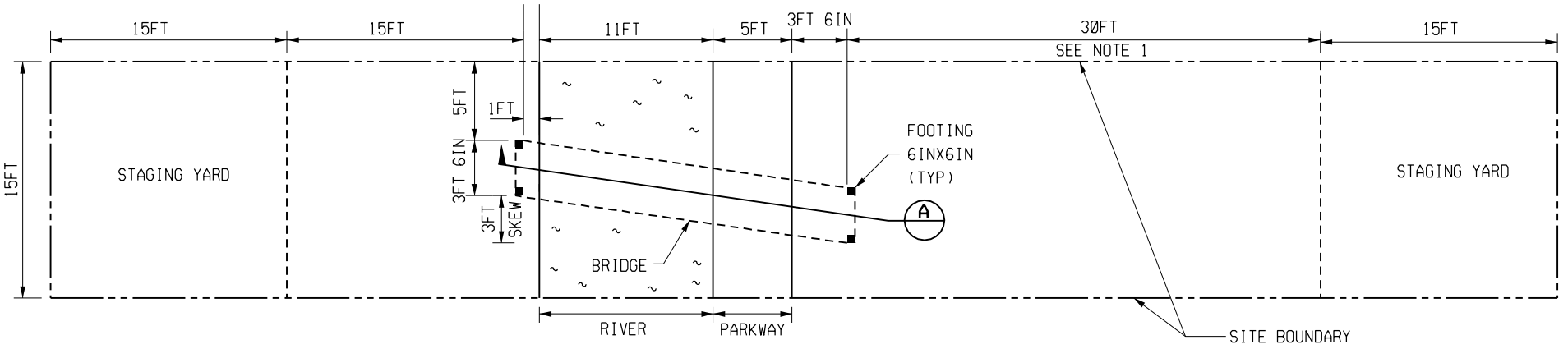
C_C (from part 16.3) _____ + C_S (from part 16.6) _____ = _____
Lowest total wins.

16.8. Ranks (Aesthetics is the tie-breaker for all categories)

A bridge will not be ranked if it was not approved for construction or load testing, or if it failed in load testing.

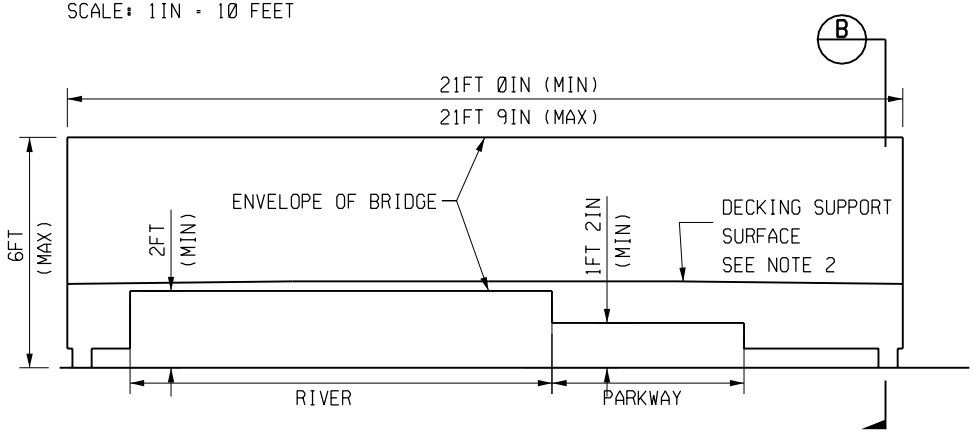
Aesthetics ____ Construction Speed _____ Lightness _____
Stiffness _____ Construction Economy _____ Structural Efficiency _____
Overall Performance _____

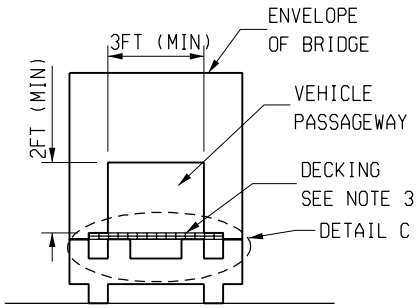
This Score Sheet implements chapter "6 Scoring." A comparable spreadsheet is available at http://www.aisc.org/steelbridge.html.

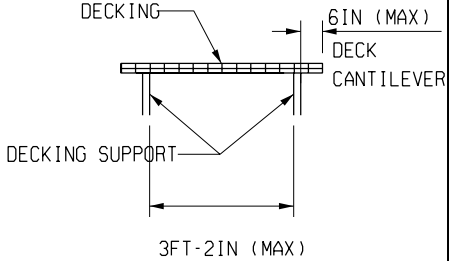


SITE PLAN - REFER TO CHAPTERS 8 & 10

SCALE: 1IN = 10 FEET







A ELEVATION - REFER TO CHAPTER 8

SCALE: 1 IN = 5 FT

B END VIEW

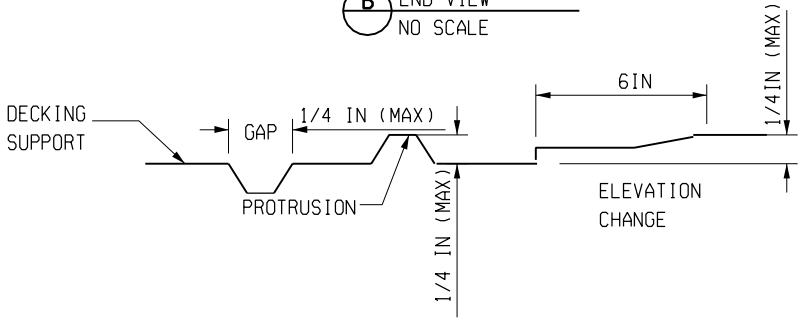
NO SCALE

C DECKING SUPPORT

NO SCALE

NOTES:

1. LENGTH CAN BE ADJUSTED TO FIT SITE CONDITIONS.
2. TOP OF THE DECKING SUPPORT SHALL BE BETWEEN 2FT-3IN AND 2FT - 6IN ABOVE GRADE.
3. BRIDGE SHALL ACCOMODATE 3FT- 9IN DECKING THROUGHOUT OVERALL LENGTH OF THE BRIDGE.



IRREGULARITIES IN DECKING SUPPORT - REFER TO CHAPTER 8

SCALE: NONE

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION
A	7-01-05						2006 NSSBC RULES

DESIGNED BY: F. HATFIELD
DRAWN BY: D. SEPULVEDA
CHECKED BY: RULES COMM.
IN CHARGE: F. ROSENBERG
DATE: 7-01-2005

ASCE - AISC
NATIONAL STUDENT STEEL BRIDGE CONTEST

ASCE American Society of Civil Engineers

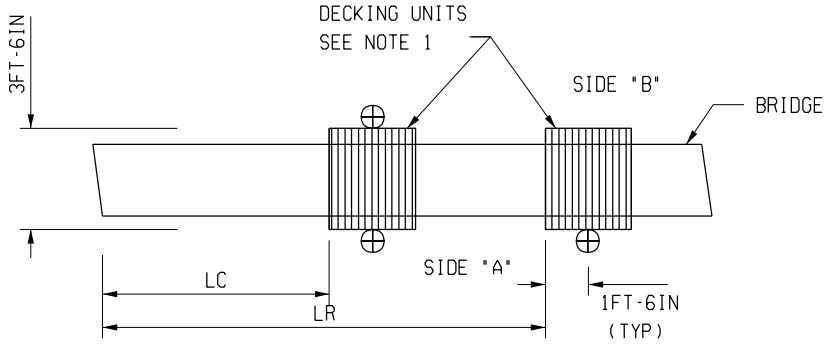
SUBMITTED

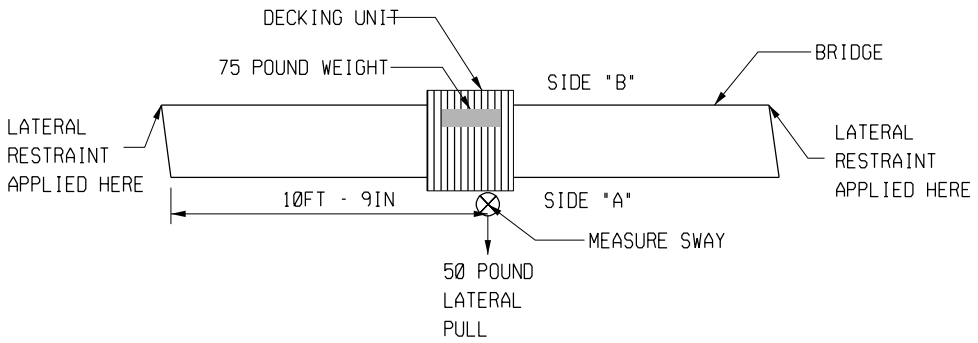
APPROVED

SITE AND BRIDGE DIAGRAM

CONTRACT NO: 2005
DRAWING NO: EXHIBIT 1
REV
SCALE: AS SHOWN
SHEET NO

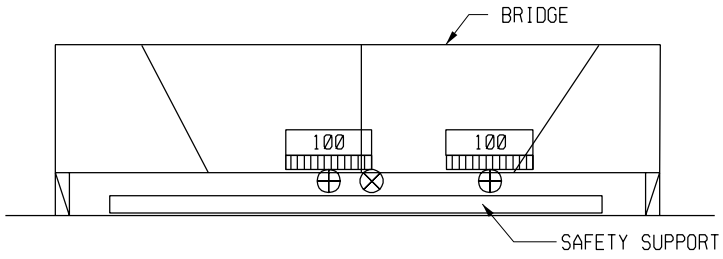
PLOTTED BY@USER$ @DATE$ @FILE$

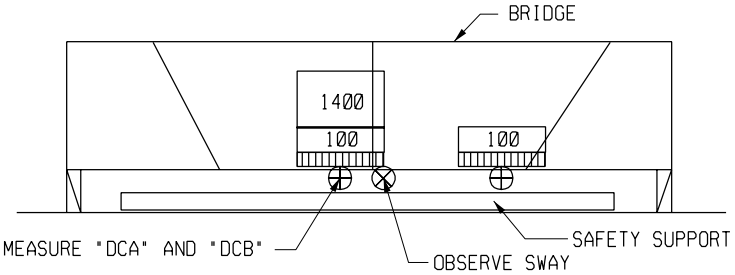




A LOCATIONS OF TARGETS AND DECKING - PLAN
REFER TO CHAPTER 11, SECTIONS 3 & 5

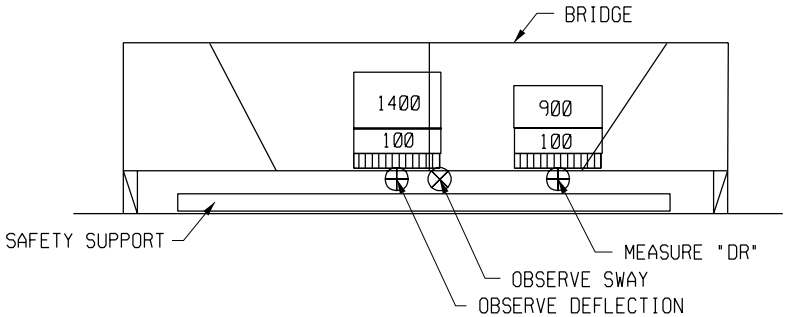
B LATERAL LOAD TEST - PLAN
CHAPTER 11, SECTIONS 3 & 4





0 VERTICAL LOAD TEST - PRELOAD
REFER TO NOTES DURING LOADING PROCESS

1 VERTICAL LOAD TEST - STEP 1
REFER TO NOTES DURING LOADING PROCESS



2 VERTICAL LOAD TEST - STEP 2
REFER TO NOTES DURING LOADING PROCESS

LEGEND

⊕ TARGETS FOR MEASURING VERTICAL DEFLECTION TO BE PLACED LONGITUDINALLY AT THE CENTER OF THE DECKING UNITS

⊗ TARGET FOR MEASURING SWAY

NOTES

1. THE LOAD IS LATERALLY CENTERED ON THE DECKING UNIT AND DISTRIBUTED OVER THE LENGTH OF THE DECKING UNIT AS UNIFORMLY AS POSSIBLE AT ALL TIMES DURING LOADING.
2. OBSERVE ALL VERTICAL TARGETS ON EACH SIDE OF THE BRIDGE FOR DEFLECTION.
3. LOADING TERMINATES IF DEFLECTION AT ANY OF THE VERTICAL DEFLECTION TARGETS EXCEEDS 2 INCHES DURING STEP 1 AND STEP 2.
4. LOADING TERMINATES IF SWAY AT SWAY TARGET EXCEEDS 1" DURING STEP 1 AND STEP 2.
5. SAFETY SUPPORT TO BE IN PLACE AT ALL TIMES DURING LOADING.
6. BRIDGE TO BE UNLOADED IN THE REVERSE ORDER OF LOADING.
7. ALL LOADING SAFETY PROCEDURES TO BE FOLLOWED.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION
A	7-01-05						2006 NSSBC RULES

DESIGNED BY F. HATFIELD
DRAWN BY D. SEPULVEDA
CHECKED BY RULES COMM.
IN CHARGE F. ROSENBERG
DATE 7-01-06

ASCE - AISC
NATIONAL STUDENT STEEL BRIDGE CONTEST

ASCE American Society of Civil Engineers

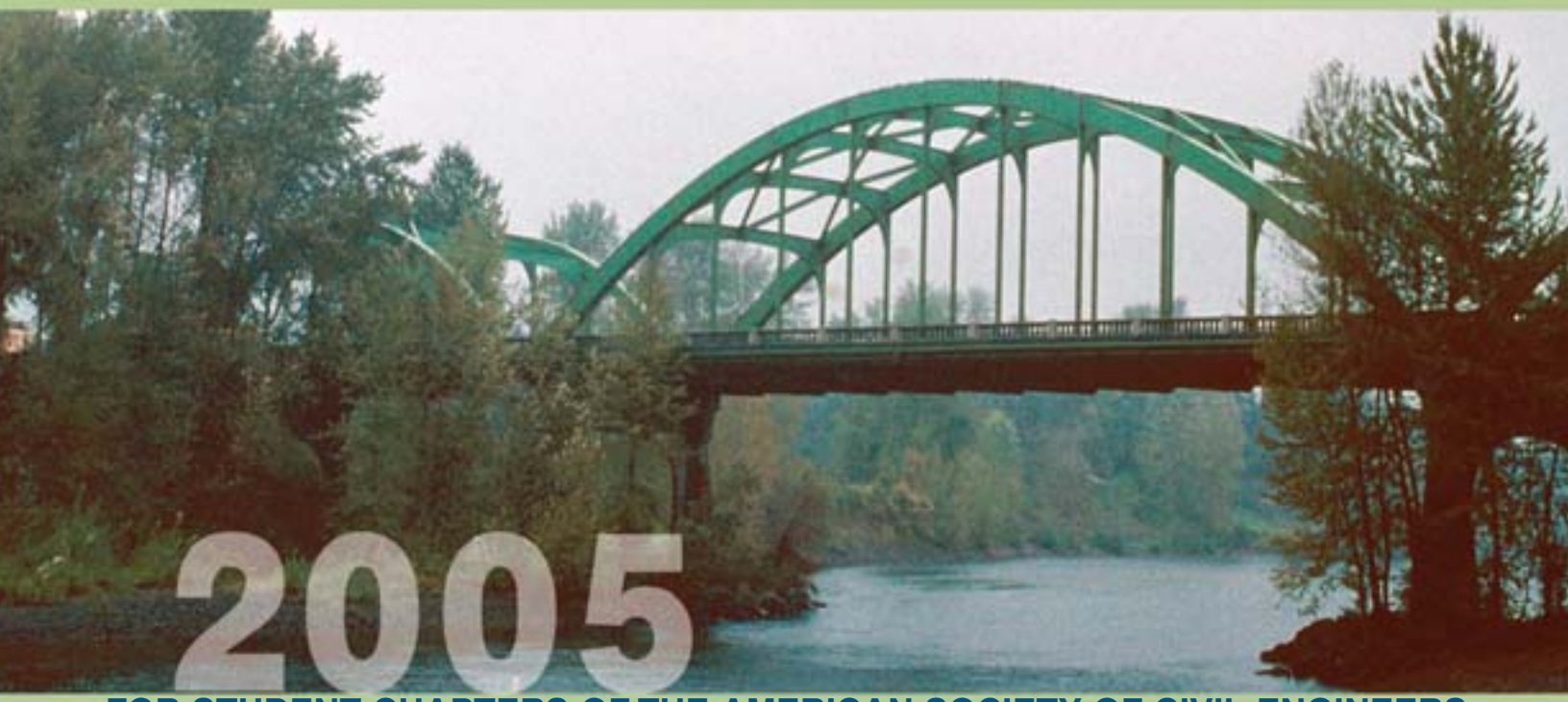
SUBMITTED _____
APPROVED _____

BRIDGE LOADING
DIAGRAM

CONTRACT NO 2005
DRAWING NO EXHIBIT 2 REV
SCALE AS SHOWN
SHEET NO

$FILE$ $DATE$ PLOTTED BY $USER$

STUDENT STEEL BRIDGE COMPETITION RULES



FOR STUDENT CHAPTERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

CO-SPONSORS

American Iron and Steel Institute

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THE WELDING EXPERTS

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STUDENT STEEL BRIDGE COMPETITION

2005 RULES

http://www.aisc.org/steelbridge.html

TABLE OF CONTENTS

1. INTRODUCTION

The Student Steel Bridge Competition is sponsored by the American Institute of Steel Construction (AISC) and by the American Society of Civil Engineers (ASCE), and co-sponsored by the American Iron and Steel Institute, the James F. Lincoln Arc Welding Foundation, the National Steel Bridge Alliance and Nucor Corporation. This inter-collegiate challenge requires Civil Engineering students to design, fabricate and construct a steel bridge.

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

Students design the bridge themselves but may seek advice from faculty and other consultants. Ideally, students should fabricate the entire bridge themselves. However, appropriate shop facilities and supervision may not be available at every college and university. Therefore, the services of a commercial fabricator may be used provided that students develop the work orders and observe the operations. Students are encouraged to maximize their personal involvement in fabricating their bridge.

This document describes the contest and states the rules for this year. It is available at http://www.aisc.org/steelbridge.html

The rules are changed every year to improve the contest and assure 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 chapter "13 Interpretation of Rules."

There are two levels of competition: regional and national. These *Rules* govern competition at both regional and national levels. Regional competitions are held in conjunction with ASCE regional conferences. Only one bridge per university may be entered in a regional competition, and a university may compete in only one region. Invitations to compete at the national level are extended only to the winner from a region with two, three or four participating universities, to the top two teams from a region with five to ten participating universities, and to the top three teams from a region with eleven or more participating universities. Only one bridge per university may be entered in the national competition.

The ASCE student chapters, clubs and international student groups entering the contest are required to be current with their national dues. A team may consist only of undergraduate and graduate students in good standing with their ASCE student chapter, club or international student group.

Additional information about the Student Steel Bridge Competition is available at http://www.aisc.org/steelbridge.html.

2. EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication and construction. Participating students gain practical experience in structural design, fabrication processes, construction planning, organization and teamwork.

Chapter "4 Problem Statement" describes challenges encountered in a representative structural engineering project. The competition is a scaled simulation of that project.

Standards for strength, durability, constructability, usability, functionality and safety reflect the volumes of regulations that govern the design and construction of full-scale bridges. Criteria for excellence are represented by the award categories of stiffness, lightness, construction speed, aesthetics, efficiency and economy. Contest judges and the Rules Committee take the role of the owner (DOT) and have the authority to accept and reject entries. As with any full-scale construction project, safety is the primary concern.

The rules of the competition accommodate a large 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.

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

3. RULE CHANGES

The following list covers some of the major changes from the 2004 rules. Not all changes are listed. Contestants and judges are cautioned to **read this entire *Rules* document carefully and disregard rules and clarifications from previous years**.

1. The bridge is single span and may be skewed.
2. Several dimensional limits are different.
3. Flexible members (cables) are prohibited.
4. Fastener holes must not allow the head of a bolt to pass through.
5. School name must be permanently lettered on the bridge.
6. Weight penalties are imposed for missing name and poster.
7. Weight of tools is limited.
8. A barge cannot be used but a temporary pier is permitted.
9. The maximum number of members in an assembly is reduced to three.
10. As few as one builder may support a constructed portion of the bridge.
11. Load patterns and scoring are different.

4. PROBLEM STATEMENT

A century-old bridge that crosses an emergent wetland must be replaced. The bridge carries traffic serving the residences, farms and agricultural processing industries that are the economic base of this rural region. A quick replacement is necessary because no other crossing is available for miles.

The state Department of Transportation (DOT) has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered but the DOT has specified steel as the material because of its durability, fast erection and high level of recycled content. Clearance under the bridge must be provided for emergent vegetation in the wetland and around the piers. The bridge must be able to carry specified patterns of loads without exceeding sway and deflection limits. Based on past experience with performance and maintenance, the DOT prefers bridges that are relatively light and stiff. The new bridge must accommodate modular decking that was salvaged from another structure. Decking units may not be modified.

Due to environmental concerns, construction of permanent piers is permitted only on the existing footings at the boundary of the wetland. A temporary pier may be placed on an existing causeway. Construction equipment is not permitted in the wetland but may operate outside the boundaries of the wetland and on the causeway. Soil conditions limit the weight of loads that may be moved.

Your company's design/build proposal is among those that the DOT has deemed responsive, and winning the contract would be a step toward becoming a leader in the bridge replacement market. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. A panel of DOT personnel will judge the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy and aesthetics. The contract will be awarded to the company whose model best meets the DOT's needs and requirements. 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 rejection of the model and termination of the company's eligibility.

5. SAFETY

Safety has the highest priority. Judges are empowered to halt any activity that they deem hazardous. Judges will stop construction procedures that could cause personal injury. Judges will not allow additional load to be placed on a bridge that has collapsed or that has swayed or deflected in excess of specified limits. A bridge that cannot be safely constructed or load tested using the equipment provided by the host is not eligible for awards in any category and must be withdrawn from participation in the contest.

6. SCORING

A university may enter only one bridge in regional competition and may compete in only one region.

Categories of competition are aesthetics, construction speed, lightness, stiffness, construction economy, and structural efficiency. In addition, overall performance is rated. A bridge that was not approved for load testing or that failed in load testing is not eligible for awards in any categories.

6.1. Aesthetics

Aesthetics is the tie-breaker for all categories of competition. Judges should not declare ties in aesthetics. Aesthetics is judged by:

6.1.1. Appearance of bridge, including balance, proportion, elegance and finish. Quality of fabrication should not be considered because some bridges may be fabricated professionally while others are student work.

6.1.2. Permanent identification of the bridge consisting of the full name or unique commonly accepted name of the college or university (not initials or name of mascot). The name must appear on the bridge in letters at least one inch high and may be formed from steel or applied with paint or decals. A 50-pound weight penalty will be imposed if the bridge lacks appropriate identification.

6.1.3. Poster describing design and fabrication. The poster must be flat with maximum dimensions of 2 feet by 3 feet. The poster is not part of the bridge but must be in place during aesthetics judging and at other times when the bridge is on display. The poster must include the full name or unique commonly accepted name of the college or university (not initials or name of mascot), a brief explanation of why the overall configuration of the bridge was selected, a brief computation demonstrating design for one limit state, and a scaled, dimensioned side view of the bridge. Additional information may be included. Electronic displays, decorated poster supports, lights and sound are not permitted and will result in the worst possible rating for the poster. A 50-pound weight penalty will be imposed if there is no poster or if the content is grossly inadequate.

6.2. Construction Speed

The bridge with the lowest construction time will win in this category. Construction time is the clock time required to assemble the bridge, regardless of number of builders, plus time penalties prescribed in sections “10.8 and 10.10 Construction: Accidents and Repairs,” “11.2 Load Tests: Damage” and “11.4 and 11.5 Load Tests: Lateral Load Test and Vertical Load Test.”

6.3. Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in sections "6.1 Scoring: Aesthetics," "8.2 Dimensions and Support: Usability," "9.2 Material and Components: Durability and Constructability" and "11.4 and 11.5 Load Tests: Lateral Load Test and Vertical Load Test." Decking, tools, temporary pier and poster are not included in total weight.

6.4. Stiffness

The bridge with the lowest aggregate deflection will win in the stiffness category. Aggregate deflection is determined from measurements as prescribed in section "11.5 Load Tests: Vertical Load Test."

6.5. Construction Economy

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

C_c = Construction time (minutes, including penalties)
x Number of builders (persons)
x 50 thousand dollars per person-minute

The number of builders includes all participants who are within the construction site at any time during timed construction.

6.6. Structural Efficiency

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

C_s = W x Δ x 10 thousand dollars per pound-inch, where
W = the larger of total weight OR 80 pounds.
Δ = the larger of aggregate deflection OR 0.25 inch.

Total weight is defined in section "6.3 Scoring: Lightness." Aggregate deflection is defined in section "6.4 Scoring: Stiffness."

6.7. 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.

7. SCHEDULE OF COMPETITION

In the months before the contest, students design their bridges, fabricate members, test load, and practice construction. The following events occur during the competition

1. Bridges are erected and judged for aesthetics. After this, bridges may not be altered, modified or enhanced in any way (except for disassembly, erection, and repairs as described in section "10.10 Construction: Repairs").

2. Judges clarify rules and conditions of the contest and answer questions.

3. Bridges are disassembled.

4. The head judge selects the locations of loads. See section "11.5 Load Tests: Vertical Load Test" and the "Locations of Targets and Decking" detail on the "Bridge Loading Diagram." Selection is done in the presence of the team captains by rolling a die twice. Let S1 and S2 be the spots from the two rolls and let LL, LC and LR be dimensional locations of decking units in feet.

$$LL = (S1 + 2) / 2$$
$$LC = (S2 + 15) / 2$$
$$LR = (S1 + 28) / 2$$

5. Judges inspect components of the bridges. See chapter "9 Material and Components" for details.

6. Timed construction. See chapter "10 Construction" for details.

7. Judges inspect assembled bridges. See chapter "8 Dimensions and Support" for details.

8. Bridges are weighed (alternatively, bridge parts may be weighed prior to construction).

9. Load testing. See chapter "11 Load Tests" for details.

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

- bridges are not modified after selection of load locations, and
- bridges are not modified between aesthetics judging and timed construction, and
- modifications between timed construction and load testing are limited to repairs as described in "10.10 Construction: Repairs."

8. DIMENSIONS AND SUPPORT

Dimensions and support will be checked with the bridge in its as-built condition after construction is completed and before the bridge is moved from the construction site or load tested. The bridge may not be modified nor distorted from its as-built condition in order to satisfy dimension and support rules. Dimensions will be checked without decking or any other applied load on the bridge.

8.1. Functionality and Safety

If any of the following regulations in this section (8.1) is violated, the bridge will not be approved for load testing, and will not be eligible for awards in any category.

8.1.1. The bridge must provide support for the decking along both of the edges that run in the span direction of the bridge. The decking support must be at least 21'6" long on each side and extend for the overall length of the bridge. See the "Elevation" on the "Site and Bridge" diagram.

8.1.2. Decking support must be rigid. At their discretion, judges may test rigidity by applying a 25-pound load at selected points on the decking support: deflection under the load exceeding 1.0 inch indicates lack of rigidity.

8.1.3. The bridge must provide access for placing the decking and load. Although decking is nominally 3'6" wide and 1 inch thick, actual widths range from 3'5.25" to 3'6.75" and thickness may be as large as 1.25 inches. This rule will be checked by sliding a unit of decking or an equivalent template along the **full overall end-to-end length of the decking support**.

8.1.4. Clear span of the decking between decking supports must not exceed 3'4". See the "Decking Support" detail on the "Site and Bridge" diagram.

8.1.5. The decking may not be attached nor anchored to the bridge, nor may it be used to distort the bridge from its as-built condition. However, judges may clamp the decking to the bridge to facilitate deflection measurements as explained in section "11.5 Load Tests: Vertical Load Test."

8.1.6. The bridge may not be anchored nor tied to the ground.

8.1.7. It must be possible to construct and load the bridge safely using equipment provided by the host university. **Bridges must accommodate local conditions.**

8.2. Usability

A weight penalty will be assessed for each rule in this section (8.2) that is violated, rather than for every violation of that rule.

The penalty for violation for each of the following rules will be an addition to the weight of the bridge determined as follows: 50 pounds for a dimensional violation of 1.0 inch or less; 150 pounds for a dimensional violation greater than 1.0 inch but not exceeding 2.0 inches; 300 pounds for a dimensional violation greater than 2.0 inches but not exceeding 3.0 inches. If a dimensional violation exceeds 3.0 inches, the bridge will not be approved for load testing and will not be eligible for awards in any category.

8.2.1. The bridge must span the wetland without touching it. No part or accessory of the completed bridge may touch the wetland, which is 21 feet wide. See the “Site Plan” on the “Site and Bridge” diagram.

8.2.2. No part of the bridge (including fasteners) may extend beyond either of the vertical planes defined by the ends of the decking supports at each end of the bridge.

8.2.3. No part of the bridge may extend more than 6'0" above the surface of the ground or wetland. See the “Elevation” on the “Site and Bridge” diagram.

8.2.4. The decking support surface must be no less than 1’5” nor more than 1’8” above the surface of the ground or wetland at any point. See the “Elevation” on the “Site and Bridge” diagram.

8.2.5. Clearance for emergent vegetation must be provided under the bridge at all points over the wetland. The clearance must be at least 1’2” high, measured from the surface of the wetland, and must traverse the entire width of the bridge. See the “Elevation” on the “Site and Bridge” diagram.

8.2.6. The bridge may bear on the ground only within the 6” by 6” squares that indicate footings located on the boundaries of the wetland. Note that the footing locations are skewed. See the “Site Plan” on the “Site and Bridge” diagram.

8.2.7. Clearance for vegetation must be provided under the bridge at all points outside the boundaries of the wetland, except over the 6” by 6” footings. The clearance must be at least 6 inches high at all points, measured from the surface of the ground. See the “End View” on the “Site and Bridge” diagram.

8.2.8. A vehicle passageway at least 3’0” wide and 2’0” high must completely traverse the bridge from end to end. That is, a vehicle that is 3’0” wide and 2’0” high must be able to cross the bridge. See the “End View” on the “Site and Bridge” diagram.

8.2.9. The edges of the decking that run in the span direction of the bridge may be cantilevered over their supports no more than 6 inches on each side. See the “Decking Support” detail on the “Site and Bridge” diagram.

8.2.10. The decking support must not have gaps exceeding 1/4 inch wide in the span direction of the bridge. See the “Irregularities in Decking Support” detail on the “Site and Bridge” diagram.

8.2.11. The decking support must not have vertical protrusions exceeding 1/4 inch high. Heads of the bolts specified in paragraph 9.2.8 are acceptable vertical protrusions. See the “Irregularities in Decking Support” detail on the “Site and Bridge” diagram.

8.2.12. Elevation of the decking support must not change more than 1/4 inch in any 6 inches of span length. See the “Irregularities in Decking Support” detail on the “Site and Bridge” diagram.

9. MATERIAL AND COMPONENTS

9.1. Safety

If any one of the following regulations in this 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 may not weigh more than 20 pounds. See section 9.2 for definition of “member.”

9.1.2. A bridge may 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 pre-stressed member with triggering device.

9.1.3. After completion of timed construction, energy may not be transmitted to or from a bridge (for example, by applying mechanical, magnetic, fluidic or other force; by sound, light radio or other wave or ray; by conduction or convection of heat; or by electric current). The exceptions are forces necessary to the competition (for example, those associated with load testing and with moving the bridge from place to place), and changes in ambient conditions that are not controlled by contestants (such as wind, temperature and lighting).

9.2. Durability and Constructability

Violation of the following rules in this section (9.2) will result in penalties being added to the weight of the bridge. The penalty for each violation is 10 pounds plus 5 times the weight of the non-conforming component. If the non-conforming component weighs less than one pound, its weight will be assumed to be one pound for the purpose of computing the penalty.

9.2.1. A bridge may be constructed only of structural steel. For the purposes of this contest, structural steel is defined as an iron alloy that is strongly attracted to a magnet. **Solder, brazing and adhesives are not permitted.** Exceptions: Paint, decals and other purely decorative items are permitted.

9.2.2. A bridge may be constructed only of members and fasteners.

Members

9.2.3 A member is a rigid steel component that retains its shape and dimensions during timed construction and in the completed bridge.

9.2.4 A member must not exceed overall dimensions of 3'6" x 6" x 6." That is, it must fit in a prismatic box of those dimensions.

9.2.5. A member must 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. Exception: Deformations caused by mechanical strain (e.g. bending, stretching) during load testing are not considered violations of this rule.

9.2.6. A member may consist of multiple parts rigidly joined together before timed construction begins. Those parts must remain rigidly joined throughout timed construction and in the completed bridge. Parts may be joined by welding or with steel bolts, screws, rivets or other steel connectors.

Fasteners

9.2.7. A fastener is a steel bolt that is not part of a member, with at least one steel nut that is not part of a member. The specified bolts and nuts are available in hardware stores.

9.2.8. The bolt in a fastener must be 3/8" nominal diameter and no more than 3" nominal length (bottom of head to end) with a hexagonal head, and it must have the configuration and dimensions of a "cap screw grade 2," "cap screw grades 5 and 8" or "hex tap bolt" illustrated on http://www.purchasepartners.com/fastenerspecs.htm. Bolts may not be mechanically altered or modified in any manner. They may be painted.

9.2.9. The nuts in a fastener must match the bolt. That is, the nominal size (inside diameter) must be 3/8" and the threads of the nuts must engage the threads on the bolt and permit the nuts to be turned onto the bolt. Nuts must be hexagonal and have the configuration and dimensions of "finished hex nut grade 2," "finished hex nut grades 5 and 8" or "heavy hex nut" as illustrated on the web site cited in paragraph 9.2.8. Nuts may not be mechanically altered or modified in any manner. They may be painted.

Member-to-member Connections

9.2.10. Each member must be connected directly to every member that it touches by at least one fastener installed during timed construction so that the connection cannot be taken apart without first removing a nut from the bolt.

9.2.11. The bolt must penetrate completely through a hole in each of the members that it connects. Dimension(s) of the hole must be small enough so that the head of the bolt specified in 9.2.8 cannot pass through the hole.

10. CONSTRUCTION

10.1. Safety Equipment and Tools

Competitors are required to provide their own tools, hardhats and protective eyewear or safety goggles.

10.1.1. A team will not be permitted to construct its bridge unless every builder is outfitted with a hardhat meeting ANSI standard Z89.1 and protective eyewear or safety goggles meeting ANSI standard Z87.1.

10.1.2. None of the following items may be used during timed construction:

- welding machine,
- tool requiring external power connection,
- tool exceeding 3'6" in any linear dimension when fully assembled and extended,
- tool weighing more than 20 pounds,
- temporary pier exceeding 3'6" in any linear dimension at any time,
- temporary pier weighing more than 20 pounds,
- more than one temporary pier.

10.2. Safety

If any of the following safety regulations is violated during timed construction, the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools and bridge components will be returned to the positions they occupied before the violation. Then the builders will be asked to resume construction using safe procedures. Builders will have the opportunity to construct their bridge safely, but if this is not possible, construction will cease and the bridge will not be approved for load testing and will not be eligible for awards in any category.

10.2.1. Builders must not be exposed to risk of personal injury.

10.2.2. At all times during construction all builders must wear hardhats and protective eyewear or safety goggles specified in 10.1.1. Safety equipment must be worn properly (e.g. hardhats with peak in front).

10.2.3. Nothing may be thrown. Under no circumstance will throwing be permitted.

10.2.4. A builder may not use the bridge, a portion of the bridge, 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 bridge if the builder is kneeling on one or both knees or if the builder is standing on the heels and toes of both feet.

10.2.5. A builder may not depend on another builder or builders for support or balance.

10.2.6. A builder may not cross the wetland by jumping, by temporary scaffolding, by crossing the bridge, or by any other means.

10.2.7. The temporary pier must not collapse while it is supporting part of the bridge.

10.2.8. An “assembly” consists of no more than three members that are connected together in the staging yards during timed construction and must remain connected. Exception: Fasteners in an assembly are not required to be installed in a staging yard. An assembly must not be modified after it leaves the staging yard.

10.2.9. A “constructed portion” consists of connected members and assemblies that are in their final positions. A constructed portion may consist of several entities that are not contiguous. A bridge must be constructed by first placing members or assemblies in their final positions on the footings or on the temporary pier (i.e. these become the initial constructed portion), then successively connecting individual members and assemblies to enlarge the constructed portion. Outside the staging yards connections may be made only to the constructed portion.

10.2.10. A constructed portion is considered to be self-supporting if all of its parts retain essentially their final positions without support by builders. A constructed portion that is not self-supporting must be supported by at least one builder.

10.2.11. Outside the staging yard, moving or supporting an assembly requires the effort of at least as many builders as there are members in that assembly. The word “moving” includes, but is not limited to, lifting, carrying, lowering, rolling, turning, sliding and tipping, as well as causing translation and/or rotation of one portion of the bridge relative to another. Exception: small movement (maximum 3 inches) of a constructed portion by as few as one builder will be allowed as necessary to facilitate connections and placement on the footings.

10.2.12. Outside the staging yard, a builder may contribute to lifting, carrying or supporting only one member or assembly at a time.

10.2.13 A builder who is supporting the constructed portion may not simultaneously contribute to moving or supporting a member or assembly.

10.2.14. A builder may not move or support the temporary pier while also moving or supporting a member, assembly or constructed portion.

10.3. Team

The construction team, also referred to as builders, consists of all participants who are within the construction site at any time during timed construction. There can be no more than six builders.

Participation is limited to undergraduate and graduate student members of ASCE chapters, clubs and international groups.

10.4. Temporary Pier

A temporary pier is a support placed on the causeway or outside the boundaries of the wetland. The use of a temporary pier is optional and only one is permitted. Each team provides its own temporary pier.

10.5. Construction Site

See the “Site Plan” on the “Site and Bridge” diagram for layout of the construction site.

Only builders and judges are permitted in the construction site during timed construction. Only judges are permitted near the construction site; coaches, managers and other spectators must observe from a safe distance that does not obstruct judges.

10.6. Start

Before construction begins, all of the following items, and nothing else, are in the staging yards: members, fasteners, tools, temporary pier (if used) and builders. Builders will be wearing hardhats and protective eyewear or safety goggles, as well as optional clothing such as pouches. Members, tools and all fasteners must be in contact with the ground. Members must not be connected nor in contact with one another. Tools and fasteners must not be in contact with members.

During timed construction, additional members, tools, fasteners, temporary supports, builders or other items must not be brought into the construction site nor must anything be removed.

Timing and construction begin when the builders signify that they are ready and the judge declares the start.

10.7. Time

Time is kept from start to finish of construction. The clock will be stopped:

10.7.1. if a builder or judge sees a condition that could cause injury, or

10.7.2. when a safety regulation has been violated (see section 10.2) or work has been accomplished by committing an "accident" (see section 10.8).

Construction ceases while the clock is stopped. After the situation has been corrected, builders, tools, temporary pier (if used) and bridge components are returned to the positions they occupied before the interruption, and the clock is restarted.

10.8. Accidents

In general, the clock is not stopped when an "accident" occurs. If an accident is continuous (for example, a builder stands in the wetland) it will be counted as multiple incidents. Builders involved in accidents may continue to build, and components involved in accidents may be recovered and 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 resuming timed construction, the builders, tools, members, temporary pier (if used) and fasteners will be returned to the positions they occupied before the accident.

Types of accidents and the corresponding time penalties, which will be added to the construction time, are:

10.8.1. The bridge must be lifted in order to move or remove the temporary pier. Penalty is 1/2 minute (30 seconds) per incident.

10.8.2. A builder or a builder's clothing touches the wetland. Penalty is 1/2 minute (30 seconds) per incident. Exception: A builder may enter the wetland without penalty to retrieve a dropped object such as a member, tool, nut, bolt or hardhat.

10.8.3. A member, assembly or constructed portion touches the wetland or ground outside a staging yard. Penalty is 1/3 minute (20 seconds) per incident. Exception: members, assemblies or the constructed portion may touch the ground within the 6-inch by 6-inch bounds of the footings.

10.8.4. The temporary pier touches the wetland. Penalty is 1/3 minutes (20 seconds) per incident.

10.8.5. A tool, nut, bolt, hardhat, protective eyewear or goggles touches the wetland or ground outside a staging yard. Penalty is 1/6 minute (10 seconds) per incident. Exception: a tool used exclusively for measuring may touch the ground during use while being held by a builder.

10.8.6. A builder steps outside the boundary of the construction site. Penalty is 1/6 minute (10 seconds) per incident.

10.9. Finish

Construction ends and the clock is stopped when:

- the bridge has been completed by connecting all the members, and
- all tools, builders and the temporary support (if used) are back in the staging yards, and
- the builders signify that they are finished.

Installation of decking is not included in timed construction.

After construction is finished the bridge may not be modified except as provided by section "10.10 Construction: Repairs."

10.10. Repairs

Before the judges inspect and measure the bridge and before the bridge is moved from the construction site, the builders will be given the opportunity to examine the bridge visually for construction mistakes. The builders must not touch the bridge during this examination. The team will be permitted, but not required, to repair construction mistakes. Judges will not inspect the bridge for violation of rules until after the builders complete repairs. Repairs are made with the clock restarted. Safety precautions (sections 10.1 and .2) apply and accidents (section 10.8) are counted. The time required to make repairs (including penalties) is multiplied by 1.5 and added to the original construction time.

11. LOAD TESTS

11.1. Safety Precautions

The judge will halt any activity that is hazardous.

A bridge could suddenly collapse or sway in any direction during load tests. Therefore, minimize the number of people near the bridge while it is being tested. Usually, the load may be placed on the bridge by only two competitors.

While participating in load testing, **competitors must wear hardhats meeting ANSI standard Z89.1, protective eyewear or safety goggles meeting ANSI standard Z87.1, 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.

During testing, safety supports must be in place below the bottom of the decking. The safety supports should be of sufficient height, strength, number and extent that none of the load will fall more than approximately six inches if the bridge collapses.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a portion of the decking that is cantilevered laterally over its support.

When any portion of the load is on the bridge, no one is permitted to crawl, reach or step under the bridge. If such an action is necessary the load must first be removed.

11.2. Damage

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

If a nut falls off its bolt while the bridge is being transported or prepared for load testing, the connection will be repaired, the nut will be replaced (finger tight) and a penalty of 2 minutes will be added to construction time.

A bridge with irreparable damage that would reduce its strength or stability (such as a broken part) will not be approved for load testing and is not eligible for awards in any category.

11.3. Preparation

The temporary pier is not used during load testing

The judge designates the “A” and “B” sides of each bridge by a random process. “Left” and “right” ends are determined by facing the “A” side.

Sway is translation in any horizontal direction. A target is established for sway measurement on the “A” side of the bridge, 11 feet from the left end of the decking support on that side. The sway target is located at the level of the decking support which is the same as the bottom of the decking. See the “Lateral Load Test” plan on the “Bridge Loading” diagram.

Three targets are established for measuring vertical deflection. Two of the vertical deflection targets are located longitudinally at the centers of two units of decking, on the “A” side of the bridge, at the level of the decking support which is the same as the bottom of the decking. The other vertical deflection target is located longitudinally at the center of the leftmost unit of decking, on the “B” side of the bridge, at the level of the decking support. Targets may be on the decking or on the bridge. See section 11.5 for location of decking units and see the “Location of Targets and Decking” plan on the “Bridge Loading” diagram.

At their discretion, judges may impose a penalty for a bridge that incorporates parts having the primary function of interfering with placement of targets or measuring equipment.

Teams must accept imperfect field conditions such as bent decking and slightly sloping floors.

11.4. Lateral Load Test

The provisions of this section are illustrated by the “Lateral Load Test” plan on the “Bridge Loading” diagram.

The lateral load test is conducted with one unit of decking placed at the center of the bridge and approximately 50 pounds of weight on the decking near the “B” side of the bridge. This load is intended to prevent the bearing points of the bridge from lifting off the ground when lateral load is applied.

The two bearing points on the “B” side of the bridge are prevented from sliding by horizontal restraint applied from the inside of the piers as close as possible to the ground. This horizontal restraint does not restrain rotation of the piers and is identical for all bridges.

Apply a 50 pound lateral pull at the sway target and measure the sway. To pass the lateral load test, the sway must not exceed one inch.

If the bridge did not pass the lateral load test it is not approved for further testing. **Do not conduct any other load test**. Add a penalty of 800 pounds to the weight of the bridge and a penalty of 30 minutes to the construction time. Record: Aggregate deflection = 60 inches.

If the bridge passed the lateral load test, remove the load and decking, and proceed with the vertical load test.

11.5. Vertical Load Test

The provisions of this section are illustrated by the three "Vertical Load Test" elevations on the "Bridge Loading" diagram.

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

Decking units are three feet long in the longitudinal (span) direction of the bridge. Place the three decking units at distances LL, LC and LR measured from the left end of the decking support on the "A" side of the bridge to the left edges of the decking units. Decking units are square with the bridge, not skewed. See item 4 in chapter 7 for determination of LL, LC and LR.

If deflection targets are on the decking rather than on the bridge, clamp the decking to the decking support at the targets to assure contact during initialization of measurements.

Position measuring devices on the three vertical deflection targets.

If a contestant disturbs a measuring device after it has been initialized and before the measurement is recorded, the judge will require the team to disassemble the bridge and repeat timed construction. Scoring will be based on the larger of the two construction times but will not exceed 125% of the initial construction time.

The three steps (increments) of vertical loading produce three measurements used in scoring:

- DL = absolute value of vertical deflection at leftmost target that occurs during step 1 (loading on leftmost decking unit)
- DC = absolute value of vertical deflection at centermost target that occurs during step 2 (loading on centermost decking unit with load from step 1 remaining in place).
- DR = absolute value of vertical deflection at rightmost target that occurs during step 3 (loading on rightmost decking unit with loads from steps 1 and 2 remaining in place).

The prescribed sequence for initializing measuring devices during the three steps produces penalties for excessive vertical deflection if any of the following exceeds 2 inches up or down.

- cumulative deflection at the leftmost target during steps 1, 2 and 3, or
- deflection at the centermost target during step 1, or
- cumulative deflection at the centermost target during steps 2 and 3, or
- cumulative deflection at the rightmost target during steps 1 and 2, or
- deflection at the rightmost target during step 3.

Step 1
Loading the leftmost unit and measuring deflection at that target

- Initialize the measuring devices on the three vertical deflection targets or record the initial readings.
- If the leftmost decking unit was clamped to the decking support, remove the clamp after initialization.
- Initialize the sway measurement.
- Place 800 pounds of load on the leftmost decking unit. The 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.
- As the load is being placed, observe sway and deflection. Stop loading if:
    a. sway exceeds one inch, or
    b. deflection measurement at any of the three vertical deflection targets exceeds 2 inches up or down, or
    c. any part of the bridge, other than the intended bearing points, comes to bear on the floor, or
    d. a decking unit falls off the bridge.

If sway or deflection is excessive (situation a or b), the bridge is not approved for further load testing. Remove the load and **do not continue load testing**. Add an 800 pound penalty to the weight of the bridge and a penalty of 30 minutes to the construction time. Record: Aggregate deflection = 60 inches.

If the bridge fails (situation c or d), it 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**.

If the bridge passes step 1, record the measured value DL = absolute value of vertical deflection of the leftmost target from its position at the start of step 1.

Step 2
Loading the centermost unit and measuring deflection at that target

- The load from step 1 remains in place.
- Re-initialize the measuring device on the centermost vertical deflection target or record the reading.
- If the centermost decking unit was clamped to the decking support, remove the clamps after initialization.
- Do **not** re-initialize the measuring devices on the other two vertical deflection targets.
- Do **not** re-initialize the sway measurement.
- Place 900 pounds of load on the centermost decking unit. The 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.
- As the load is being placed, observe sway and deflection. Stop loading if:
    a. sway exceeds one inch, or
    b. deflection measurement at any of the three vertical deflection targets exceeds 2 inches up or down, or
    c. any part of the bridge, other than the intended bearing points, comes to bear on the floor, or
    d. a decking unit falls off the bridge.

If sway or deflection is excessive (situation a or b), the bridge is not approved for further load testing. Remove the load and **do not continue load testing**. Add a 700 pound penalty to the weight of the bridge and a penalty of 30 minutes to the construction time. Record: Aggregate deflection = 60 inches.

If the bridge fails (situation c or d), it 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**.

If the bridge passes step 2, record the measured value DC = absolute value of vertical deflection of the centermost target from its position at the start of step 2.

Step 3

Loading the rightmost unit and measuring deflection at that target

- The loads from steps 1 and 2 remain in place.
- Re-initialize the measuring device on the rightmost vertical deflection target or record the reading.
- If the rightmost decking unit was clamped to the decking support, remove the clamp after initialization.
- Do **not** re-initialize the measuring devices on the other two vertical deflection targets.
- Do **not** re-initialize the sway measurement.
- Place 800 pounds of load on the rightmost decking unit. The 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.
- As the load is being placed, observe sway and deflection. Stop loading if:
    a. sway exceeds one inch, or
    b. deflection measurement at any of the three vertical deflection targets exceeds 2 inches up or down, or
    c. any part of the bridge, other than the intended bearing points, comes to bear on the floor, or
    d. a decking unit falls off the bridge.

If sway or deflection is excessive (situation a or b), the bridge is not approved for further load testing. Remove the load and **do not continue load testing**. Add a 600 pound penalty to the weight of the bridge and a penalty of 30 minutes to the construction time. Record: Aggregate deflection = 60 inches.

If the bridge fails (situation c or d), it 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**.

If the bridge passes step 3, record the measured value DR = absolute value of vertical deflection of the rightmost target from its position at the start of step 3. Compute and record: Aggregate deflection = DL + DC + DR

11.6. Unloading

If the bridge collapses during unloading, it is not eligible for awards in any category.

12. EQUIPMENT PROVIDED BY HOST

The web site http://www.aisc.org/steelbridge.html has detailed descriptions and illustrations of hosting equipment. The following partial list is intended to help competitors know what to expect. Competitors should acquire similar equipment for use in practice and testing before the competition.

12.1. Lateral Load Device

Capable of applying a 50-pound force in the horizontal direction.

12.2. Equipment for Measuring Sway

Sway is horizontal translation and is measured by any accurate method. A suggested method is to suspend a plumb bob from the sway target and measure sway from a point marked on the ground.

12.3. Equipment for Measuring Deflection

Deflection is vertical translation and is measured at three points by any accurate method.

12.4. 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 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 of the grating that are perpendicular to the length.

12.5. Load

2500 pounds total. The load should be supplied in uniform pieces of size and weight that may 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.

12.6. Safety Supports

The safety supports must be used during load testing and are intended to limit the consequences of a bridge collapsing. The safety supports should 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, plastic buckets, timbers, sand bags or masonry units.

12.7. Floor

The surfaces on which the bridges will bear should be as nearly flat and level as possible, in both the construction site and loading area.

13. INTERPRETATION OF RULES

The web site http://www.aisc.org/steelbridge.html lists answers to questions about the rules and illustrates some violations. Competitors, judges and host personnel may submit questions via a form on that web site but should **first read the previously posted clarifications and reread this *Rules* document carefully in its entirety**. The names of students and their universities will be posted with their questions. Questions must be submitted before 5:00 PM Eastern Daylight Saving Time, 16 May 2005.

14. JUDGING

The host 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 rating are the sole responsibility of the judges and will be final. The host will assure that the judges are fully informed of the rules and procedures, and fully equipped for their tasks. More information for hosts and judges, including a spread sheet for scoring, is available at http://www.aisc.org/steelbridge.html.

15. APPEALS

15.1. Regional Competitions

15.1.1. At the beginning of the competition each team will designate a student as team captain. The host university will identify the regional head judge (RHJ).

15.1.2. A penalty, decision, measurement, score or condition of competition may be appealed only by a team captain and only to the RHJ. The appeal must be made as soon as possible after the situation becomes apparent. The RHJ will not hear the appeal if he or she is approached by students other than the team captain. The RHJ will hear the appeal as soon as possible and may interrupt the contest. Participants are reminded that civility and ethical behavior are expected during the contest and particularly concerning appeals.

15.1.3. After the regional competition, the team captain has the option to appeal the decision of the RHJ by sending an e-mail message to Mr. Fromy Rosenberg <rosenberg@aisc.org> followed by a letter mailed to Mr. Rosenberg (AISC, Suite 3100, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to ASCE Student Services (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The e-mail message and letter should include

- name of the college or university making the appeal,
- team captain's name, e-mail address, postal address and telephone number,
- faculty adviser's name, e-mail address, postal address and telephone number,
- brief description of the problem,
- action taken at the contest to deal with the problem,
- action that the appealing team feels should have been taken,
- data showing that the team should have qualified for national competition,
- team captain's signature (letter only).

Appeals must be made by e-mail followed by letter. An appeal will be considered only if the e-mail is received and the letter is postmarked within **one week** after the regional contest. Mr. Rosenberg will disseminate the appeal to the ASCE/AISC Rules Committee for their evaluation. The only redress that may be made is an invitation to participate in the national competition if the Rules 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 regional 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 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 not hear the appeal if he or she is approached by students other than the team captain. 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 contest 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 ASCE/AISC 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 ASCE/AISC Rules Committee within fifteen minutes after hearing the NHJ's ruling. The Rules 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 ASCE/AISC Rules Committee is final; there are no further appeals. However, AISC and ASCE welcome written suggestions for improving future competitions.

16. SCORE SHEET

16.1. Aesthetics (see section 6.1 for criteria)

- Appearance: balance, proportion, elegance, finish.
- Name of college or university on bridge in letters at least one inch high.
- Poster describing design and fabrication, no larger than 2 x 3 feet.

Judges should not declare ties in aesthetics

AESTHETICS SCORE = _____

16.2. Construction Speed and Time Penalties

Clock time = _____ minutes

Time penalties, see "10.8 Construction: Accidents"
items 1,2: violations _____ x 1/2 = + _____ minutes
items 3,4: violations _____ x 1/3 = + _____ minutes
items 5,6: violations _____ x 1/6 = + _____ minutes
Repair time, see "10.10 Construction: Repairs"
_____ x 1.5 = + _____ minutes
Time penalty, see "11.2 Load Tests: Damage" + _____ minutes
Time penalty, see "11.4 Lateral Load Test" (30 min) + _____ minutes
Time penalty, see "11.5 Vertical Load Test" (30 min) + _____ minutes

CONSTRUCTION TIME (add) = _____ minutes
Lowest time wins.

16.3. Lightness and Weight Penalties

Bridge weight = _____ pounds

Weight penalties, "6.1 Aesthetics" (50 or 100) + _____ pounds
"8.2 Dimensions and Support: Usability"
Number violations • 1 inch _____ x 50 = + _____ pounds
Number violations 1 - 2 inch _____ x 150 = + _____ pounds
Number violations 2 - 3 inch _____ x 300 = + _____ pounds
"9.2 Material & Components: Durability & Constructability"
Number of violations _____ x 10 pounds = + _____ pounds
Wt. of parts in violation _____ pounds x 5 = + _____ pounds
"11.4 and .5 Load Tests: Lateral Load and Vertical Load"
(800, 700 or 600) + _____ pounds

TOTAL WEIGHT (add) = _____ pounds
Lowest weight wins.

16.4. Stiffness

AGGREGATE DEFLECTION: DL + DC + DR = _____ inches
Lowest deflection wins.

16.5. Construction Economy

Number of builders _____

Construction Time (part 16.2) x _____ minutes

x 50

CONSTRUCTION COST (multiply): C_c = _____ thousand $
Lowest cost wins.

16.6. Structural Efficiency

W = larger of total weight (part 16.3) or 80 = _____ pounds

Δ = larger of aggregate deflection (part 16.4) or 0.25 = x _____ inches

x 10

STRUCTURAL COST (multiply): C_s = _____ thousand $
Lowest cost wins.

16.7. Overall Performance

C_c (from part 16.5) _____ + C_s (from part 16.6) _____ = _____
Lowest total wins.

16.8. Ranks (Aesthetics is the tie-breaker for all categories)

A bridge will not be ranked if it was not approved for construction or load testing, or if it failed in load testing.

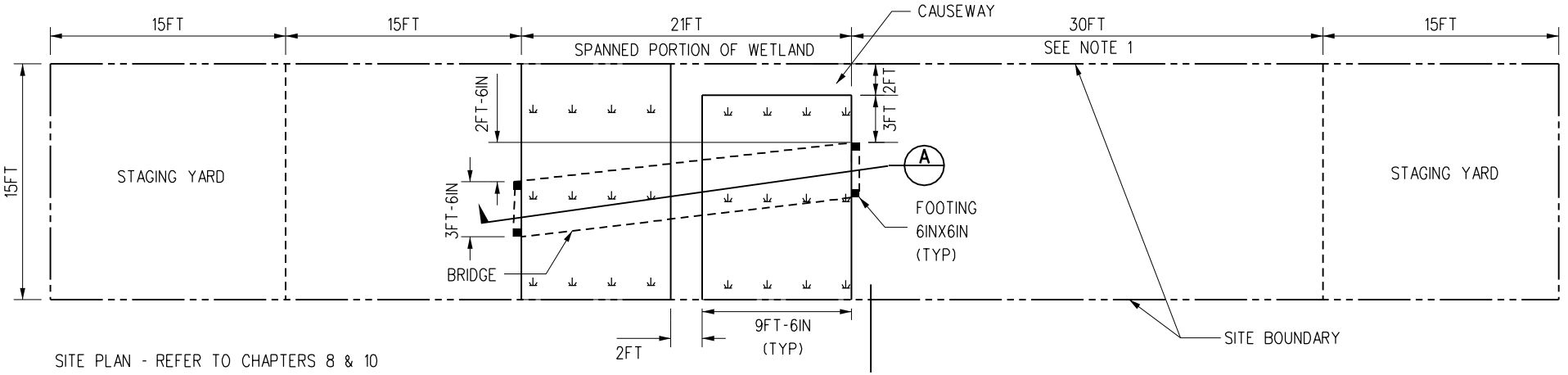
Aesthetics _____ Construction Speed _____

Lightness _____ Stiffness _____

Construction Economy _____ Structural Efficiency _____

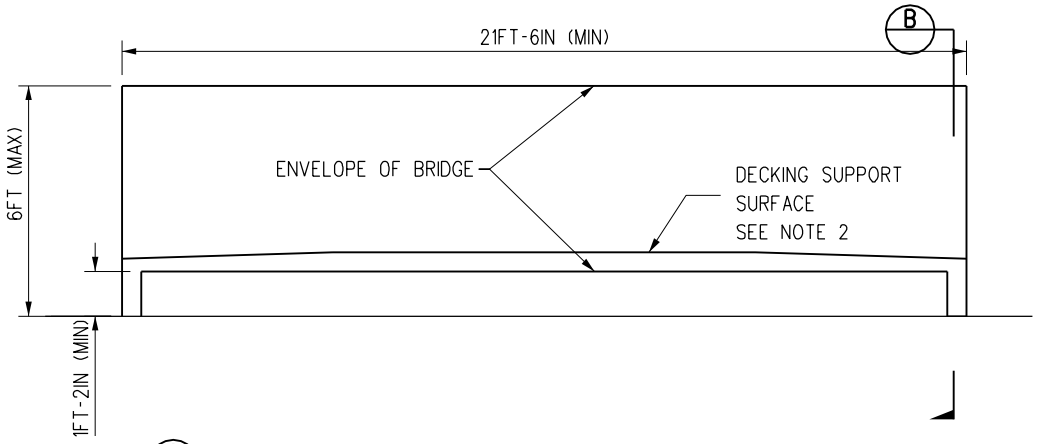
Overall Performance _____

This Score Sheet implements chapter "6 Scoring." A comparable spreadsheet is available at http://www.aisc.org/steelbridge.html.



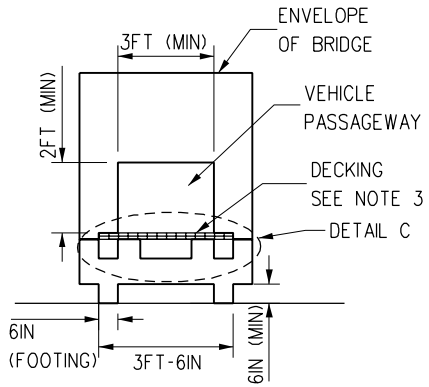
SITE PLAN - REFER TO CHAPTERS 8 & 10

SCALE: 1IN = 10 FEET



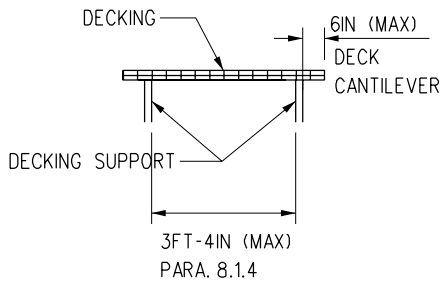
A ELEVATION - REFER TO CHAPTER 8

SCALE: 1 IN = 5 FT



B END VIEW

NO SCALE

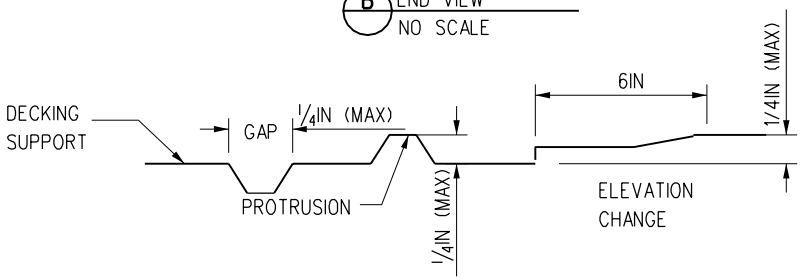


C DECKING SUPPORT

NO SCALE

NOTES:

1. LENGTH CAN BE ADJUSTED TO FIT SITE CONDITIONS.
2. tHE DECKING SUPPORT SHALL BE BETWEEN 1'5" AND 1'8" ABOVE GRADE AT ALL POINTS.
3. BRIDGE SHALL ACCOMODATE 3FT-6" +/-$\frac{3}{4}$" DECKING THROUGHOUT OVERALL LENGTH OF THE BRIDGE.



IRREGULARITIES IN DECKING SUPPORT - REFER TO CHAPTER 8

SCALE: NONE

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION
A	7-1-2004						2005 NSSBC RULES

DESIGNED BY F. HATFIELD
DRAWN BY D. SEPULVEDA
CHECKED BY RULES COMM.
IN CHARGE F. ROSENBERG
DATE 7-01-2004

ASCE - AISC
NATIONAL STUDENT STEEL BRIDGE CONTEST

ASCE American Society of Civil Engineers

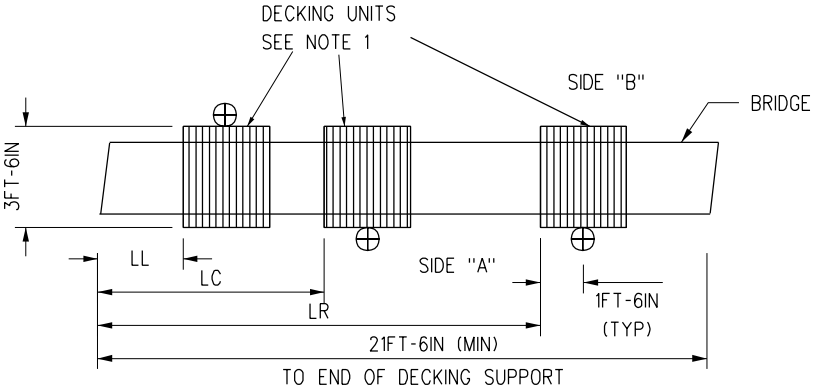
SUBMITTED

APPROVED

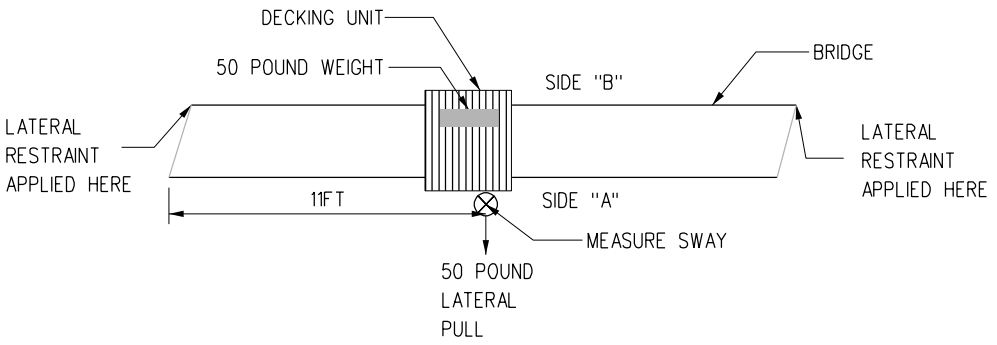
SITE AND BRIDGE DIAGRAM

CONTRACT NO 2005
DRAWING NO EXHIBIT 1
REV
SCALE AS SHOWN
SHEET NO

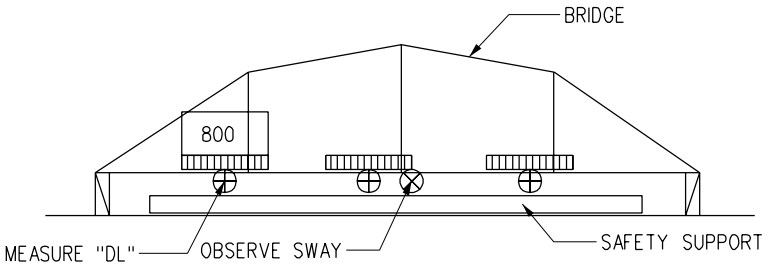
Plotted by: $USER$ $DATE$ $FILE$



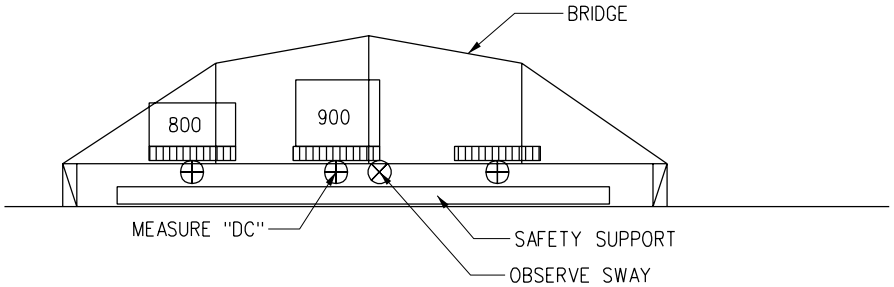
A LOCATIONS OF TARGETS AND DECKING - PLAN
REFER TO CHAPTER 11, SECTIONS 3 & 5



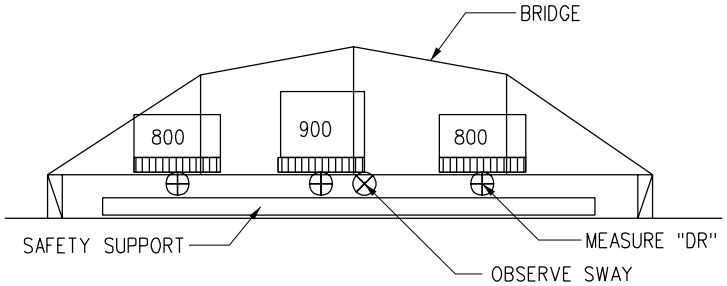
B LATERAL LOAD TEST - PLAN
CHAPTER 11, SECTIONS 3 & 4



1 VERTICAL LOAD TEST - STEP 1
REFER TO NOTES DURING LOADING PROCESS



2 VERTICAL LOAD TEST - STEP 2
REFER TO NOTES DURING LOADING PROCESS



3 VERTICAL LOAD TEST - STEP 3
REFER TO NOTES DURING LOADING PROCESS

LEGEND

⊕ TARGETS FOR MEASURING VERTICAL DEFLECTION TO BE PLACED LONGITUDINALLY AT THE CENTER OF THE DECKING UNITS

⊗ TARGET FOR MEASURING SWAY

NOTES

1. THE LOAD IS LATERALLY CENTERED ON THE DECKING UNIT AND DISTRIBUTED OVER THE LENGTH OF THE DECKING UNIT AS UNIFORMLY AS POSSIBLE AT ALL TIMES DURING LOADING.
2. OBSERVE ALL VERTICAL TARGETS ON EACH SIDE OF THE BRIDGE FOR DEFLECTION.
3. LOADING TERMINATES IF DEFLECTION AT ANY OF THE VERTICAL DEFLECTION TARGETS EXCEEDS LIMITS SPECIFIED IN CHAPTER 11, SECTION 5 AT ANY TIME DURING LOADING.
4. LOADING TERMINATES IF SWAY AT SWAY TARGET EXCEEDS 1" AT ANY TIME DURING LOADING.
5. SAFETY SUPPORT TO BE IN PLACE AT ALL TIMES DURING LOADING.
6. BRIDGE TO BE UNLOADED IN THE REVERSE ORDER OF LOADING.
7. ALL LOADING SAFETY PROCEDURES TO BE FOLLOWED.

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION
A	7-1-2004						2005 NSSBC RULES

DESIGNED BY F. HATFIELD
DRAWN BY D. SEPULVEDA
CHECKED BY RULES COMM.
IN CHARGE F. ROSENBERG
DATE 7-01-2004

ASCE - AISC
NATIONAL STUDENT STEEL BRIDGE CONTEST

ASCE American Society of Civil Engineers

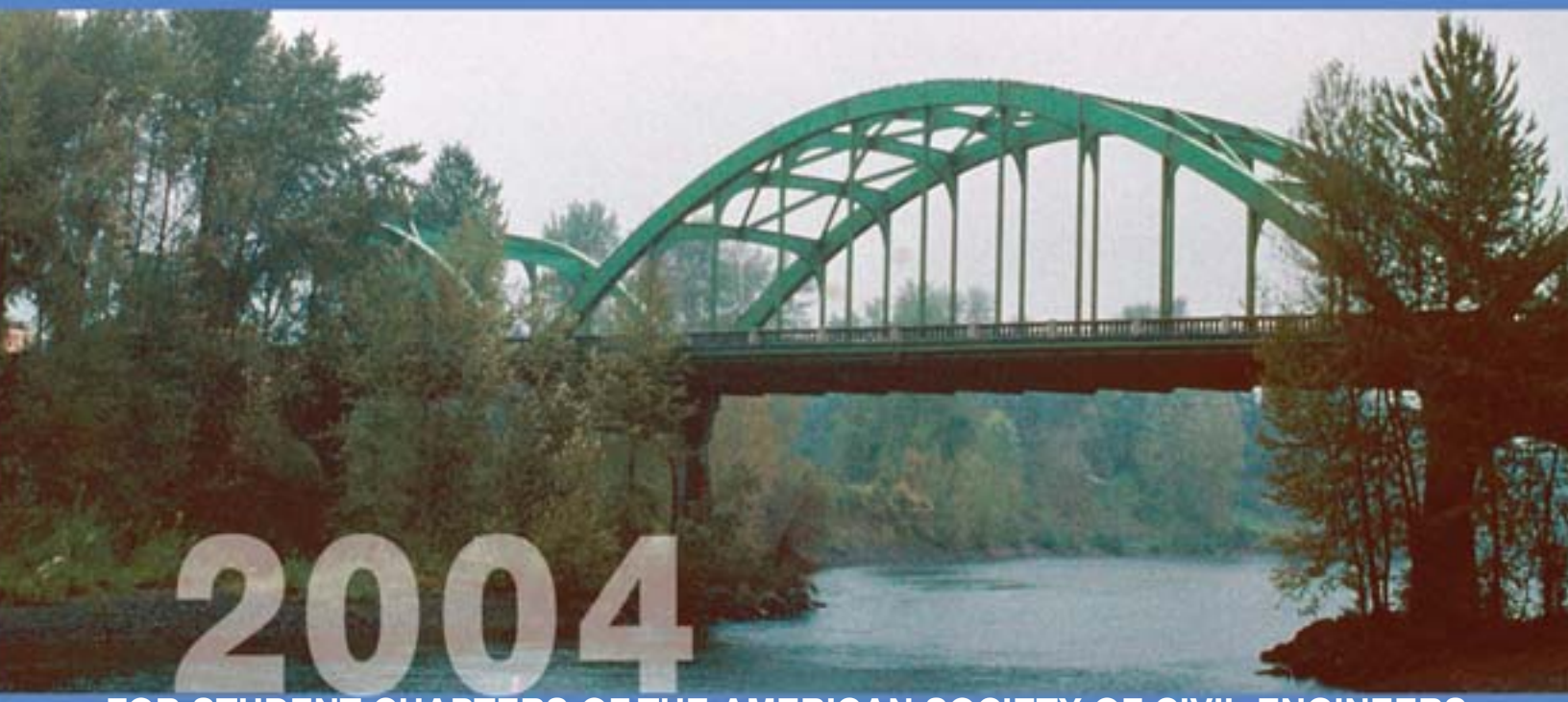
SUBMITTED _____
APPROVED _____

BRIDGE LOADING DIAGRAM

CONTRACT NO 2005
DRAWING NO EXHIBIT 2 REV
SCALE AS SHOWN
SHEET NO

Plotted by: $USER$ $DATE$ $FILE$

STUDENT STEEL BRIDGE COMPETITION RULES



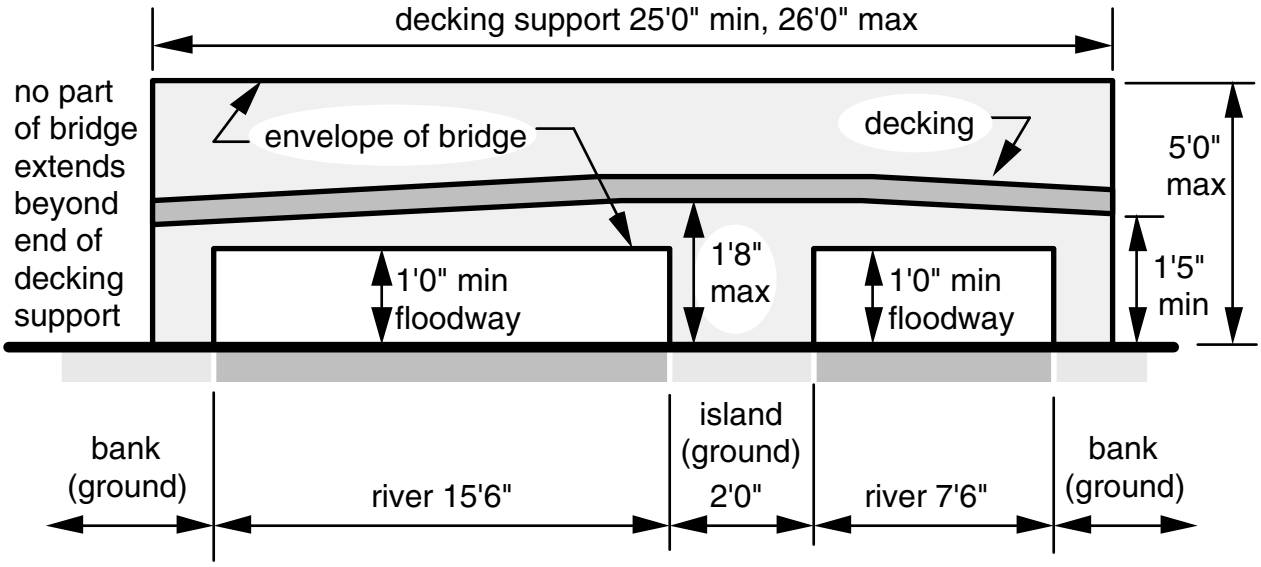
FOR STUDENT CHAPTERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

CO-SPONSORS

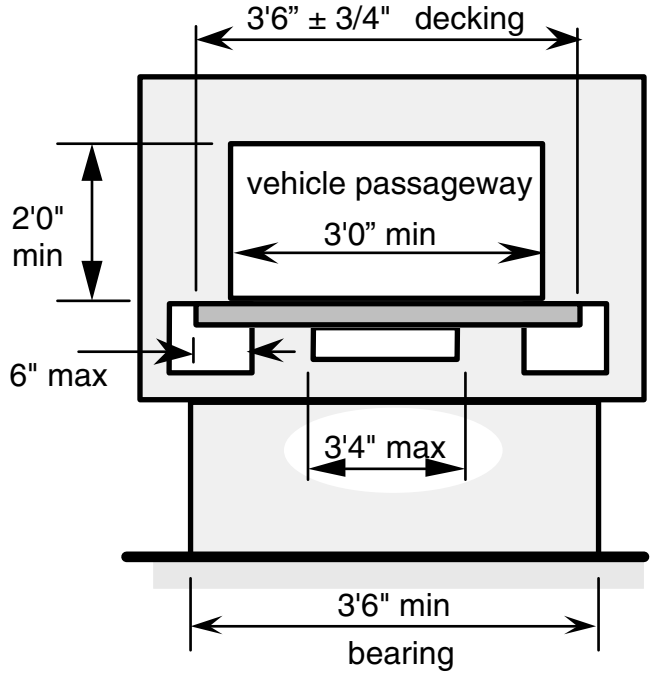
STUDENT STEEL BRIDGE COMPETITION

2004 RULES

http://www.aisc.org/steelbridge.html



Spans and Clearance (Side View)



Decking Support, Roadway and Bearing (End View)

TABLE OF CONTENTS

1. INTRODUCTION

The Student Steel Bridge Competition is sponsored by the American Institute of Steel Construction (AISC) and by the American Society of Civil Engineers (ASCE), and co-sponsored by the American Iron and Steel Institute, the James F. Lincoln Arc Welding Foundation, the National Steel Bridge Alliance and Nucor Corporation. This inter-collegiate challenge requires Civil Engineering students to design, fabricate and construct a steel bridge.

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

Students design the bridge themselves but may seek advice from faculty and other consultants. Ideally, students should fabricate the entire bridge themselves. However, appropriate shop facilities and supervision may not be available at every college and university. Therefore, the services of a commercial fabricator may be used provided that students observe the operations. Students are encouraged to maximize their personal involvement in fabricating their bridge.

This booklet describes the contest and states the official rules for this year. It is distributed to universities throughout the country. A companion booklet, *Guide for Hosts and Judges*, is distributed to hosts and provides directions for conducting a competition.

The rules are changed every year to improve the contest and assure 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 chapter "13 Interpretation of Rules."

There are two levels of competition: regional and national. These *Rules* govern competition at both regional and national levels. Regional competitions are held in conjunction with ASCE regional conferences. Winners and first runners-up from most regions are invited to compete at the national level. However, invitations are extended only to the winner from a region with two, three or four participating universities, and to the top three teams from a region with eleven or more participating universities. Only one bridge per university may be entered in regional competitions.

The ASCE student chapters and clubs entering the contest are required to be current with their national dues. Teams may consist only of undergraduate and graduate students in good standing with their ASCE chapter or club.

2. EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication and construction. Participating students gain practical experience in structural design, fabrication processes, construction planning, organization and teamwork.

Chapter "4 Problem Statement" describes challenges encountered in a representative structural engineering project. The competition is a scaled simulation of that project.

Standards for strength, durability, constructability, usability, functionality and safety reflect the volumes of regulations that govern the design and construction of full-scale bridges. Criteria for excellence are represented by the award categories of stiffness, lightness, construction speed, aesthetics, efficiency and economy. As with a full-scale construction project, safety is the primary concern.

The rules of the competition accommodate a large 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.

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

3. RULE CHANGES

The following list covers some of the major changes from the 2003 rules. Minor changes are not listed. Contestants and judges are cautioned to read this entire *Rules* booklet carefully and disregard rules and web-site postings from previous years.

1. Scoring.
2. Span.
3. Vehicle passageway.
4. Limit on weight of members.
5. Cable adjustment.
6. Bearing plate requirement is eliminated.
7. Holes for fasteners may be any shape.
8. Limit on number of builders.
9. Limit on length of tools.
10. Tools are not required to be hand-held.
11. Assemblies must be constructed in staging yards.
12. Support and connection of members and assemblies.
13. Placement of deflection targets and load.
14. Aesthetics criteria.

4. PROBLEM STATEMENT

A century-old bridge that crosses an environmentally sensitive river must be replaced. The bridge carries truck traffic serving the farms and agricultural processing industries that are the basis for the economy of this rural region, as well as providing access and emergency services to residences. A quick replacement is necessary because no other river crossing is available for miles.

The State Department of Transportation has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered but the State DOT has specified steel as the material because of its durability and fast erection. The bridge must provide clearance for flood flows and it must be able to carry specified patterns of loads without exceeding sway and deflection limits. Based on past experience with performance and maintenance, the DOT prefers bridges that are relatively light and stiff. The new bridge must accommodate modular decking, which the DOT salvaged from another bridge. Decking units may not be modified.

Flood control and environmental concerns prohibit piers in the river; piers must be built on the banks and on a natural island that is connected to the river bank by an existing causeway. A construction barge may be operated within a designated section of the river but must not disturb the river banks, causeway or island. Soil conditions restrict the weight that may be lifted by cranes.

Your company's design/build proposal is among those that the State DOT has deemed responsive. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. The DOT will evaluate the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy and aesthetics. The contract will be awarded to the company that submits the best model. This is an opportunity to become leaders in the bridge replacement market.

5. SAFETY

Safety has the highest priority. Judges are empowered to halt any activity that they deem hazardous. Judges are directed to disqualify bridges that cannot be safely constructed or load tested using the equipment provided by the host, as described in this booklet. Collapse, sway or deflection in excess of specified limits is incontrovertible evidence of an unsafe bridge and will result in disqualification. A disqualified bridge is not eligible for awards in any category and must be withdrawn from all subsequent participation in the contest.

6. SCORING

A university may enter only one bridge in regional competition and may compete in only one region.

Categories of competition are construction speed, lightness, aesthetics, stiffness, construction economy, and structural efficiency. In addition, overall performance is rated. Bridges that have been disqualified are not eligible for awards in any categories.

6.1. Construction Speed

The bridge with the lowest construction time will win in this category. Construction time is the clock time required to assemble the bridge, regardless of number of builders, plus time penalties prescribed in sections "10.7 Construction: Accidents" and "11.2 Load Tests: Damage."

6.2. Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in sections "8.2 Dimensions and Support: Usability" and "9.2 Material and Components: Durability and Constructability." Decking, tools and posters are not included in total weight.

6.3. Aesthetics

Aesthetics is the tie-breaker for all categories of competition. Judges should not declare ties in aesthetics. Aesthetics is judged by

6.3.1. Appearance of bridge, including balance and proportion, elegance and finish. Quality of fabrication should not be considered because some bridges may be fabricated professionally while others are student work.

6.3.2. Full name of the college or university must appear on the bridge or on a banner or placard attached to the bridge, in letters at least 2 inches high. The banner or placard is installed during timed construction and is included in total weight. It should be in place on the bridge during aesthetics judging and at other times when the bridge is on display.

6.6.3. Poster describing design and fabrication. Maximum dimensions of the poster are 2 feet by 3 feet, and it should be displayed within the floor area occupied by the bridge. The poster is not part of the bridge but should be in place during aesthetics judging and at other times when the bridge is on display. The poster must include an brief explanation of why the overall configuration of the bridge was selected, a brief computation demonstrating design for one limit state, and a scaled, dimensioned side view of the bridge. Additional material may be included.

Electronic displays, decorated poster supports, lights and sound are not permitted and will result in the worst possible rating for the poster.

6.4. Stiffness

The bridge with the lowest aggregate deflection will win in the stiffness category. Aggregate deflection is determined from measurements as prescribed in section "11.5 Load Tests: Vertical Load."

6.5. Construction Economy

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

C_c = Construction time (minutes, including penalties)
x Number of builders (persons)
x One thousand dollars per person-minute

The number of builders includes all participants who are within the construction site at any time during timed construction.

6.6. Structural Efficiency

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

C_s = W x Δ x One thousand dollars per pound-inch, where

W = the larger of total weight OR 80 pounds.
Δ = the larger of aggregate deflection OR 0.25 inch.

Total weight is the weight of the bridge plus weight penalties prescribed in sections "8.2 Dimensions and Support: Usability" and "9.2 Material and Components: Durability and Constructability." Decking, tools and poster are not included in total weight.

Aggregate deflection is determined from measurements as prescribed in section "11.5 Load Tests: Vertical Load."

6.7. 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.

7. SCHEDULE OF COMPETITION

In the months before the contest students design their bridges, fabricate members, load test and practice construction. Elements of the competition are:

1. Judges clarify rules and conditions of the contest and answer questions.

2. If judges permit minor alterations to be made to the bridges, the contest should not be delayed significantly and teams should be given equal time for alterations. After this, bridges may not be altered, modified or enhanced in any way (except for erection, disassembly and repairs as described in section "10.9 Construction: Repairs").

3. Bridges are erected and judged for aesthetics.

4. The head judge selects the locations of loads. See section "11.5 Load Tests: Vertical Load" and the figure titled "Location of Targets and Decking" for explanation. Selection is done in the presence of the team captains by rolling a die twice. Let S1 and S2 be the spots from the two rolls and let LM and LB be dimensional locations of decking units in feet.

   If $S1 \leq 3$ then $LM = S1 + 1$;
   if $S1 \geq 4$ then $LM = S1 + 6$;
   $LB = (0.5 \times S2) + 1$.

   The head judge also uses a random process to select the side of the bridges to which the lateral load will be applied during load testing.

5. Bridges are disassembled.

6. Judges inspect components of the bridges.

7. Timed construction. See chapter "10 Construction" for details.

8. Judges inspect assembled bridges.

9. Load testing. See chapter "11 Load Tests" for details.

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

1. bridges are not modified after selection of load locations,

2. bridges are not modified between aesthetics judging and timed construction, and

3. modifications between timed construction and load testing are limited to repairs as described in "10.9 Construction: Repairs."

8. DIMENSIONS AND SUPPORT

Dimensions and support will be checked with the bridge in its as-built condition after construction is completed and before the bridge is moved from the construction site or load tested. The bridge may not be modified nor distorted from its as-built condition in order to satisfy dimension and support rules. Dimensions will be checked without decking or other load on the bridge.

8.1. Functionality and Safety

If any of the following regulations in this section (8.1) is violated, the bridge must be **disqualified**. The figures titled "Spans and Clearance" and "Decking Support, Roadway and Bearing" illustrate some of the requirements.

8.1.1. The bridge must provide support for the decking along both of the edges that run in the span direction of the bridge. The decking support must be at least 25 feet long. Also see paragraph 8.2.2.

8.1.2. Decking support must be connected structurally for the full length of the bridge.

8.1.3. Decking support must be rigid. Horizontal cables do not provide rigid support. At their discretion, judges may test rigidity by applying a 25-pound load at selected points on the decking support: deflection under the load exceeding 1.0 inch indicates lack of rigidity.

8.1.4. The bridge must provide access for placing the decking and load. Although decking is nominally 3'6" wide and 1 inch thick, actual widths range from 3'5.25" to 3'6.75" and thickness may be as large as 1.25 inches. This rule will be checked by sliding a piece of decking or an equivalent template along the full overall end-to-end length of the decking support.

8.1.5. Clear span of the decking between decking supports should not exceed 3'4".

8.1.6. The decking may not be attached nor anchored to the bridge, nor may it be used to distort the bridge from its as-built condition. However, judges may clamp the decking to the bridge to facilitate deflection measurements as explained in section "11.5 Load Tests: Vertical Load."

8.1.7. The bridge may not be anchored nor tied to the ground.

8.1.8. It must be possible to construct and load the bridge safely using equipment provided by the host university. Bridges must accommodate local conditions.

8.2. Usability

A penalty will be assessed for each rule in this section (8.2) that is violated, rather than for every violation of that rule. The figures titled “Spans and Clearance,” “Decking Support, Roadway and Bearing” and “Irregularities in Decking Support” illustrate some of the requirements.

The penalty for violation for each of the following rules will be an addition to the weight of the bridge determined as follows: 100 pounds for a dimensional violation of 1.0 inch or less; 300 pounds for a dimensional violation greater than 1.0 inch but not exceeding 2.0 inches; 600 pounds for a dimensional violation greater than 2.0 inches but not exceeding 3.0 inches. The bridge must be **disqualified** if a dimensional violation exceeds 3.0 inches.

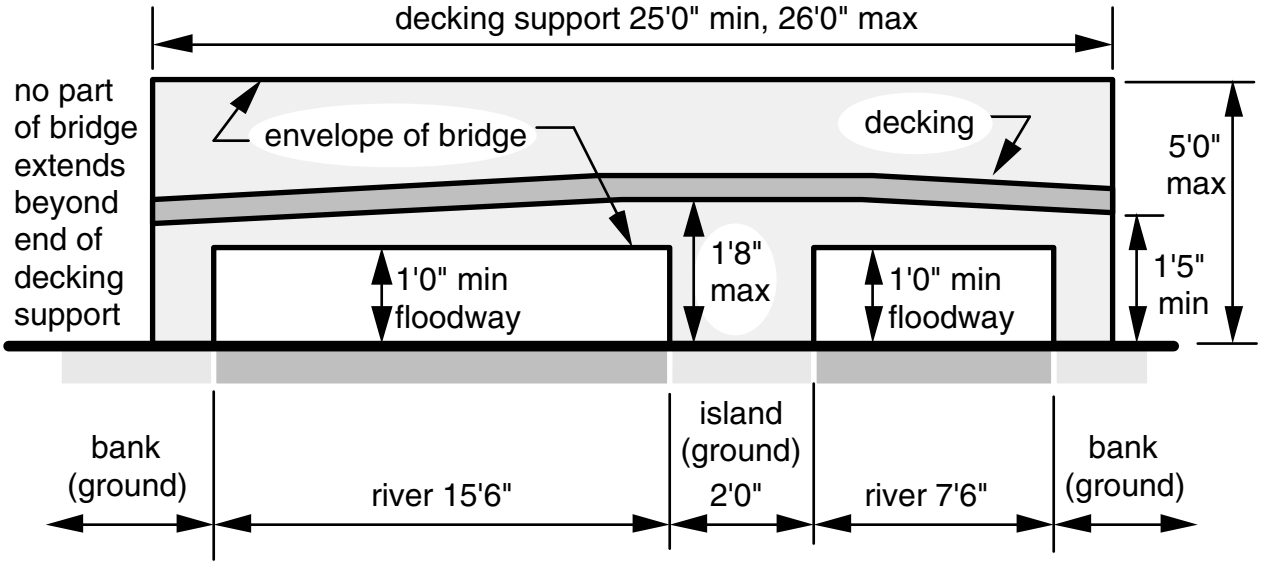
8.2.1. The bridge must span both parts of the river without touching it. No part or accessory of the completed bridge may touch the river. One part of the river is 15’6” wide and the other is 7’6” wide.

8.2.2. The decking support may not be longer than 26’0”. Also see paragraph 8.1.1.

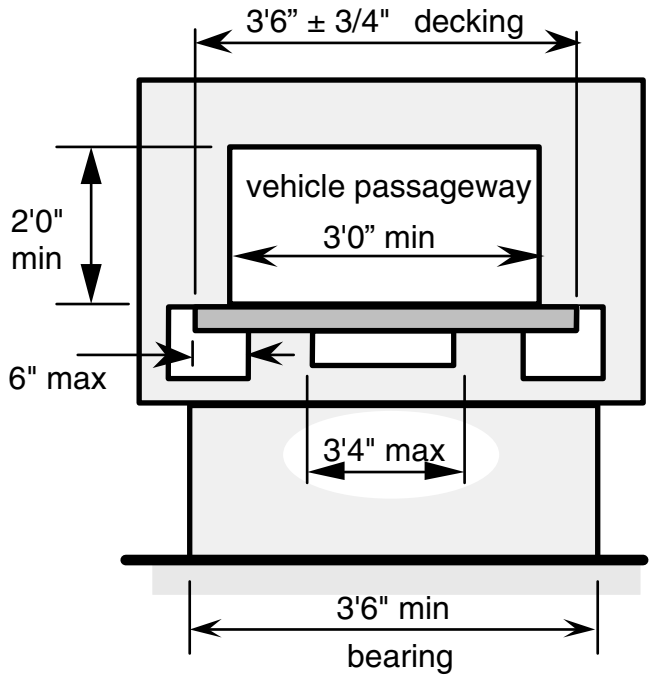
8.2.3. No part of the bridge (including fasteners) may extend beyond either end of the decking support.

8.2.4. No part of the bridge may extend more than 5'0" above the ground or river surface, which have the same elevation.

8.2.5. The decking support must be no less than 1’5” nor more than 1’8” above the surface of the ground and river at any point. Note that the surfaces of the ground and river have the same elevation.



Spans and Clearance (Side View)



Decking Support, Roadway and Bearing (End View)

8.2.6. A floodway must be provided under the bridge. The floodway must be at least 1’0” high at all points over the river, measured from the surface of the river, and it must extend from one bank to the edge of the island and from the other edge of the island to the other bank. The floodway must traverse the entire width of the bridge.

8.2.7. On the island and on each river bank the bridge must bear on the ground over a width of at least 3’6.” Bearing is not required to be continuous over that width.

8.2.8. A vehicle passageway at least 3’0” wide and 2’0” high must completely traverse the bridge from end to end. That is, a vehicle that is 3’0” wide and 2’0” high should be able to cross the bridge.

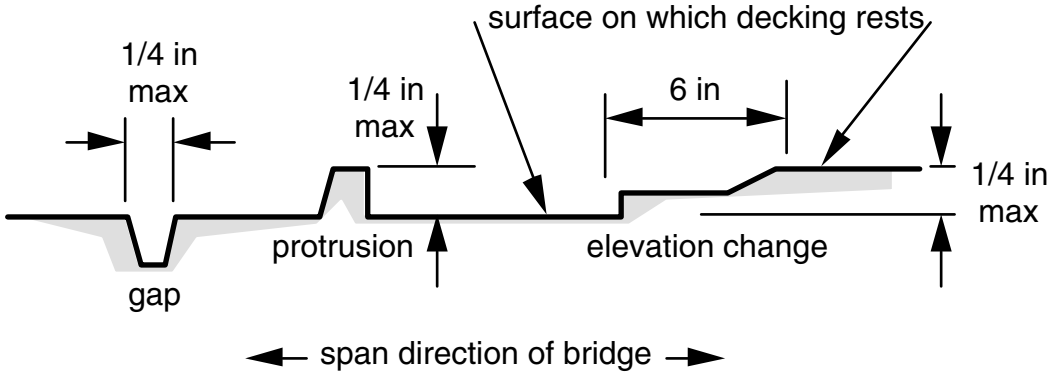
8.2.9. The edges of the decking that run in the span direction of the bridge may be cantilevered over their supports no more than 6 inches on each side.

8.2.10. The decking support must not have gaps exceeding 1/4 inch wide in the span direction of the bridge.

8.2.11. The decking support must not have vertical protrusions exceeding 1/4 inch high. Heads of the bolts specified in paragraph 9.2.16 are acceptable vertical protrusions.

8.2.12. Elevation of the decking support must not change more than 1/4 inch in any 6 inches of span length.

8.2.13. The bridge must bear on the island and banks only on the island side of the reference line. See the figure titled “Site Plan” for location of the reference line.



Irregularities in Decking Support (Side View)

9. MATERIAL AND COMPONENTS

9.1. Safety

If any one of the following regulations in this section (9.1) is violated, the bridge must be **disqualified**.

9.1.1. A member may not weigh more than 20 pounds. See section 9.2 for definitions of “rigid member” and “flexible member.”

9.1.2. A bridge may 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 a motor, electromagnet, hydraulic or pneumatic piston, turbine, chemical reactor, pressure vessel, pre-loaded spring or electric cell.

9.1.3. After completion of timed construction, energy may not be transmitted to or from a bridge (for example, by applying mechanical, magnetic, fluidic or other force; by sound, light radio or other wave or ray; by conduction or convection of heat; or by electric current). The exceptions are forces necessary to the competition (for example, those associated with load testing and with moving the bridge from place to place), and changes in ambient conditions that are not controlled by contestants (such as wind, temperature and lighting).

9.2. Durability and Constructability

Violation of the following rules in this section (9.2) will result in penalties being added to the weight of the bridge. The penalty for each violation is 10 pounds plus 5 times the weight of the non-conforming components.

9.2.1. A bridge may be constructed only of structural steel. For the purposes of this contest, structural steel is defined as an iron alloy that is strongly attracted to a magnet. Exceptions: Paint, banners, placards and other purely decorative items.

9.2.2. A bridge may be constructed only of rigid members, flexible members and fasteners. Also see paragraph 10.1.9.

Rigid Members

9.2.3 A rigid member is a steel component that retains its shape and dimensions during timed construction and in the completed bridge.

9.2.4 A rigid member may not exceed overall dimensions of 3'6" x 6" x 6." That is, it must fit in a prismatic box of those dimensions.

9.2.5. A rigid member must 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. Exception: Deformations caused by mechanical strain (i.e. bending, stretching) during load testing are not considered violations of this rule.

9.2.6. A rigid member may consist of several parts rigidly joined together (e.g. welded, bolted, screwed) before timed construction begins. Those parts must remain rigidly joined throughout timed construction and in the completed bridge.

Flexible Members

9.2.7 A flexible member is a steel component that retains its length in the completed bridge. A flexible member consists of flexible cable and rigid fittings. Fittings are necessary for connections to other members (see paragraph 9.2.19).

9.2.8. A flexible member must be capable of being coiled to a six-inch diameter and then uncoiled without damage.

9.2.9. A cable (i.e. flexible part of a flexible member) must be comprised of several strands and must have a nearly circular cross-section.

9.2.10. A fitting (i.e. a rigid part of a flexible member) must not exceed six inches in any linear dimension.

9.2.11. Steel turnbuckles and other devices for adjusting length during timed construction are considered to be fittings. Turnbuckles or other devices may not be adjusted after timed construction.

9.2.12. A flexible member may have any number of fittings and ends.

9.2.13. The length of a flexible member may not exceed 20'0". The length of a branched (i.e. more than two ends) flexible member is the total of the lengths of all branches. Length will be checked with adjustments (e.g. turnbuckles) fully extended.

9.2.14. A flexible member may consist of several parts joined together before timed construction begins. Those parts must remain joined throughout timed construction and in the completed bridge.

Fasteners

9.2.15. A fastener is a steel bolt with at least one steel nut. The specified bolts and nuts are available in hardware stores.

9.2.16. The bolt in a fastener must be 3/8" nominal diameter and no more than 3" nominal length (bottom of head to end) with a hexagonal head, and it must have the configuration and dimensions of a "cap screw grade 2," "cap screw grades 5 and 8" or "hex tap bolt" illustrated on http://www.purchasepartners.fastenerspecs.htm. Bolts may not be altered or modified in any manner.

9.2.17. The nuts in a fastener must match the bolt. That is, the nominal size (inside diameter) must be 3/8" and the threads of the nuts must engage the threads on the bolt and permit the nuts to be turned onto the bolt. Nuts must be hexagonal and have the configuration and dimensions of "finished hex nut grade 2," "finished hex nut grades 5 and 8" or "heavy hex nut" as illustrated on the web site cited in paragraph 9.2.16. Nuts may not be altered or modified in any manner.

Member-to-member Connections

9.2.18. Each rigid or flexible member must be connected directly to every other rigid or flexible member that it touches by at least one fastener installed during timed construction so that the connection cannot be taken apart without first removing a nut from the bolt. The bolt must penetrate completely through a hole in each of the members that it connects.

9.2.19. Cable (i.e. flexible part of a flexible member) must not be in direct contact with any part of a fastener in the completed bridge.

10. CONSTRUCTION

10.1. Safety

If any of the following safety regulations is violated during timed construction, the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools and bridge components will be returned to the positions they occupied before the violation. Then the builders will be asked to resume construction using safe procedures. A bridge that cannot be constructed safely must be **disqualified**.

10.1.1. Builders must not be exposed to risk of personal injury.

10.1.2. Field welding and tools requiring external power connections are prohibited. Tools may not be used to support or elevate builders.

10.1.3. When fully assembled and extended a tool may not exceed 3’6” in any linear dimension.

10.1.4. During timed construction all builders must wear hardhats meeting ANSI standard Z89.1 and protective eyewear or safety goggles meeting ANSI standard Z87.1. Safety equipment must be worn properly (e.g. hardhats with peak in front).

10.1.5. Nothing may be thrown. Under no circumstance will throwing be permitted.

10.1.6. A builder may not use the bridge, a portion of the bridge, 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 bridge if the builder is kneeling on one or both knees or if the builder is standing on the heels and toes of both feet.

10.1.7. A builder may not depend on another builder or builders for support or balance.

10.1.8. A builder may not cross either part of the river by jumping, by temporary scaffolding, by crossing the bridge, or by any other means. Exception: the builder designated as the barge may walk on the river.

10.1.9. An “assembly” consists of no more than four members that are connected together in the staging yards during timed construction and must remain connected. Exception: Fasteners in an assembly are not required to be installed in a staging yard.

10.1.10. A “constructed portion” consists of connected members and assemblies that are in their final positions. A bridge must be constructed by placing members or assemblies on the island and river banks in their final positions (i.e. these become the initial constructed portion), then successively connecting individual members and assemblies to enlarge the constructed portion. Outside the staging yards connections may be made only to the constructed portion.

10.1.11. The builder or builders who move a member or assembly into position for connection to the constructed portion must continue to support that member or assembly until the constructed portion, including the newly added member or assembly, is self-supporting. A constructed portion is considered to be self-supporting if all of its parts retain essentially their final positions without support by builders.

10.1.12. Outside the staging yard, moving or supporting an assembly requires the effort of at least as many builders as there are members in that assembly. The word “moving” includes, but is not limited to, lifting, carrying, lowering, rolling, turning, sliding and tipping, as well as causing translation and/or rotation of one portion of the bridge relative to another. Exception: small movement (maximum 3 inches) of an assembly or constructed portion by as few as one builder will be allowed as necessary to facilitate connections and placement on the site.

10.1.13. Outside the staging yard, a builder may contribute to lifting, carrying or supporting only one member or assembly at a time.

10.2. Team

The construction team, also referred to as builders, consists of all participants who are within the construction site at any time during timed construction. There can be no more than six builders.

Participation is limited to undergraduate and graduate student members of an ASCE chapter or club or similar invited organization.

The team captain may designate one builder to be a barge. This builder will operate only in the river from start to finish of timed construction.

10.3. Tools and Safety Equipment

Competitors provide their own tools, hardhats and protective eyewear or safety goggles. See paragraphs 10.1.2 - 4.

10.4. Construction Site

See the figure titled “Site Plan” for layout of the construction site.

The reference line is provided to guide construction. It is perpendicular to the banks of the river, extends from bank to bank and separates the island from the causeway.

The island and river banks (i.e. places on which the bridges will bear) should lie in a common plane. If the island and river banks deviate from a common plane by more than ±1/4” the host must adjust the elevations of the island and river banks to within that tolerance using steel plates, plywood or other flat, solid materials. Before timed construction team captains may use a string line to verify that the river banks and island are sufficiently coplanar and may improve planarity with material they supply.

Only builders and judges are permitted in the construction site during timed construction. Only judges are permitted near the construction site; coaches, managers and other spectators must observe from a safe distance that does not obstruct judges.

10.5. Start

Before construction begins, all of the following items, and nothing else, are in the staging yards: members, fasteners, tools and builders except for the barge. If a builder has been designated to be the barge, that builder will be in the river but without members, tools or fasteners (these may be handed to the barge during timed construction). Builders, including the barge, will be wearing hardhats and protective eyewear or safety goggles, as well as optional clothing such as pouches. Members, tools and all fasteners must in contact with the ground. Members must not be connected nor in contact with one another. Tools and fasteners must not be in contact with members.

During timed construction no additional members, tools or builders may be brought into the construction site nor may anything be removed.

Timing and construction begin when the builders signify that they are ready and the judge declares the start.

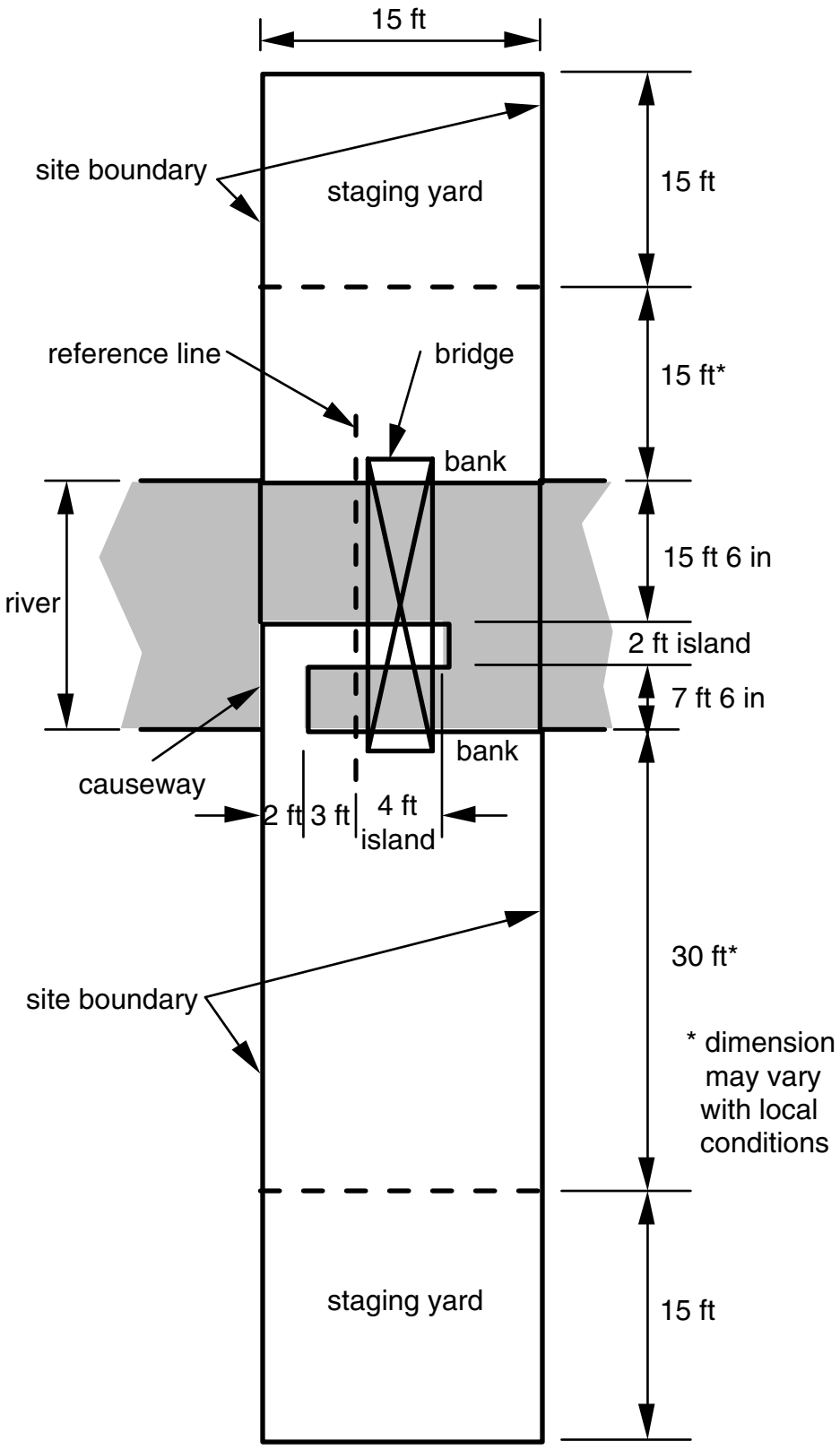
10.6. Time

Time is kept from start to finish of construction. The clock will be stopped:

10.6.1. if a builder or judge sees a condition that could cause injury, or

10.6.2. when a safety regulation has been violated or work has been accomplished by committing an “accident.” See sections 10.1 and 7.

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 before the interruption, and the clock is restarted.


15 ft
site boundary
staging yard
15 ft
15 ft*
reference line
bridge
bank
15 ft 6 in
river
2 ft island
7 ft 6 in
bank
causeway
2 ft
3 ft
4 ft
island
30 ft*
site boundary
* dimension may vary with local conditions
staging yard
15 ft

Site Plan

10.7. Accidents

In general, the clock is not stopped when an "accident" occurs. If an accident is continuous (for example, a builder stands in the river) it will be counted as multiple incidents. Builders involved in accidents may continue to build, and components involved in accidents may be recovered and 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 resuming timed construction, the builders, tools, members and fasteners will be returned to the positions they occupied before the accident.

Types of accidents and the corresponding time penalties, which will be added to the construction time, are:

10.7.1. A builder, other than the one designated as a barge, touches the river. Penalty is 1/2 minute (30 seconds) per incident. Exception: Builders may step in the river without penalty to retrieve a dropped member, tool, nut, bolt or hardhat.

10.7.2. The builder designated as the barge (if there is one) touches the river bank, island or causeway. Penalty is 1/2 minute (30 seconds) per incident.

10.7.3. The builder designated as the barge crosses the island or causeway, for example by stepping or jumping across. Penalty is 1/2 minute (30 seconds) per incident.

10.7.4. A member, assembly or constructed portion touches the river or the ground outside a staging yard. Penalty is 1/3 minute (20 seconds) per incident. Exception: No penalty is assessed when the island or river bank is touched by a constructed portion in its final position.

10.7.5. A tool, nut, bolt or hardhat touches the river or the ground outside a staging yard. Penalty is 1/6 minute (10 seconds) per incident. Exception: a tool used exclusively for measuring may touch the ground during use while being held by a builder.

10.7.6. A builder steps outside the boundary of the construction site. Penalty is 1/6 minute (10 seconds) per incident.

10.8. Finish

Construction ends when the bridge has been completed by connecting all the members, tools and builders are back in the staging yards (except the barge, which remains in the river), and the builders signify that they are finished. Installation of decking is not included in timed construction.

After construction is finished the bridge may not be modified except as provided by section "10.9 Construction: Repairs."

10.9. Repairs

Before the judges inspect and measure the bridge and before the bridge is moved from the construction site, the builders will be given the opportunity to examine the bridge for construction mistakes. The team will be permitted, but not required, to repair these mistakes. Judges will not inspect the bridge for violation of rules until after the builders complete repairs. Repairs are made with the clock restarted. Safety precautions (section 10.1) apply and accidents (section 10.7) are counted. The time required to make repairs (including penalties) is multiplied by 1.5 and added to the original construction time.

11. LOAD TESTS

11.1. Safety Precautions

The judge will halt any activity that is hazardous.

A bridge could suddenly collapse or sway in any direction during load tests. Therefore, minimize the number of people near the bridge while it is being tested. Usually, the load may be placed on the bridge by only two competitors.

While participating in load testing, **competitors must wear hardhats meeting ANSI standard Z89.1, protective eyewear or safety goggles meeting ANSI standard Z87.1, gloves and leather construction boots**. This safety equipment is provided by the competitors. Judges will not permit load testing and will **disqualify** the bridge if competitors involved in testing are not wearing the specified safety equipment or are wearing it improperly.

During testing, safety supports must be in place below the bottom of the decking. The safety supports should be of sufficient height, strength, number and extent that none of the load will fall more than four inches if the bridge collapses.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a portion of the decking that is cantilevered laterally over its support.

When any portion of the load is on the bridge, no one is permitted to crawl, reach or step under the bridge. If such an action is necessary the load must first be removed.

11.2. Damage

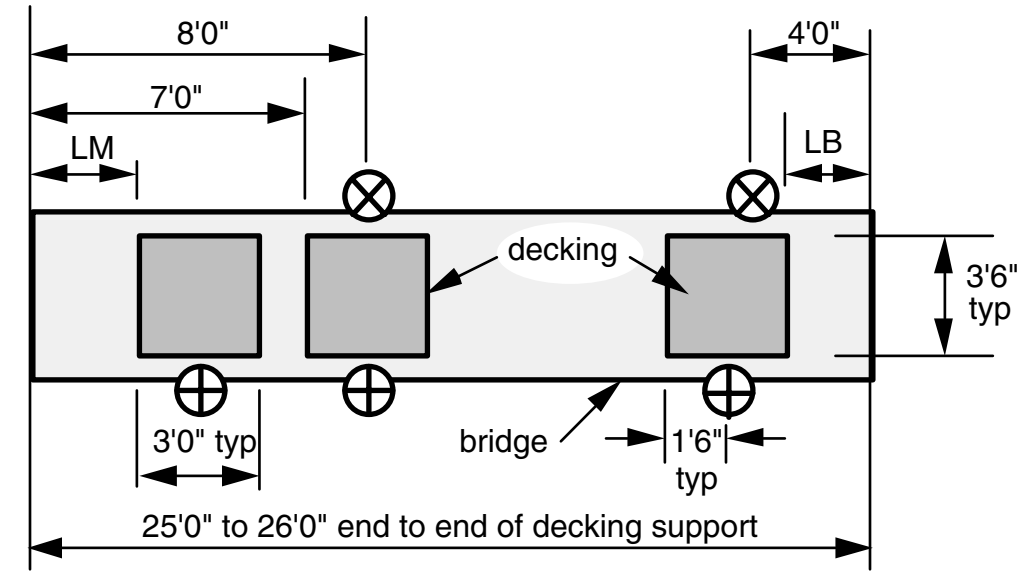
A bridge will not be tested in a condition that compromises its strength or stability.

If a nut falls off its bolt while the bridge is being transported or prepared for load testing, the connection will be repaired, the nut will be replaced (finger tight) and a penalty of 2 minutes will be added to construction time.

A bridge with irreparable damage that would reduce its strength or stability (such as a broken part) will be **disqualified** and will not be load tested.

11.3. Preparation

The floor surfaces on which the bridges will bear should lie in a common plane. If the floor is not flat to within ±1/4", adjust the elevations of the island and river banks to within that tolerance with steel plates or steel shims. If a team requires a closer tolerance they are permitted to make finer adjustments using steel plates, sheets or shims that they provide. Plates, sheets or shims may not be used to compensate for imprecise construction or fabrication of the bridge.



⊗ targets for measuring sway ⊕ targets for measuring deflection

Location of Targets and Decking (Plan)

Sway is translation in any horizontal direction. Two targets are established for sway measurements: one is 8 feet from the end of the decking support of the longer span and the other is 4 feet from the end of the decking support of the shorter span as illustrated in the figure titled “Location of Targets and Decking.” Sway targets are located at the level of the decking support which is the same as the bottom of the decking, and are on the side of the bridge determined at the beginning of the competition (chapter “7 Schedule of Competition”).

Three targets are established for measuring vertical deflection. Vertical deflection targets are located longitudinally at the centers of the three units of decking, on the side opposite the sway targets, at the level of the decking support which is the same as the bottom of the decking. Targets may be on the decking or on the bridge. See section 11.5 for location of decking.

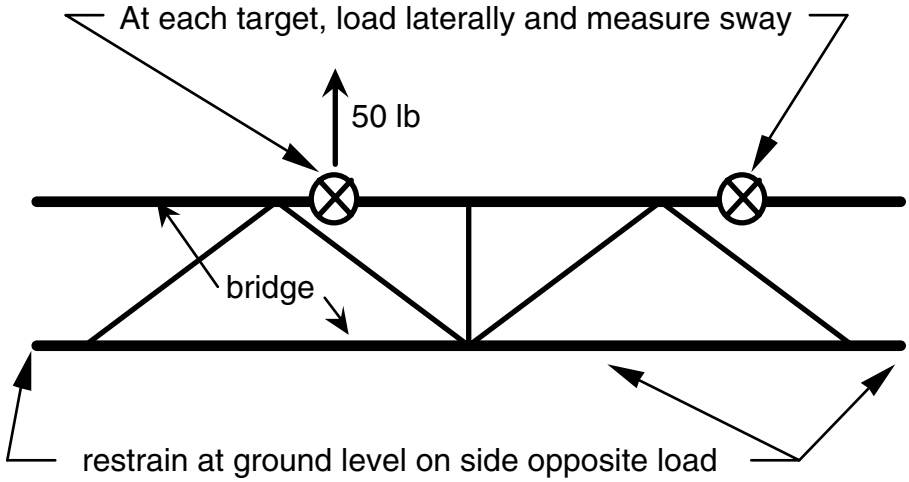
At their discretion judges may impose a penalty for a bridge that incorporates parts having the primary function of interfering with placement of targets or measuring equipment.

Teams must accept imperfect field conditions such as bent decking.

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

A BRIDGE THAT COLLAPSES DURING LOADING, DEFLECTION MEASUREMENTS OR UNLOADING MUST BE DISQUALIFIED.

11.4. Lateral Load



Lateral Load Test (Plan)

The lateral load test is conducted without decking but with restraint at the bearing points on the side opposite the load to prevent the bridge from sliding or tipping. As shown in the figure titled “Lateral Load Test” apply a 50 pound

lateral force at one of the sway targets (and on the same side), and measure the sway. Repeat the process at the other sway target. To pass the lateral load test, the sway must not exceed one inch at either sway target. If the bridge does not pass the lateral load test it is disqualified; do not conduct any other load test. Remove the lateral load; it is not part of the next load test.

11.5. Vertical Load

Decking locations are illustrated in the figure titled "Location of Targets and Decking." Decking units are three feet long in the span direction. Place the two decking units on the longer span seven feet and LM from the end, and place the decking unit on the shorter span LB from the other end. LM and LB are determined by the head judge at the beginning of the competition and are the same for all bridges (see paragraph 4 of chapter 7).

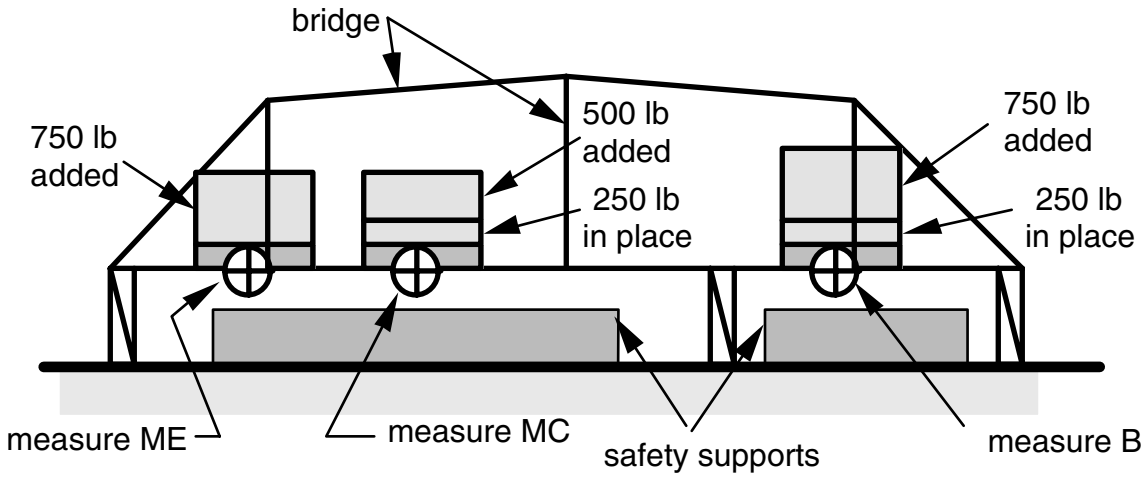
If deflection targets are on the decking rather than on the bridge, clamp the decking to the decking support at the targets to assure contact during initialization of measurements.

Position measuring devices on the three vertical deflection targets.

Uniformly distribute 250 pounds of load on the unit of decking closest to the center of the longer span and 250 pounds of load on the unit of decking on the shorter span. Deflection caused by these initial loads is not measured.

Either initialize the measuring devices to zero or record the initial readings. If the decking was clamped to the decking support, remove the clamps after initialization. Also initialize for sway measurement.

Uniformly distribute additional 750 pounds of load on the unit of decking on the shorter span, additional 500 pounds of load on the unit of decking closest to the center of the longer span, and 750 pounds of load on the other unit of decking on the longer span as shown in the figure titled "Vertical Load Test."



Vertical Load Test (Side View)

As the additional 2000 pound load is being placed, observe sway and deflection. Stop loading and disqualify the bridge if

a. sway at either sway target exceeds 1/2 inch, or
b. vertical deflection at any deflection target exceeds 2 inches, or
c. any part of the bridge, other than its intended bearing points, comes to bear on the floor, or
d. the decking falls off the decking support.

If the full 2500 pounds of load was successfully placed without exceeding sway or deflection limits, record the following measurements

B = downward translation of the deflection target on the shorter span from its position before the 2000 pounds of additional load was placed.

MC = downward translation of the deflection target closest to the center of the longer span from its position before the 2000 pounds of additional load was placed.

ME = downward translation of the other deflection target on the longer span from its position before the 2000 pounds of additional load was placed.

If a sway or deflection limit was exceeded, remove all load and disqualify the bridge.

11.6. Unloading

The bridge must be disqualified if it collapses during unloading.

11.7. Computing Aggregate Deflection

Compute and record: Aggregate deflection = B + MC + ME.
If B, MC or ME is negative (i.e. translation upward) replace that value with zero when computing aggregate deflection.

12. EQUIPMENT PROVIDED BY HOST

A complete list of hosting equipment appears in the *Guide for Hosts and Judges* which is distributed to host universities as a separate document. The following partial list is intended to help competitors know what to expect. Competitors should acquire similar equipment for use in practice and testing before the competition.

12.1. Lateral Load Device

Capable of applying 50 pound force in the horizontal direction.

12.2. Equipment for Measuring Sway

Sway is horizontal translation and is measured at two points by any accurate method. A suggested method is to suspend plumb bobs from the sway target points and measure sway from points marked on the ground.

12.3. Equipment for Measuring Deflection

Deflection is vertical translation and is measured at three points by any accurate method.

12.4. 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 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 of the grating that are perpendicular to the length.

12.5. Load

2500 pounds total. The load should be supplied in uniform pieces of size and weight that may 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.

12.6. Safety Supports

The safety supports must be used during load testing and are intended to limit the consequences of a bridge collapsing. The safety supports should be of sufficient height, strength, number and extent so that none of the load will fall more than four inches if the bridge collapses. Safety supports may be steel, plastic buckets, timbers, sand bags or masonry units.

12.7. Floor

In both the construction site and loading area the surfaces on which the bridges will bear (river banks and island) should be as nearly co-planar as possible. If necessary, the host will build up parts of the floor with steel plates to reduce the deviation from plane to less than 1/4 inch.

13. INTERPRETATION OF RULES

The web site http://www.aisc.org/steelbridge.html lists answers to questions about 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 and reread this *Rules* booklet carefully in its entirety. The names of students and their universities will be posted with their questions.

14. JUDGING

The host 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, rating and disqualification are the sole responsibility of the judges and will be final. The host will assure that the judges are fully informed of the rules and procedures, and fully equipped for their tasks. The host and judges will follow directions in the *Guide for Hosts and Judges* provided by AISC.

A spread sheet to assist with judging and scoring is available at http://www.aisc.org/steelbridge.html.

15. PROTESTS AND APPEALS

15.1. Before the Contest

Each team will designate a student as team captain. The host will identify the head judge.

15.2. During the Contest

A penalty, disqualification, measurement, score, or condition of competition may be protested only by a team captain and only to the head judge. The protest must be made as soon as possible after the situation becomes apparent. The head judge will not hear the protest if he or she is approached by students other than the team captain. As soon as possible after a protest is made, the head judge will interrupt the contest if necessary, gather the other judges and the captains of the teams involved, and hear the protest. The decision of the head judge is final.

Participants are reminded that civility and ethical behavior are expected during the contest and particularly concerning protests.

15.3. After the Regional Contest

If a team wants to appeal the decision of the head judge regarding a protest it may do so in an e-mail message to Mr. Fromy Rosenberg (rosenberg@aisc.org) followed by a letter mailed to Mr. Rosenberg (AISC, Suite 3100, One E. Wacker Dr., Chicago, IL 60601-2000) with a copy mailed to ASCE Student Activities Coordinator (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The e-mail message and letter should include the name of the college or university making the appeal; the names, addresses and telephone numbers of the faculty adviser and one team member; brief description of the problem, the action taken at the contest to deal with it and the action that the appealing team feels should have been taken; and data showing that the appealing team should have qualified for national competition.

Appeals must be made by e-mail followed by letter. An appeal will be considered only if the e-mail is received and the letter is postmarked within one week after the regional contest.

The only redress that may be made is an invitation to participate in the national competition if the Rules Committee is convinced that the appeal is valid and that the appealing team should have qualified. Decisions and rankings made by regional judges will not be overturned.

15.4. After the National Contest

Appeals will not be accepted. However, AISC welcomes written suggestions for improving future competitions.

16. TIPS FOR COMPETITORS

16.1. Strive for challenging but realistic goals for design and construction. The following statistics from the 2003 National Student Steel Bridge Competition suggest the levels of performance that are possible. However, when reviewing these statistics keep in mind that the rules and scoring for 2004 differ from those for 2003.

	Winning bridge in category	Winning bridge, overall
Weight (pounds)	92	102
Construction time (minutes)	1.03	1.70
Aggregate deflection (inches)	0.33	0.66

16.2. Start work on the design early, leaving adequate time to procure materials, fabricate the bridge, load test it and practice construction.

16.3. Design a bridge that may be fabricated, erected and load tested safely, using available materials, tools and facilities.

16.4. Structural analysis may fail to disclose instability, such as buckling of slender compression members, sway, and torsion of under-deck trusses of triangular cross-section.

16.5. Design a bridge that accommodates imperfect field conditions such as uneven floor, non-standard load, and non-standard or bent decking.

16.6. Allow tolerances for all limiting dimensions in order to accommodate imprecise measurement, fabrication, thermal expansion, elastic and inelastic deformation, wear, etc. For example, if a bridge is required to provide at least 12 inches of clearance, and it is designed to provide exactly that clearance, then there is a high probability that the actual as-built clearance will be less than the specified minimum, resulting in a penalty. That probability of error may be reduced by designing the bridge to provide more than the required minimum clearance.

16.7. When fabricating your bridge, use safe tools, operate them carefully and with adequate supervision.

16.8. Follow all safety regulations and guidelines during construction practice and loading.

16.9. When practicing construction, wear hardhats and protective eyewear or safety goggles both for safety and to accustom yourself to contest conditions.

16.10. It is strongly recommended that bridges be load tested before competition, if it can be done safely, so that weaknesses and instability can be corrected.

16.11. When load testing your bridge use safety supports under the decking, sufficient in height, strength, number and extent to minimize the distance the load will drop if the bridge collapses. This will reduce risk of injury and limit damage to the bridge if it collapses. Keep hands and feet out from under the bridge.

16.12. When load testing your bridge wear hardhats, protective eyewear or safety goggles, gloves and leather construction boots.

16.13. Don't stand, sit or lie on your bridge.

16.14. To expedite the competition have a preset plan for unloading and staging components of your bridge.

16.15. The island and river banks at the contest should be within 1/4 inch of co-planar. If your bridge will be adversely affected by larger deviations from planarity you should take some thin steel sheets to the contest to help with fine adjustments.

16.16. When packing for the competition, remember to bring hardhats, protective eyewear or safety goggles, gloves and construction boots.

17. SCORE SHEET

17.1. Construction Speed and Time Penalties

Clock time = _____ minutes

Repair time, see "10.9 Construction: Repairs"
_____ x 1.5 = + _____ minutes

Time penalties, see "10.7 Construction: Accidents"
items 1,2,3: violations _____ x 1/2 = + ____ minutes
item 4: violations _____ x 1/3 = + ____ minutes
items 5,6: violations _____ x 1/6 = + ____ minutes

Time penalty, see "11.2 Load Tests: Damage" + _____ minutes

CONSTRUCTION TIME (add) = _____ minutes
Lowest time wins.

17.2. Lightness and Weight Penalties

Bridge weight = pounds

Weight penalties, see "8.2 Dimensions and Support: Usability"
Number violations ≤ 1 inch _____ x 100 pounds = + _____ pounds
Number violations 1 - 2 inch ____ x 300 pounds = + _____ pounds
Number violations 2 - 3 inch ____ x 600 pounds = + _____ pounds

See "9.2 Material & Components: Durability & Constructability"
Number of violations _____ x 10 pounds = + _____ pounds
Wt. of parts in violation _____ pounds x 5 = + _____ pounds

TOTAL WEIGHT (add) = _____ pounds
Lowest weight wins.

17.3. Aesthetics (see section 6.3 for criteria)

Appearance: balance, proportion, elegance, finish.

Full name of college or university on bridge or on attached banner or placard in letters at least 2 inches high.

Poster describing design and fabrication, no larger than 2 x 3 feet.

Judges should not declare ties in aesthetics

AESTHETICS SCORE = _____

17.4. Stiffness

AGGREGATE DEFLECTION: B + MC + ME = _____ inches
Lowest deflection wins.

17.5. Construction Economy

Number builders _____ x Const. Time (part 17.1) _____

C_c = CONSTRUCTION COST = _____ thousand $
Lowest cost wins.

17.6. Structural Efficiency

W = larger of total weight (part 17.2) or 80 = _____ pounds

Δ = larger of aggregate deflection (part 17.4) or 0.25 = x _____ inches

C_s = STRUCTURAL COST (multiply) = _____ thousand $
Lowest cost wins.

17.7. Overall Performance

C_c (from part 17.5) _____ + C_s (from part 17.6) _____ = _____
Lowest total wins.

17.8. Ranks

Disqualified bridges will not be ranked.

Aesthetics is the tie-breaker for all categories

Construction Speed _____ Lightness _____

Aesthetics _____ Stiffness _____

Construction Economy _____ Structural Efficiency _____

Overall Performance _____

This Score Sheet implements chapter "6 Scoring."

RULES

ASCE/AISC STUDENT STEEL BRIDGE COMPETITION

2003

PDF Version

http://www.aisc.org/steelbridge.html

31 July 2002

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I. INTRODUCTION

The Student Steel Bridge Competition is sponsored by the American Institute of Steel Construction and co-sponsored by the American Society of Civil Engineers, the American Iron and Steel Institute, the James F. Lincoln Arc Welding Foundation, the National Steel Bridge Alliance, Nucor Corporation and TXI Chaparral Steel. This inter-collegiate challenge requires Civil Engineering students to design, fabricate and construct a steel bridge.

Safety is of primary importance. The AISC requests that competitors, hosts and judges take all necessary precautions to prevent injury.

The competition rules are changed every year to improve the contest and assure that competitors design and build new bridges.

Students design the bridge themselves but may seek advice from faculty and other consultants.

Ideally, students should fabricate the entire bridge themselves. However, appropriate shop facilities and supervision may not be available at every college and university. Therefore, the services of a commercial fabricator may be used provided that students observe the operations. Students are encouraged to maximize their personal involvement in fabricating their bridge.

There are two levels of competition: regional and national. These *Rules* govern competition at both regional and national levels. Regional competitions are held in conjunction with ASCE regional conferences. Winners and first runners-up from most regions are invited to compete at the national level. However, invitations are extended only to the winner from a region with two, three or four participating universities, and to the top three teams from a region with eleven or more participating universities. Only one bridge per university may be entered in regional competitions.

This booklet describes the contest and states the official rules for this year. It is distributed to universities throughout the country. A companion booklet, *Guide for Hosts and Judges*, is distributed to hosts and provides directions for conducting a competition.

The rules are intended to be prescriptive but may require some interpretation. The procedure for requesting clarification of the rules is described in section “XIII Interpretation of Rules.”

The ASCE student chapters and clubs entering the contest are required to be current with their national dues. Teams may consist only of undergraduate and graduate students in good standing with their ASCE chapter or club.

II. EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication and construction. Participating students gain practical experience in structural design, fabrication processes, construction planning, organization and teamwork.

The "Problem Statement" describes challenges encountered in a representative structural engineering project. The competition is a scaled simulation of that project.

Standards for strength, durability, constructability, usability, functionality and safety reflect the volumes of regulations that govern the design and construction of full-scale bridges. Criteria for excellence are represented by the award categories of stiffness, lightness, construction speed, aesthetics, efficiency and economy. As with a full-scale construction project, safety is the primary concern.

The rules of the competition accommodate a large 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.

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

III. RULE CHANGES

The following list covers some of the major changes from the 2002 rules. Minor changes are not listed. Contestants and judges are cautioned to read this entire *Rules* booklet carefully and disregard rules from previous years.

1. A university may enter only one bridge in regional competitions.

2. Several changes in scoring and penalties.

3. A poster is required for the regional contest.

4. No cantilevers, and the bridge will be dual span. Consequently there are changes in dimensions, construction site, deflection targets and load pattern.

5. Cables and round tubes are permitted.

6. Fasteners are standardized.

7. Limit on number of components in an assembly.

8. One builder may serve as a barge and work in the river. However, a temporary pier is not permitted.

9. Restriction on handling multiple members and assemblies.

10. A new schedule limits changes made to a bridge during competition.

IV. PROBLEM STATEMENT

A century-old bridge that crosses an environmentally sensitive river must be replaced. The bridge carries truck traffic serving the farms and agricultural processing industries that are the basis for the economy of this rural region, as well as providing access and emergency services to residences. A quick replacement is necessary because no other river crossing is available for miles.

The State Department of Transportation has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered but the State DOT has specified steel as the material because of its durability and fast erection. The bridge must provide clearance for flood flows and it must be able to carry specified patterns of loads without exceeding sway and deflection limits. Based on past experience with performance and maintenance, the DOT prefers bridges that are relatively light and stiff, with low profiles. The new bridge must accommodate modular decking, which the DOT salvaged from another bridge. Decking units may not be modified.

Flood control and environmental concerns prohibit piers in the river; piers must be built on the banks and on a natural island that is connected to the river bank by an existing causeway. A construction barge may be operated within a designated section of the river but must not disturb the river banks, causeway or island. Soil conditions restrict the weight that may be lifted by cranes.

Your company's design/build proposal is among those that the State DOT has deemed responsive. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. The DOT will evaluate the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy and aesthetics. The contract will be awarded to the company that submits the best model. This is an opportunity to become leaders in the bridge replacement market.

V. SAFETY

Safety has the highest priority. Judges are empowered to halt any activity that they deem hazardous. Judges are directed to disqualify bridges that cannot be safely constructed or load tested using the equipment provided by the host, as described in this booklet. Collapse, sway or deflection in excess of specified limits is incontrovertible evidence of an unsafe bridge and will result in disqualification. A

disqualified bridge is not eligible for awards in any category and must be withdrawn from all subsequent participation in the contest.

VI. SCORING

A university may enter only one bridge in regional competition and may compete in only one region.

Categories of competition are construction speed, lightness, aesthetics, stiffness, construction economy, and structural efficiency. In addition, overall performance is rated. Bridges that have been disqualified are not eligible for awards in any categories.

A. Construction Speed

The bridge with the lowest construction time will win in this category. Construction time is the clock time required to assemble the bridge, regardless of number of builders, plus time penalties prescribed in sections "X.G Construction: Accidents" and "XI.B Load Tests: Damage."

B. Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in sections "VIII.B Dimensions and Support: Usability" and "IX.B Material and Components: Durability and Constructability." Decking, tools and poster are not included in total weight.

C. Aesthetics

The full name of the college or university must appear on the bridge or on a banner or placard attached to the bridge, in letters at least 2 inches high. The banner or placard is included in total weight but need not be installed during timed construction. It should be in place on the bridge during aesthetics judging and at other times when the bridge is on display.

Every bridge must be accompanied by a poster illustrating and briefly describing design and fabrication processes. Maximum dimensions of the poster are 2 feet by 3 feet, and it should be designed to be displayed within the floor area occupied by the bridge. The poster is not part of the bridge but should be in place during aesthetics judging and at other times when the bridge is on display.

In addition to the college or university name and the poster, other factors that may be considered include general appearance, balance and proportion of the design, elegance, and finish. Quality of fabrication should not be considered because some bridges may be fabricated professionally while others are student work.

Aesthetics is the tie-breaker for overall performance and for all other categories of competition. Judges should not declare ties in aesthetics.

D. Stiffness

The bridge with the lowest aggregate deflection will win in the stiffness category. Aggregate deflection is determined from measurements as prescribed in section "XI Load Tests."

E. 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 = Construction time (minutes, including penalties)
x Number of builders (persons) x 100 (thousand $ / person-minute)

The number of builders includes all participants who are within the construction site at any time during timed construction.

F. Structural Efficiency

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

$C_s = W \times \Delta \times D$, where

W = the larger of total weight OR 100 pounds.
Δ = the larger of aggregate deflection OR 1.000 inch.
D = the largest of maximum height of bridge minus 18 inches OR 18 inches minus minimum clearance OR 24 inches.

Total weight is the weight of the bridge plus weight penalties prescribed in sections "VIII.B Dimensions and Support: Usability" and "IX.B Material and Components: Durability and Constructability." Decking, tools and poster are not included in total weight.

Aggregate deflection is determined from measurements as prescribed in section "XI Load Tests."

Maximum height of the bridge is the vertical distance (in inches) from the ground or river surface to the highest point on the bridge structure (not including decking).

Minimum clearance is the vertical distance (in inches) from the river to the lowest point on the bridge over the river.

G. 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.

VII. SCHEDULE OF COMPETITION

In the months before the contest students design their bridges, fabricate members, load test and practice erection. Elements of the competition are:

1. Judges clarify rules and conditions of the contest and answer questions.

2. If judges permit minor alterations to be made to the bridges, the contest should not be delayed significantly and teams should be given equal time for alterations. After this, bridges may not be altered, modified or enhanced in any way (except for erection, disassembly and repairs as described in section "X.I Construction: Repairs").

3. Bridges are erected and judged for aesthetics.

4. The head judge selects the locations of vertical deflection targets. See section "XI.C Load Tests: Preparation" for explanation of deflection targets. Selection is done in the presence of the team captains by rolling a die twice. The first roll determines which of the locations L1 through L6 will be used; the second roll determines which of the locations S1 through S6 will be used. The head judge also uses a random process to select the side of the bridges to which the lateral load will be applied during load testing.

5. Timed construction. See section "X Construction" for details.

6. Load testing. See section "XI Load Tests" for details.

The national contest will be conducted in the order shown above, with several bridges being constructed simultaneously, while other completed bridges are being load tested. A different schedule may be better for regional contests with few entries. However, it is essential that

1. bridges are not modified after selection of target locations,

2. bridges are not modified between aesthetics judging and timed construction, and

3. modifications between timed construction and load testing are limited to repairs as described in "X.I Construction: Repairs."

VIII. DIMENSIONS AND SUPPORT

Dimensions and support will be checked with the bridge in its as-built condition after construction is completed and before the bridge is moved from the construction site. The bridge may not be modified nor distorted from its as-built condition in order to satisfy dimension and support rules. Dimensions will be checked without decking or other load on the bridge.

A. Functionality and Safety

If any of the following regulations in this section (VIII.A) is violated, the bridge must be **disqualified**. The figures titled "Spans and Clearance" and "Deck Support, Roadway and Bearing" illustrate some of the requirements. The first and second regulations will be verified by sliding a piece of decking or an equivalent template along the full overall end-to-end length of the decking support.

1. The bridge must provide continuous rigid support for the decking along both of the edges that run in the longitudinal direction of the bridge. The decking support must be at least 23 feet long, and it must be rigid and continuous in plan view. Also see paragraphs VIII.B.2 and 12. Horizontal cables do not provide rigid support.

2. The bridge must provide access for placing the decking and load. Although decking is nominally 3'6" wide and 1 inch thick, actual widths range from 3'5.25" to 3'6.75" and thickness may be as large as 1.25 inches. Also see paragraph VIII.B.9 and 13.

3. The decking may not be attached nor anchored to the bridge, nor may it be used to distort the bridge from its as-built condition. However, judges may clamp the decking to the bridge to facilitate deflection measurements as explained in section "XI Load Tests."

4. The bridge may not be anchored nor tied to the ground.

5. It must be possible to construct and load the bridge safely using equipment provided by the host university. Bridges must accommodate local conditions.

B. Usability

A penalty will be assessed for each rule in this section (VIII.B) that is violated, rather than for every violation of that rule. The figures titled "Spans and Clearance" and "Deck Support, Roadway and Bearing" illustrate some of the requirements.

The penalty for violation for each of the following rules will be an addition to the weight of the bridge determined as follows: 100 pounds for a dimensional violation of 1.0 inch or less; 300 pounds for a dimensional violation greater than 1.0 inch but not exceeding 2.0 inches; 600 pounds for a dimensional violation greater than 2.0 inches but not exceeding 3.0 inches. The bridge must be **disqualified** if a dimensional violation exceeds 3.0 inches.

1. The bridge must span both parts of the river without touching it. No part or accessory of the completed bridge may touch the river. One part of the river is 14'0" wide and the other is 7'0" wide.

2. The decking support may not be longer than 25'0". Also see paragraph VIII.A.1.

3. No part of the bridge (including fasteners and bearing plates) may extend beyond either end of the decking support.

4. At completion of timed construction, the bridge must bear on the river banks and on the island. See the figure titled “Site Plan” for size and location of the island.

5. The entire bridge must be located on the island side of the reference line. See the figure titled “Site Plan” for location of the reference line.

6. A rectangular floodway must be provided under the bridge. The floodway must be at least 1’0” high at all points over the river, measured from the surface of the river, and it must extend from one bank to the edge of the island and from the other edge of the island to the other bank. The floodway must traverse the entire width of the bridge.

7. At each point where it bears on the ground the bridge will include a solid bearing plate at least 1/4 inch thick, at least 2 inches long and at least 2 inches wide. In plan view, a bearing plate may be any shape into which a 2 x 2 inch rectangle may be inscribed. Bearing plates must be smooth and flat on the bottom. Bearing plates are part of the bridge.

8. On the island and on each river bank the bridge must bear on the ground over a width of at least 3’6” measured from the outside edges of the bearing plates. Bearing is not required to be continuous over that width.

9. A vehicle passageway at least 3’0” wide must completely traverse the bridge from end to end, and must extend upward from the decking through the top of the bridge for the full length of the bridge. That is, a vehicle that is 3’0” wide and infinitely high should be able to cross the bridge. Also see paragraph VIII.A.2.

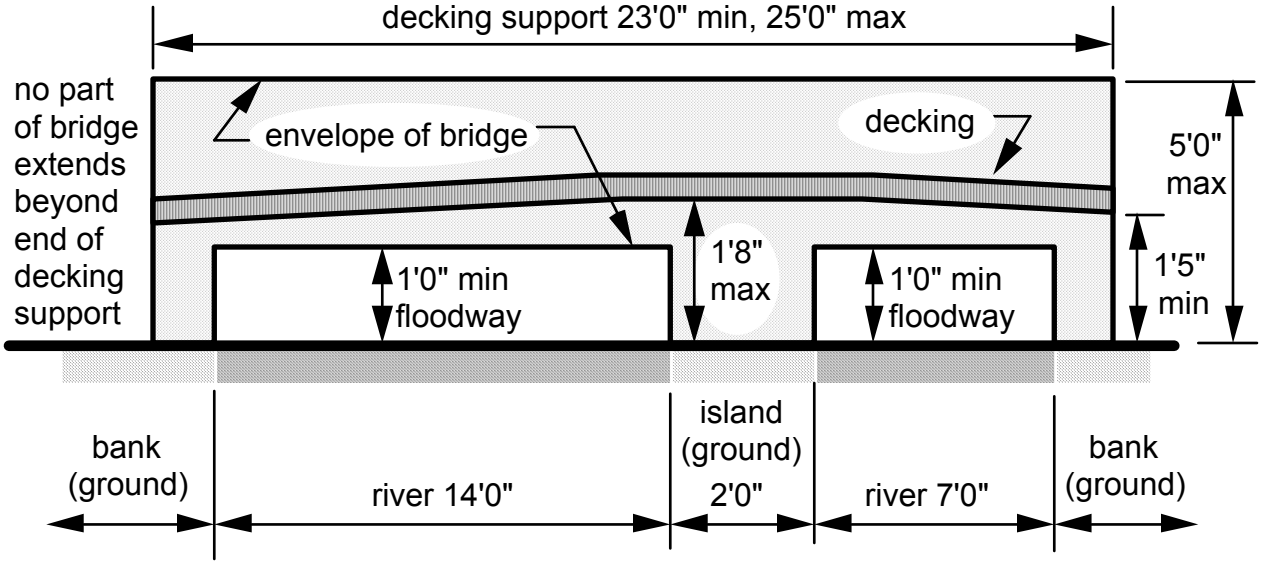
10. No part of the bridge may extend more than 5'0" above the ground or river surface, which have the same elevation.

11. The top surface of the decking supports must be no less than 1’5” nor more than 1’8” above the surface of the ground and river at any point. Note that the surfaces of the ground and river have the same elevation.

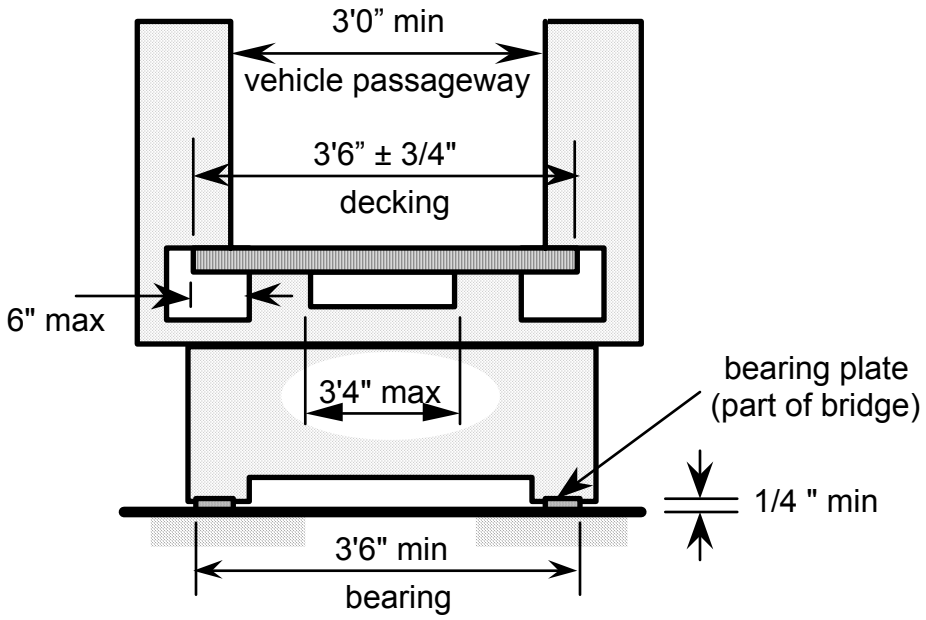
12. Decking must be supported without overlaps, longitudinal discontinuities, abrupt elevation differences or protrusions exceeding 1/4 inch. Also see paragraph VIII.A.1.

13. Clear span of the decking between decking supports should not exceed 3’4”. Also see paragraph VIII.A.2.

14. The edges of the decking that run in the longitudinal direction of the bridge may be cantilevered over their supports no more than 6 inches on each side.



Spans and Clearance (Side View)



Deck Support, Roadway and Bearing (End View)

IX. MATERIAL AND COMPONENTS

A. Safety

If any one of the following regulations in this section (IX.A) is violated, the bridge must be **disqualified**.

1. A rigid member or cable with fittings may not weigh more than 40 pounds. See section IX.B for definitions of “rigid member” and “cable with fittings.”

2. A bridge may 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 a motor, electromagnet, hydraulic or pneumatic piston, turbine, chemical reactor, pressure vessel, pre-loaded spring or electric cell.

3. Energy may not transmitted to or from a bridge (for example, by applying mechanical, magnetic, fluidic or other force; by sound, light radio or other wave or ray; by conduction or convection of heat; or by electric current). The exceptions are forces necessary to the competition (for example, those associated with load testing and with moving the bridge from place to place), and changes in ambient conditions that are not controlled by contestants (such as wind, temperature and lighting).

B. Durability and Constructability

Violation of the following rules in this section (IX.B) will result in weight penalties being added to the weight of the bridge. The penalty for each violation is 10 pounds plus 5 times the weight of the non-conforming components.

1. A bridge may be constructed only of structural steel. For the purposes of this contest, structural steel is defined as an iron alloy that is strongly attracted to a magnet. Exceptions: Paint, banners, placards and other purely decorative items.

2. A bridge may be constructed only of components conforming to the following definitions:

   a. A rigid member is a steel component that retains its shape and dimensions during timed construction and in the completed bridge. Paragraphs IX.B.3 - 6 govern rigid members.

   b. A cable with fittings is a flexible steel component that retains its length during timed construction and in the completed bridge. A fitting is a rigid steel part of a cable with fittings, and is necessary at connections to rigid members or to other cables with fittings. Paragraphs IX.B.7 - 14 govern cables with fittings.

c. A fastener is a steel bolt with at least one steel nut. Paragraphs IX.B.15 and 16 govern fasteners.

d. An assembly consists of no more than four rigid members and/or cables with fittings plus any number of fasteners that are connected together in the staging yards during timed construction. Paragraphs IX.B.17 and 18 govern assemblies.

3. A rigid member may not exceed overall dimensions of 3'6" x 6" x 6." That is, it must fit in a prismatic box of those dimensions.

4. A rigid member must 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. Exception: Deformations caused by mechanical strain (i.e. bending, stretching) during load testing are not considered violations of this rule.

5. A rigid member may consist of several parts rigidly joined together (e.g. welded, bolted, screwed) before timed construction begins. Those parts must remain rigidly joined throughout the construction process and in the completed bridge.

6. Each rigid member must be connected directly to every other rigid member and/or cable with fittings that it touches by at least one fastener installed during timed construction so that the connection cannot be taken apart without first removing a nut from the bolt. The bolt must penetrate completely through a round hole in each of the rigid members and/or cables with fittings that it connects.

7. A cable with fittings must be capable of being coiled to a six-inch diameter and then uncoiled without damage.

8. The cross-section of the flexible part of a cable with fittings (i.e. the cable) must be nearly circular.

9. The flexible part of a cable with fittings (i.e. the cable) must not be in direct contact with any part of a fastener in the completed bridge.

10. A fitting (i.e. a rigid part of a cable with fittings) may not exceed 2" in any linear dimension.

11. A cable with fittings may have any number of fittings and ends.

12. The length of a cable with fittings may not exceed 20'0". The length of a branched (i.e. more than two ends) cable with fittings is the total of the lengths of all branches.

13. Cables with fittings may include steel turnbuckles and other devices for adjusting lengths prior to timed construction. Turnbuckles or other devices may not be adjusted during or after timed construction.

14. A cable with fittings may consist of several parts joined together before timed construction begins. Those parts must remain joined throughout the construction process and in the completed bridge.

15. The bolt in a fastener must be 3/8" nominal diameter and no more than 3" nominal length (bottom of head to end) with a hexagonal head, and it must have the configuration and dimensions of a "hex cap screw" or "tap bolt" illustrated on http://www.americanfastener.com/techref/capscrew.htm. Bolts may not be altered or modified in any manner.

16. The nuts in a fastener must match the bolt. That is, the nominal size (inside diameter) must be 3/8" and the threads of the nuts must engage the threads on the bolt and permit the nuts to be turned onto the bolt. Nuts must be hexagonal and have the configuration and dimensions of "finished hex nuts," "heavy hex nuts," or "hex machine screw nuts" as illustrated on http://www.americanfastener.com/techref/nuts.htm. Nuts may not be altered or modified in any manner.

17. An assembly may consist of no more than four rigid members and/or cables with fittings.

18. The components of an assembly must remain connected.

X. CONSTRUCTION

A. Safety

If any of the following safety regulations is violated during timed construction, the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools and bridge components will be returned to the positions they occupied before the violation. Then the builders will be asked to resume construction using safe procedures. A bridge that cannot be constructed safely must be **disqualified**.

1. Builders must not be exposed to risk of personal injury.

2. Nothing may be thrown. Also see paragraph X.G.1.

3. Only tools that are hand-held during use are permitted. Field welding and tools requiring external power connections are prohibited. Tools may not be used to support or elevate builders.

4. All builders must wear hardhats and safety glasses or goggles during timed construction.

5. A builder may not use the bridge, a portion of the bridge, 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 bridge if the builder is kneeling on one or both knees or if the builder is standing on the heels and toes of both feet.

6. A builder may not depend on another builder or builders for support or balance.

7. A builder may not cross either part of the river by jumping, by temporary scaffolding, by crossing the bridge, or by any other means. Exception: the builder who is designated as the barge may walk on the river.

8. Outside the staging yard, a builder may contribute to lifting, carrying or supporting only one rigid member, or one cable with fittings, or one assembly at a time.

9. Outside the staging yard, moving an assembly requires the effort of at least as many builders as there are rigid members and/or cables with fittings in that assembly. The word “moving” includes, but is not limited to, lifting, carrying, lowering, rolling, turning, sliding and tipping, as well as causing translation and/or rotation of one portion of the bridge relative to another. Exception: small movement (maximum 3 inches) of a portion of the bridge or of the entire bridge by as few as one builder will be allowed as necessary to facilitate connections and placement on the site.

10. Outside the staging yard, any portion of the bridge that is not moving must either be supported by as many builders as there are rigid members and/or cables with fittings in that portion of the bridge, or must be supported without the assistance of builders by the portion itself and/or other portions of the bridge.

B. Team

Participation is limited to undergraduate and graduate student members of an ASCE chapter or club or similar invited organization. The construction team, also referred to as builders, consists of all participants who are within the construction site at any time during timed construction. There can be no more than ten participants on the construction team.

The team captain may designate one builder to be a barge. This builder will operate only in the river from start to finish of timed construction.

C. Tools and Safety Equipment

Competitors provide their own tools, hardhats and safety glasses or goggles. See paragraphs X.A.3 and 4.

D. Construction Site

See the figure titled “Site Plan” for layout of the construction site.

The reference line is provided to guide construction. It is perpendicular to the banks of the river, extends from bank to bank and separates the island from the causeway.

The island and river banks (i.e. places on which the bridges will bear) should lie in a common plane. If the island and river banks deviate from a common plane by more than ±1/4” the host must adjust the elevations of the island and river banks to within that tolerance using steel plates, plywood or other flat, solid materials. Before timed construction team captains may use a string line to verify that the river banks and island are sufficiently coplanar and may improve planarity with material they supply.

Only builders and judges are permitted in the construction site during timed construction. Only judges are permitted near the construction site; coaches, managers and other spectators must observe from a safe distance that does not obstruct judges.

E. Start

Before construction begins, all of the following items, and nothing else, are in the staging yards: rigid members, cables with fittings, fasteners, tools and builders except for the barge. If a builder has been designated to be the barge, that builder and nothing else will be in the river. Builders will be wearing hardhats and safety glasses or goggles, as well as optional clothing such as pouches. Rigid members, cables with fittings, tools and fasteners must be on the ground. Rigid members and cables with fittings must not be connected nor in contact with one another. Each cable with fittings must be coiled to an approximate diameter of 6”. Tools and fasteners must not be in contact with rigid members or with cables with fittings.

During timed construction, no additional rigid members, cables with fittings, fasteners, tools or builders may be brought into the construction site nor may anything be removed from the construction site.

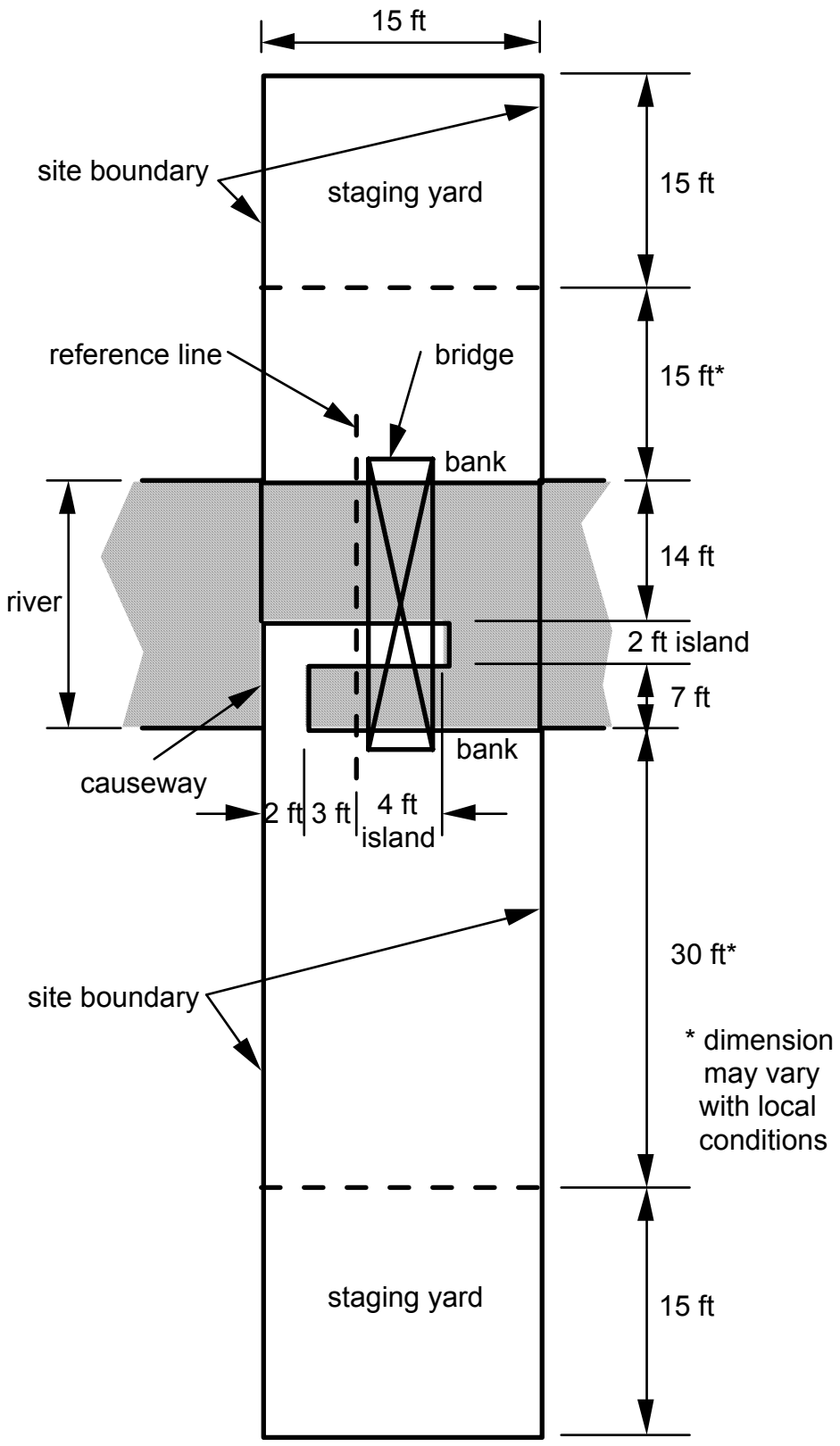
Timing and construction begin when the builders signify that they are ready and the judge declares the start.

F. Time

Time is kept from start to finish of construction. The clock will be stopped:

1. if a builder or judge sees a condition that could cause injury, or

2. when a safety regulation has been violated or work has been accomplished by committing an “accident.” See sections X.A and G.


15 ft
site boundary
staging yard
15 ft
15 ft*
reference line
bridge
bank
14 ft
river
2 ft island
7 ft
bank
causeway
2 ft
3 ft
4 ft
island
30 ft*
site boundary
* dimension
may vary
with local
conditions
staging yard
15 ft

Site Plan

Construction ceases while the clock is stopped. The clock is restarted after the situation has been corrected.

G. Accidents

In general, the clock is not stopped when an "accident" occurs. If an accident is continuous (for example, a builder stands in the river) it will be counted as multiple incidents. Builders involved in accidents may continue to build, and components involved in accidents may be recovered and 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 resuming timed construction, the builders, tools, rigid members, cables with fittings and fasteners will be returned to the positions they occupied before the accident.

Types of accidents and the corresponding time penalties, which will be added to the construction time, are:

1. A builder throws something. Penalty is one minute (60 seconds) per incident. Also see paragraph X.A.2.

2. A builder, other than the one designated as a barge, touches the river. Penalty is 1/2 minute (30 seconds) per incident. Exception: Builders may step in the river without penalty to retrieve a dropped member, tool, nut, bolt or hardhat.

3. The builder designated as the barge (if there is one) touches the river bank, island or causeway. Penalty is 1/2 minute (30 seconds) per incident.

4. The builder designated as the barge crosses the island or causeway, for example by stepping or jumping across. Penalty is 1/2 minute (30 seconds) per incident.

5. A rigid member, cable with fittings or portion of the bridge touches the river or the ground outside a staging yard. Penalty is 1/3 minute (20 seconds) per incident. Exception: No penalty is assessed when the ground is touched by the bottom of a bearing plate that will bear on the island or river bank when the bridge is completed. Also see paragraph VIII.B.7.

6. A tool, nut, bolt or hardhat touches the river or the ground outside a staging yard. Penalty is 1/6 minute (10 seconds) per incident. Exception: a tool used exclusively for measuring may touch the ground during use while being held by a builder.

7. A builder steps outside the boundary of the construction site. Penalty is 1/6 minute (10 seconds) per incident.

H. Finish

Construction ends when the bridge has been completed by connecting all the rigid members and cables with fittings, all tools and builders are back in the staging yards (except the barge, which remains in the river), and the builders signify that they are finished. Installation of decking is not included in timed construction.

After construction is finished the bridge may not be modified except as provided by section "X.I Construction: Repairs."

I. Repairs

Before the judges inspect and measure the bridge and before the bridge is moved from the construction site, the builders will be given the opportunity to examine the bridge for construction mistakes. The team will be permitted, but not required, to repair these mistakes. Repairs are made with the clock restarted. Safety precautions (section X.A) apply and accidents (section X.G) are counted. The time required to make repairs is multiplied by 1.5 and added to the original construction time. Violations of sections VIII and IX will not be penalized if they have been repaired successfully.

XI. LOAD TESTS

A. Safety Precautions

The judge will halt any activity that is hazardous.

A bridge could suddenly collapse or sway in any direction during load tests. Therefore, minimize the number of people near the bridge while it is being tested. Usually, the load may be placed on the bridge by only two competitors.

While participating in load testing, **competitors must wear hardhats, safety glasses or goggles, gloves and leather construction boots**. This safety equipment is provided by the competitors. Similar equipment is recommended for judges who will be near the bridge during load testing.

During testing, safety supports must be in place below the bottom of the decking. The safety supports should be of sufficient height, strength, number and extent that none of the load will fall more than four inches if the bridge collapses.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a portion of the decking that is cantilevered laterally over its support.

When any portion of the load is on the bridge, no one is permitted to crawl, reach or step under the bridge. If such an action is necessary, the load must first be removed.

B. Damage

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

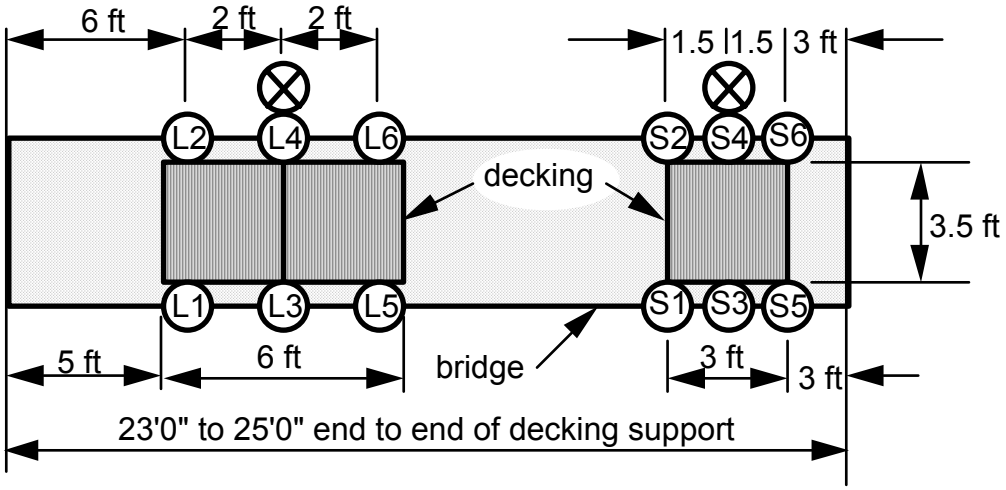
If a nut falls off its bolt while the bridge is being transported or prepared for load testing, the connection will be repaired, the nut will be replaced (finger tight) and a penalty of 2 minutes will be added to construction time.

A bridge with irreparable damage that would reduce its strength or stability (such as a broken part) will be **disqualified** and will not be load tested.

C. Preparation

The floor surfaces on which the bridges will bear should lie in a common plane. If the floor is not flat to within ±1/4", adjust the elevations of the island and river banks to within that tolerance with steel plates or steel shims under the bearing plates of the bridge. If a team requires a closer tolerance they are permitted to make finer adjustments using steel plates, sheets or shims that they provide. Plates, sheets or shims may not be used to compensate for imprecise construction or fabrication of the bridge.

Sway is translation in any horizontal direction. Two targets are established for sway measurements: one is near the center of the longer span, and the other is near the center of the shorter span as illustrated in the figure titled "Location of Targets and Decking". Sway targets are on the side of the bridge determined at the beginning of the competition (section "VII Schedule of Competition").



L1 through L6 and S1 through S6 are possible locations for vertical deflection targets. Only one L and one S are used (section VII).

⊗ targets for measuring sway

Location of Targets and Decking (Plan)

Two targets are established for measuring vertical deflection. One target is at one of the locations L1 through L6 on the longer span; the other target is at one of the locations S1 through S6 on the shorter span as illustrated in the figure titled "Location of Targets and Decking". These locations were determined at the beginning of the competition (section "VII Schedule of Competition"). Vertical deflection targets are located at the level of the top of the decking support, which is the same as the bottom of the decking. Targets may be on the decking or on the decking support.

At their discretion judges may impose a penalty for a bridge that incorporates parts having the primary function of interfering with placement of targets or measuring equipment.

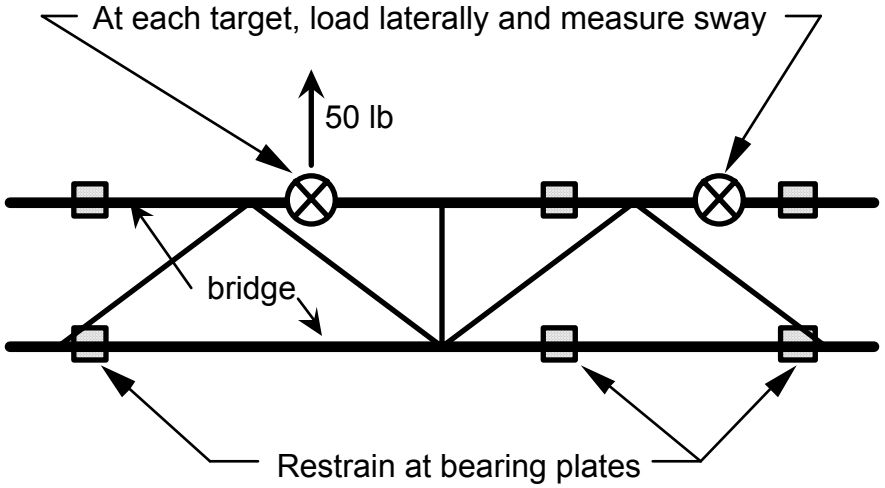
Teams must accept imperfect field conditions such as bent decking.

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

A BRIDGE THAT COLLAPSES DURING LOADING, DEFLECTION MEASUREMENTS OR UNLOADING MUST BE DISQUALIFIED.

D. Load Test 1 - Lateral

Load test 1 is conducted without decking but with restraint at the bearing plates to prevent the bridge from sliding or tipping. As shown in the figure titled "Load Test 1," apply a 50 pound lateral force at one of the sway targets (and on the same side), and measure the sway. Repeat the process at the other sway target. To pass load test 1, the sway must not exceed 1.0" at either sway target. If the bridge does not pass load test 1 it is disqualified; do not conduct any other load test. Remove the lateral load; it is not part of the remaining load tests.



Load Test 1 (Plan)

E. Load Test 2 - Shorter Span

Place two units of decking near the center of the longer span and extending 6 feet in the span direction. Place one unit of decking near the center of the shorter span. Decking locations are illustrated in the figure titled "Location of Targets and Decking."

Position measuring devices on the two vertical deflection targets.

Uniformly distribute 500 pounds of load on the unit of decking closest to the end of the longer span. The purpose of this load is to minimize uplift of that end of the bridge. The deflection caused by this load is not measured.

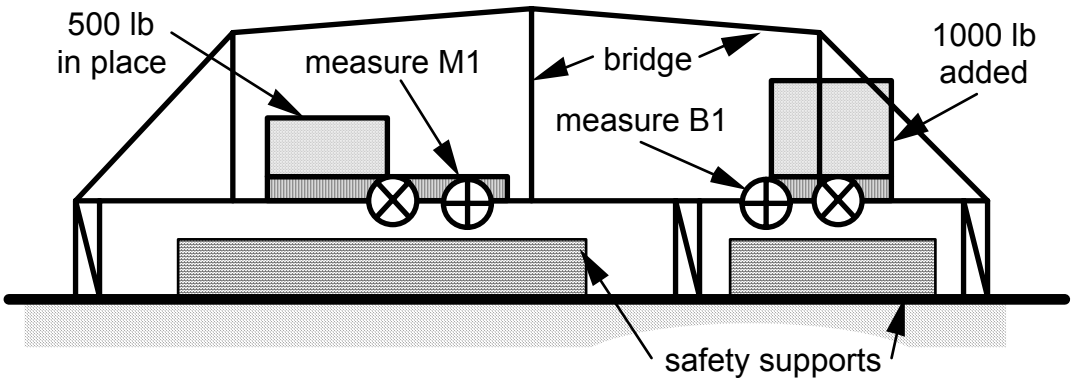
If deflection targets are on the decking rather that on the decking support, clamp the decking to the decking support at the targets to assure contact during initialization of measurements.

Either initialize the measuring devices to zero or record the initial readings. If the decking was clamped to the decking support, remove the clamp on the shorter span after initialization.

Uniformly distribute load on the unit of decking on the shorter span, as shown in the figure titled "Load Test 2."

As the 1000 pound load is being placed on the shorter span, observe sway and deflection. Stop loading and disqualify the bridge if

a. sway at either sway target exceeds 1/2 inch, or
b. vertical deflection at either deflection target exceeds 2 inches, or
c. any part of the bridge, other than its bearing plates, comes to bear on the floor, or
d. the decking falls off the decking support.



Load Test 2 (Side View)

If the 1000 pounds of load (in addition to decking) was successfully placed on the shorter span without exceeding sway or deflection limits, record the following measurements:

B1 = absolute value of the vertical distance of the deflection target on the shorter span from its position before any load was placed on the shorter span.

M1 = absolute value of the vertical distance of the deflection target on the longer span from its position before any load was placed on the shorter span.

If a sway or deflection limit was exceeded, remove all load and disqualify the bridge. Do not proceed to the next test.

In preparation for the next load test, record the vertical deflection at the target on the long span.

F. Load Test 3 - Longer Span

If the decking was clamped to the decking support, remove the clamp on the longer span.

With the 500 pound load remaining in place on the longer span and the 1000 pound load remaining in place on the shorter span, uniformly distribute additional load over the units of decking on the longer span as shown in the figure titled “Load Test 3.”

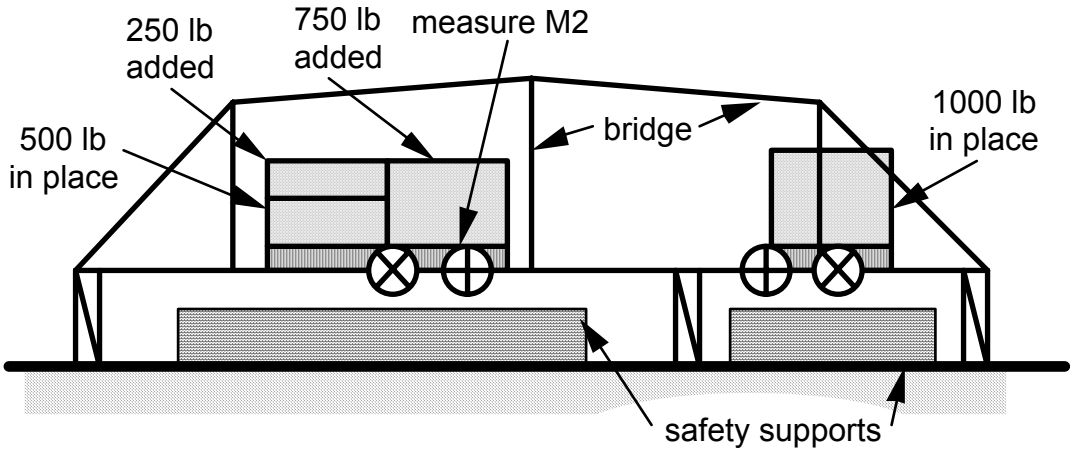
As the load is being placed, observe sway and deflection. Stop loading and disqualify the bridge if

a. sway at either sway target exceeds 1/2 inch measured from the position at the beginning of load test 2, or

b. vertical deflection at either deflection target exceeds 2 inches measured from the position at the beginning of load test 2, or

c. any part of the bridge, other than its bearing plates, comes to bear on the floor, or

d. the decking falls off the decking support.



Load Test 3 (Side View)

If the additional 1000 pounds of load (in addition to decking) was successfully placed on the longer span without exceeding sway or deflection limits, record the following measurement:

M2 = absolute value of the vertical distance of the deflection target on the longer span from its position at the end of load test 2 but before any of the additional 1000 pound load was placed on the longer span. That is, M2 measures deflection of the longer span that occurred during load test 3 while the additional load was being placed on the longer span.

If a sway or deflection limit was exceeded, remove all load and disqualify the bridge.

G. Unloading

The bridge must be disqualified if it collapses during unloading.

H. Computing Aggregate Deflection

Compute and record: Aggregate deflection = B1 + (5 x M1) + M2

XII. EQUIPMENT PROVIDED BY HOST

A complete list of hosting equipment appears in the *Guide for Hosts and Judges* which is distributed to host universities as a separate document. The following partial list is intended to help competitors know what to expect. Competitors should acquire similar equipment for use in practice and testing before the competition.

A. Lateral Load Device

Capable of applying 50 pound force in the horizontal direction.

B. Equipment for Measuring Sway

Sway is horizontal translation and is measured at two points by any accurate method. A suggested method is to suspend plumb bobs from the sway target points and measure sway from points marked on the ground.

C. Equipment for Measuring Deflection

Deflection is vertical translation and is measured at two points by any accurate method.

D. 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 2'11-3/4" x 1" and the weight is approximately 50 pounds. However, the host may provide a different type of decking with 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 of the grating that are perpendicular to the length.

E. Load

2500 pounds total. The load should be supplied in uniform pieces of size and weight that may 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.

F. Safety Supports

The safety supports must be used during load testing and are intended to limit the consequences of a bridge collapsing. The safety supports should be of sufficient height, strength, number and extent so that none of the load will fall more than four inches if the bridge collapses. Safety supports may be steel, timbers, sand bags or masonry units.

G. Floor

In both the construction site and loading area the surfaces on which the bridges will bear (river banks and island) should be as nearly co-planar as possible. If necessary, the host will build up parts of the floor with steel plates to reduce the deviation from plane to less than 1/4 inch.

XIII. INTERPRETATION OF RULES

Competitors, judges and host personnel who have questions are requested to consult web site http://www.aisc.org/steelbridge.html and to reread this *Rules* booklet carefully in its entirety. If questions remain unanswered, they may be submitted by e-mail to Mr. Fromy Rosenberg (rosenberg@aisc.org). Questions and answers will be posted on the web site.

XIV. JUDGING

The host 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, rating and disqualification are the sole responsibility of the judges and will be final. The host will assure that the judges are fully informed of the rules and procedures, and fully equipped for their tasks. The host and judges will follow directions in the *Guide for Hosts and Judges* provided by AISC.

XV. PROTESTS AND APPEALS

A. Before the Contest

Each team will designate a student as team captain. The host will identify the head judge.

B. During the Contest

A penalty, disqualification, measurement, score, or condition of competition may be protested only by a team captain and only to the head judge. The protest must be made as soon as possible after the situation becomes apparent. The head judge will not hear the protest if he or she is approached by students other than the team captain. As soon as possible after a protest is made, the head judge will interrupt the contest if necessary, gather the other judges and the captains of the teams involved, and hear the protest. The decision of the head judge is final.

Participants are reminded that civility and ethical behavior are expected during the contest and particularly concerning protests.

C. After the Regional Contest

If a team wants to appeal the decision of the head judge regarding a protest it may do so in an e-mail message to Mr. Fromy Rosenberg (rosenberg@aisc.org) followed by a letter mailed to Mr. Rosenberg (AISC, Suite 3100, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to ASCE Student Activities Coordinator (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The letter should include the name of the college or university making the appeal; the names, addresses and telephone numbers of the faculty adviser and one team member; brief description of

the problem, the action taken at the contest to deal with it, and the action that the appealing team feels should have been taken; and computation showing how the appealing team's rankings would have been improved if a different action had been taken.

Appeals must be made by e-mail followed by letter. An appeal will be considered only if both the e-mail and the letter are received within one week after the regional contest.

The only redress that may be made is an invitation to participate in the national competition if the Rules Committee is convinced that the appeal is valid and that the appealing team should have qualified. Decisions and rankings made by regional judges will not be overturned.

D. After the National Contest

Appeals will not be accepted. However, AISC welcomes written suggestions for improving future competitions.

XVI. TIPS FOR COMPETITORS

1. Strive for challenging but realistic goals for design and construction. The following statistics from the 2002 National Student Steel Bridge Competition suggest the levels of performance that are possible. However, when reviewing these statistics keep in mind that the rules and scoring for 2003 differ from those for 2002.

	Winning bridge in category	Winning bridge, overall
Weight (pounds)	114	158
Construction time (minutes)	1.47	2.45
Aggregate deflection (inches)	0.81	1.54

2. Start work on the design early, leaving adequate time to procure materials, fabricate the bridge, load test it and practice construction.

3. Design a bridge that may be fabricated, erected and load tested safely, using available materials, tools and facilities.

4. Structural analysis may fail to disclose instability, such as buckling of slender compression members, sway, and torsion of under-deck trusses of triangular cross-section.

5. Design a bridge that accommodates imperfect field conditions such as uneven floor, non-standard load, and non-standard or bent decking.

6. Allow tolerances for all limiting dimensions in order to accommodate imprecise measurement, fabrication, thermal expansion, elastic and inelastic deformation, wear, etc. For example, if a bridge is required to provide at least 12

inches of clearance, and it is designed to provide exactly that clearance, then there is a high probability that the actual as-built clearance will be less than the specified minimum, resulting in a penalty. That probability of error may be reduced by designing the bridge to provide more than the required minimum clearance.

7. When fabricating your bridge, use safe tools, operate them carefully and with adequate supervision.

8. Follow all safety regulations and guidelines during construction practice and loading.

9. When practicing construction, wear hardhats and safety glasses or goggles both for safety and to accustom yourself to contest conditions.

10. It is strongly recommended that bridges be load tested before competition, if it can be done safely, so that weaknesses and instability can be corrected.

11. When load testing your bridge use safety supports under the decking, sufficient in height, strength, number and extent to minimize the distance the load will drop if the bridge collapses. This will reduce risk of injury and limit damage to the bridge if it collapses. Keep hands and feet out from under the bridge.

12. When load testing your bridge wear hardhats, safety glasses or goggles, gloves and leather construction boots.

13. Don't stand, sit or lie on your bridge.

14. To expedite the competition have a preset plan for unloading and staging components of your bridge.

15. The island and river banks at the contest should be within 1/4 inch of co-planar. If your bridge will be adversely affected by larger deviations from planarity you should take some thin steel sheets to the contest to help with fine adjustments.

16. When packing for the competition, remember to bring hardhats, safety glasses or goggles, gloves and construction boots.

XVII. SCORE SHEET

A. Construction Speed and Time Penalties

Clock time = _____ minutes

Repair time, see "X.I Construction: Repairs"
_____ x 1.5 = + _____ minutes

Time penalties, see "X.G Construction: Accidents"
item 1: violations _____ x 1 = + _____ minutes
items 2,3,4: violations _____ x 1/2 = + ____ minutes
item 5: violations _____ x 1/3 = + ____ minutes
items 6,7: violations _____ x 1/6 = + ____ minutes

Time penalty, see "XI.B Load Tests: Damage" + _____ minutes

CONSTRUCTION TIME (add) = _____ minutes
Lowest time wins.

B. Lightness and Weight Penalties

Bridge weight = pounds

Weight penalties, see "VIII.B Dimensions and Support: Usability"
Number violations = 1 inch _____ x 100 pounds = + _____ pounds
Number violations 1 - 2 inch ____ x 300 pounds = + _____ pounds
Number violations 2 - 3 inch ____ x 600 pounds = + _____ pounds

See "IX.B Material & Components: Durability & Constructability"
Number of violations _____ x 10 pounds = + _____ pounds
Wt. of parts in violation _____ pounds x 5 = + _____ pounds

TOTAL WEIGHT (add) = _____ pounds
Lowest weight wins.

C. Aesthetics

Full name of college or university appears on bridge or on attached banner or placard in letters at least 2 inches high.

Poster describing design and fabrication, no larger than 2 x 3 feet.

Other items that may be considered:

General appearance	Finish
Balance and proportion	Elegance

Judges should not declare ties in aesthetics

AESTHETICS SCORE = _____

D. Stiffness

AGGREGATE DEFLECTION: B1 + (5 x M1) + M2 = _____ inches
Lowest deflection wins.

E. Construction Economy

Number builders _____ x Const. Time (part A) _____ x 100 = _____ thousand $

C_c = CONSTRUCTION COST = _____ thousand $
Lowest cost wins.

F. Structural Efficiency

W = larger of total weight (part B) or 100 = _____ pounds

Δ = larger of aggregate deflection (part D) or 1.00 = x _____ inches

D = larger of (maximum height - 18) or
(18 - minimum clearance) or 24 = x _____ inches

C_s = STRUCTURAL COST (multiply) = _____ thousand $
Lowest cost wins.

G. Overall Performance

C_c (from part E) _____ + C_s (from part F) _____ = _____
Lowest total wins.

H. Ranks

Disqualified bridges will not be ranked.

Aesthetics is the tie-breaker for all categories

Construction Speed _____ Lightness _____

Aesthetics _____ Stiffness _____

Construction Economy _____ Structural Efficiency _

Overall Performance _____

_____
This Score Sheet implements section "VI Scoring."

RULES

AISC STUDENT STEEL BRIDGE

COMPETITION

2002

31 July 2001

TABLE OF CONTENTS

I. INTRODUCTION

The Student Steel Bridge Competition is sponsored by the American Institute of Steel Construction and co-sponsored by the American Society of Civil Engineers, the American Iron and Steel Institute, the James F. Lincoln Arc Welding Foundation, the National Steel Bridge Alliance, Nucor Corporation and Chaparral Steel. This inter-collegiate challenge requires Civil Engineering students to design, fabricate and construct a steel bridge.

Safety is of primary importance. The AISC requests that competitors, hosts and judges take all necessary precautions to prevent injury.

The competition rules, particularly the scoring, have been changed for 2002 in order to improve the contest and assure that competitors design and build new bridges.

Students design the bridge themselves but may seek advice from faculty and other consultants.

Ideally, students should fabricate the entire bridge themselves. However, appropriate shop facilities and supervision may not be available at every college and university. Therefore, the services of a commercial fabricator may be used provided that students observe the operations. Students are encouraged to maximize their personal involvement in fabricating their bridge.

There are two levels of competition: regional and national. These *Rules* govern competition at both regional and national levels. Regional competitions are held in conjunction with ASCE regional conferences. Winners and first runners-up from most regions are invited to compete at the national level. However, invitations are extended only to the winner from a region with two, three or four participating universities, and to the top three teams from a region with eleven or more participating universities. A university may enter more than one bridge in regional competition but only the best one may qualify for national competition.

This booklet describes the contest and states the official rules for this year. It is distributed to universities throughout the country. A companion booklet, *Guide for Hosts and Judges*, is distributed to hosts and provides directions for conducting a competition.

The rules are intended to be prescriptive but may require some interpretation. The procedure for requesting clarification of the rules is described in section “XII Interpretation of Rules” (**p. 21**).

The ASCE student chapters and clubs entering the contest are required to be current with their national dues. Teams may consist only of undergraduate and graduate students in good standing with their ASCE chapter or club.

II. EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication and construction. Participating students gain practical experience in structural design, fabrication processes, construction planning, organization and teamwork.

The "Problem Statement" describes challenges encountered in a representative structural engineering project. The competition is a scaled simulation of that project.

Standards for strength, durability, constructability, usability, functionality and safety reflect the volumes of regulations that govern the design and construction of full-scale bridges. Criteria for excellence are represented by the award categories of stiffness, lightness, construction speed, aesthetics, efficiency and economy. As with a full-scale construction project, safety is the primary concern.

The rules of the competition accommodate a large 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.

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

III. RULE CHANGES

The following list covers some of the major changes from the 2001 rules. Minor changes are not listed. Contestants and judges are cautioned to read this entire *Rules* booklet carefully and disregard rules from previous years.

1. Overall performance score is C_c+C_s rather than C_cC_s.
2. Computation of construction cost C_c.
3. Locations where deflection will be measured.
4. Span and envelope dimensions.
5. Height of deck.
6. Definition of "fastener" and requirement for connections.
7. Smaller maximum length of member.
8. Temporary members are eliminated.

IV. PROBLEM STATEMENT

The main span of a century-old bridge that crosses a navigable river must be replaced. The bridge carries truck traffic serving the farms and agricultural processing industries that are the basis for the economy of this rural region, as well as providing access and emergency services to residences. A quick replacement is necessary because no other river crossing is available for miles.

The State Department of Transportation has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered but the State DOT has specified steel as the material because of its durability and fast erection. The bridge must provide clearance for recreational navigation on the river and for access roads along the river banks. The bridge must be able to carry specified patterns of loads without exceeding sway and deflection limits. Based on past experience with performance and maintenance, the DOT prefers bridges that are relatively light and stiff, with low profiles. The new bridge must accommodate modular decking, which the DOT salvaged from another bridge. Decking units may not be modified.

Flood control and environmental concerns prohibit permanent piers in the river although a temporary pier would be allowed to facilitate construction. Soil conditions restrict the weight that may be lifted by cranes.

Your company's design/build proposal is among those that the State DOT has deemed responsive. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. The DOT will evaluate the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy and aesthetics. The contract will be awarded to the company that submits the best model. This is an opportunity to become leaders in the bridge replacement market.

V. SAFETY

Safety has the highest priority. Judges are empowered to halt any activity that they deem hazardous. Judges are directed to disqualify bridges that cannot be safely constructed or load tested using the equipment provided by the host, as described in this booklet. Collapse, sway or deflection in excess of limits specified in this booklet is incontrovertible evidence of an unsafe bridge and will result in disqualification. A disqualified bridge is not eligible for awards in any category and must be withdrawn from all subsequent participation in the contest.

VI. SCORING

A university may enter several bridges in a regional competition. However, only the best one of that university's bridges may be invited to participate in the national contest.

Categories of competition are construction speed, lightness, aesthetics, stiffness, construction economy, and structural efficiency. In addition, overall performance is rated. Bridges that have been disqualified are not eligible for awards in any categories.

A. Construction Speed

The bridge with the lowest construction time will win in this category. Construction time is the clock time required to assemble the bridge, regardless of number of builders, plus time penalties prescribed in sections “IX.I Construction: Accidents” (**p. 14**) and “X.B Load Tests: Repairs” (**p. 16**).

B. Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in sections “VII.B Dimensions and Support: Usability” (**p. 6**) and “VIII.B Material and Components: Durability and Constructability” (**p. 9**). Decking, tools and the temporary pier are not included in total weight.

C. Aesthetics

The full name of the college or university must appear on the bridge or on a banner or placard attached to the bridge, in letters at least 2 inches high. The banner or placard is included in total weight but need not be installed during timed construction. It should be in place on the bridge during aesthetics judging and at other times when the bridge is on display.

In addition to the college or university name, other factors that may be considered include general appearance, balance and proportion of the design, elegance, and finish. Quality of fabrication should not be considered because some bridges may be fabricated professionally while others are student work.

Every team entering the national competition must prepare a 2 x 3 foot poster illustrating and briefly describing design and fabrication processes. The poster should be designed to be displayed within the floor area occupied by the bridge.

Aesthetics is the tie-breaker for overall performance and for all other categories of competition. Judges should not declare ties in aesthetics.

D. Stiffness

The bridge with the lowest aggregate deflection will win in the stiffness category. Aggregate deflection is determined from measurements as prescribed in section "X Load Tests" (**p. 15**).

E. 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 = Construction time (minutes, including penalties)
x Number of builders (persons) x 30 (thousand $ / person-minute)
+ 200 (thousand $) if a temporary pier is used.

The number of builders includes all participants who are within the construction site at any time during timed construction.

F. Structural Efficiency

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

$C_s = W \times \Delta \times D$, where

W = the larger of total weight OR 100 pounds.
Δ = the larger of aggregate deflection OR 1.000 inch.
D = maximum height of the bridge minus minimum clearance.

Total weight is the weight of the bridge plus weight penalties prescribed in sections "VII.B Dimensions and Support: Usability" (**p. 6**) and "VIII.B Material and Components: Durability and Constructability" (**p. 9**). Decking, tools and the temporary pier are not included in total weight.

Aggregate deflection is determined from measurements as prescribed in section "X Load Tests" (**p. 15**).

Maximum height of the bridge is the vertical distance from the ground or river surface to the highest point on the bridge structure (not including decking).

Minimum clearance is the smallest of the following three quantities: 1'6" OR vertical distance from the river surface to the lowest point on the bridge structure over the navigation passage OR vertical distance from the ground surface to the lowest point on the bridge structure over the access roads.

G. 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.

VII. DIMENSIONS AND SUPPORT

Dimensions and support will be checked with the bridge in its as-built condition after construction is completed and before the bridge is moved from the construction site. The bridge may not be modified nor distorted from its as-built condition in order to satisfy dimension and support rules. Dimensions will be checked without decking or other load on the bridge.

A. Functionality and Safety

If any of the following regulations is violated, the bridge must be **disqualified**. The figures titled "Spans and Clearance" (**p. 8**) and "Deck Support, Roadway and Bearing" (**p. 8**) illustrate some of the requirements. The first and second regulations will be verified by sliding a piece of decking or an equivalent template along the full overall end-to-end length of the bridge.

1. The bridge must provide continuous rigid support for the decking along both of the edges that run in the longitudinal direction of the bridge. The support must be continuous and rigid for the overall length of the bridge. Also see paragraph VII.B.12 (**p. 7**).

2. The bridge must provide access for placing the decking and load. Although decking is nominally 3'6" wide and 1 inch thick, actual widths range from 3'5.75" to 3'6.25" and thickness may be as large as 1.25 inches. Also see paragraph VII.B.8 (**p. 7**).

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

4. The bridge may not be anchored nor tied to the ground.

B. Usability

A penalty will be assessed for each rule that is violated, rather than for every violation of that rule. The figures titled "Spans and Clearance" (**p. 8**) and "Deck Support, Roadway and Bearing" (**p. 8**) illustrate some of the requirements.

The penalty for violation for each of the following rules will be an addition to the weight of the bridge determined as follows: 200 pounds for a dimensional violation of 1.0 inch or less; 400 pounds for a dimensional violation greater than 1.0 inch but not exceeding 2.0 inches; 600 pounds for a dimensional violation greater than 2.0 inches but not exceeding 3.0 inches.

The bridge must be **disqualified** if a dimensional violation exceeds 3.0 inches.

1. The bridge must span the river, which is 12'0" feet wide, without touching it. No part or accessory of the completed bridge may touch the river.

2. A rectangular navigation passage must be provided under the bridge. The navigation passage must be at least 1’6” high, measured from the surface of the river, and it must be at least 10’0” wide. The entire width of the navigation passage must be located within the width of the river.

3. The bridge may bear on the ground only within the margins bounded by the edges of the river and abutment limits, which are lines on the ground parallel to and located 9 inches from the edges of the river.

4. At each point where it bears on the ground the bridge will include a solid bearing plate at least 1/4 inch thick, 2 inches long and 2 inches wide. Bearing plates must be smooth and flat on the bottom. Bearing plates are part of the bridge.

5. On each side of the river the bridge must bear on the ground over a width of at least 3’6” measured from the outside edges of the bearing plates. Bearing is not required to be continuous over that width.

6. The ends of the bridge must be at least 4’0” beyond the abutment limits.

7. At each end of the bridge there must be clearance for an access road running along the bank of the river. This clearance must completely traverse the width of the bridge; it must be at least 1’6” high measured from the surface of the ground; it must extend from the abutment limit to the end of the bridge.

8. A vehicle passageway at least 3’0” wide must completely traverse the bridge from end to end, and must extend upward from the decking through the top of the bridge. Also see paragraph VII.A.2 (**p. 6**).

9. No part of the bridge may extend more than 4'0" above the ground or river surface, which have the same elevation.

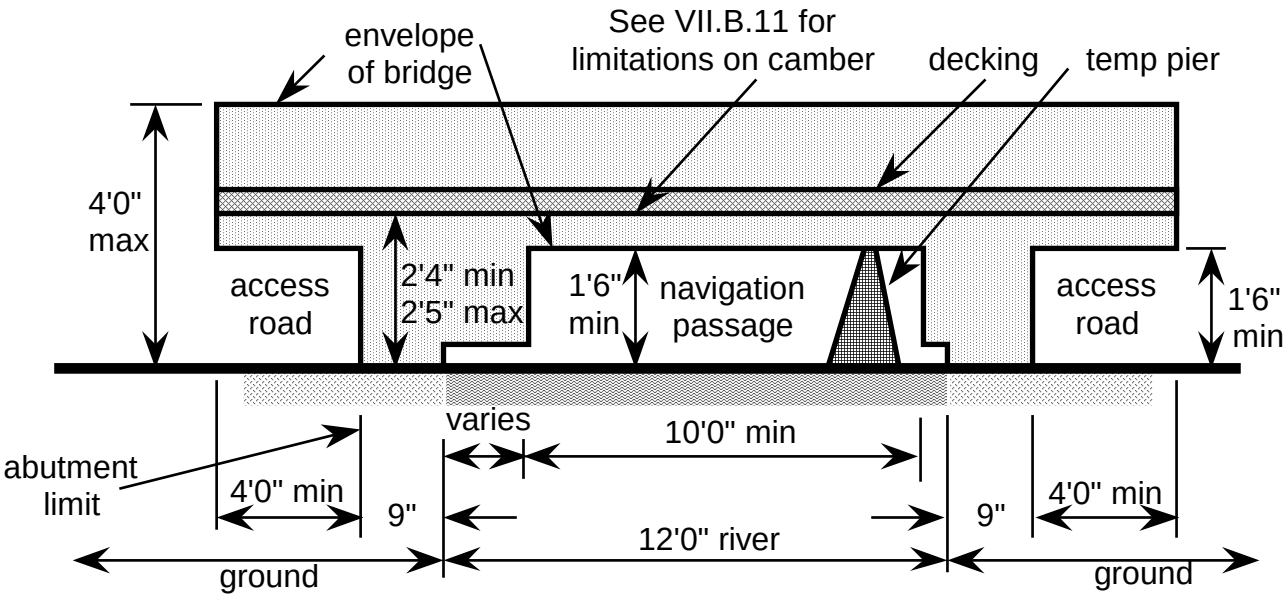
10. The top surface of the decking supports must be between 2’4” and 2’5” above the surface of the ground at points over centers of the bearing plates.

11. At other points the top surface of the decking supports must be between 2’2” and 2’7” above the surface of the ground and river. That is, the bridge may be cambered.

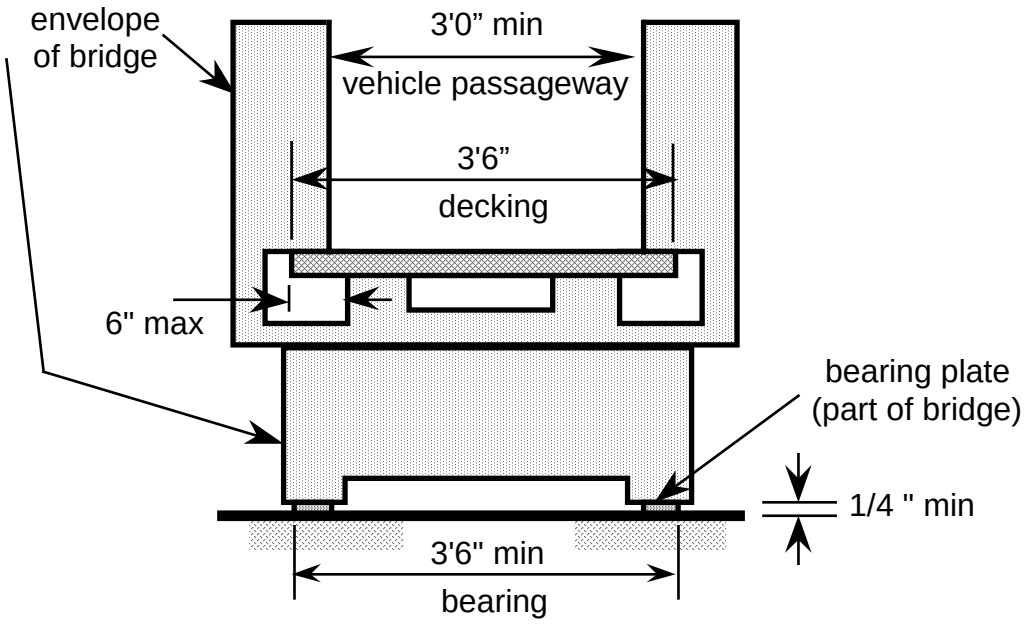
12. Decking must be supported without overlaps, gaps, abrupt elevation differences or protrusions exceeding 1/4 inch. Also see paragraph VII.A.1 (**p. 6**).

13. The edges of the decking that run in the longitudinal direction of the bridge may be cantilevered over their supports no more than 6 inches on each side.

14. A temporary pier, if used, may not exceed overall dimensions of 4’0” (horizontal) x 4’0” (horizontal) x 2’0” (vertical). That is, it must fit in a three-dimensional prismatic box of those dimensions.



Spans and Clearance (Side View)



Deck Support, Roadway and Bearing (End View)

Hollow circular and oval tube and other curvilinear closed shapes

Fabricated sections including closed curvilinear components

Example Unacceptable Member Cross-Sections

VIII. MATERIAL AND COMPONENTS

A. Safety

If either of the following regulations is violated, the bridge must be **disqualified**.

1. A bridge member may not weigh more than 40 pounds. See section VIII.B (**p. 9**) for definition of "bridge member."

2. A temporary pier, if used, must not weigh more than 40 pounds, and it must be made primarily of steel and/or wood. See section IX.D (**p. 13**) for definition of "temporary pier."

B. Durability and Constructability

Violation the following rules will result in weight penalties being added to the weight of the bridge. The penalty for each violation is 10 pounds plus 5 times the weight of the non-conforming components.

1. A bridge may be constructed only of structural steel. For the purposes of this contest, structural steel is defined as an iron alloy that is strongly attracted to a magnet. Exceptions: Paint, banners, placards and other purely decorative items.

2. A bridge may be constructed only of components conforming to the following definitions of bridge members and fasteners.

   a. A bridge member is a rigid component that retains its shape, dimensions and rigidity.

   b. A fastener consists of one steel bolt and at least one matching solid steel nut. The bolt and nut may not be attached to a member or to one another before the start of timed construction.

3. A bridge member may not have a cross-section that is both closed (hollow) and curvilinear. For example, a bridge member may not be fabricated from pipe, conduit, circular tube or oval tube. The figure titled "Example Unacceptable Member Cross-Sections" (**p. 8**) shows examples of unacceptable cross-sections. Exception: washers, bushings and similar short sections pertaining to connections.

4. A bridge member may not exceed overall dimensions of 3'6" x 6" x 6." That is, it must fit in a prismatic box of those dimensions.

5. A bridge member must be rigid. That is, hinged, jointed, articulated and telescoping members are prohibited, as are those parts that move during construction. This prohibition includes members with parts that are intended to slide, rotate, deflect or bend relative to the member during construction, such as cams, latches, sliding pins, springs, and snap-lock devices. Cables and strapping are prohibited, as are similar materials that would not be damaged by coiling and uncoiling.

6. A bridge member may consist of several parts rigidly joined together (e.g. welded, bolted, screwed) before timed construction begins. Those parts must remain rigidly joined throughout the construction process and in the completed bridge.

7. A bolt may not exceed 3.5 inches in overall length. It must be straight, threaded and have a hexagonal or square head suitable for external wrenching. Eye bolts are not permitted.

8. A nut may not exceed 2 inches in any linear dimension. It must be threaded internally to fit its bolt, and the threads must be continuous around the complete circumference of the hole in the nut. A nut may not have moving parts.

9. Each member must be connected to every other member that it touches by at least one fastener installed during timed construction so that the connection cannot be taken apart without first unscrewing a nut from the bolt. The bolt must penetrate completely through a hole in each of the members that it connects.

IX. CONSTRUCTION

A. Safety

If any of the following safety regulations is violated during timed construction, the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools and bridge components will be returned to the positions they occupied before the violation. Then the builders will be asked to resume construction using safe procedures. A bridge that cannot be constructed safely must be disqualified.

1. Builders must not be exposed to risk of personal injury.

2. Nothing may be thrown. Also see paragraph IX.I.1 (**p. 14**)

3. The temporary pier must not break nor collapse during construction.

4. Only tools that are hand-held during use are permitted. Field welding and tools requiring external power connections are prohibited. Tools may not be used to support or elevate builders.

5. All builders must wear hardhats and safety glasses or goggles during timed construction.

6. A builder may not use the bridge, a portion of the bridge, a tool or the temporary pier 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 bridge or temporary pier if the builder is kneeling on the ground or if the builder is standing with both feet flat on the ground (heels and toes of both feet touching the ground).

7. A builder may not depend on another builder or builders for support or balance.

8. A builder may not cross the river by jumping, by temporary scaffolding, by crossing the bridge, or by any other means.

9. Outside the staging yard, moving a portion of the bridge requires the effort of as many builders as there are members in that portion of the bridge. The term “portion of the bridge” includes, but is not limited to, single and multiple bridge members, bridge members that are connected together, and the entire bridge. The word “moving” includes, but is not limited to, lifting, carrying, lowering, rolling, turning, sliding and tipping, as well as causing translation and/or rotation of one portion of the bridge relative to another. Exception: small movement (maximum 3 inches) of a portion of the bridge by as few as one builder will be allowed as necessary to facilitate connections.

10. Outside the staging yard, any portion of the bridge that is not moving must either be supported by as many builders as there are bridge members in that portion of the bridge, or must be supported without the assistance of builders by any combination of the following: the portion itself, other portions of the bridge, and temporary pier.

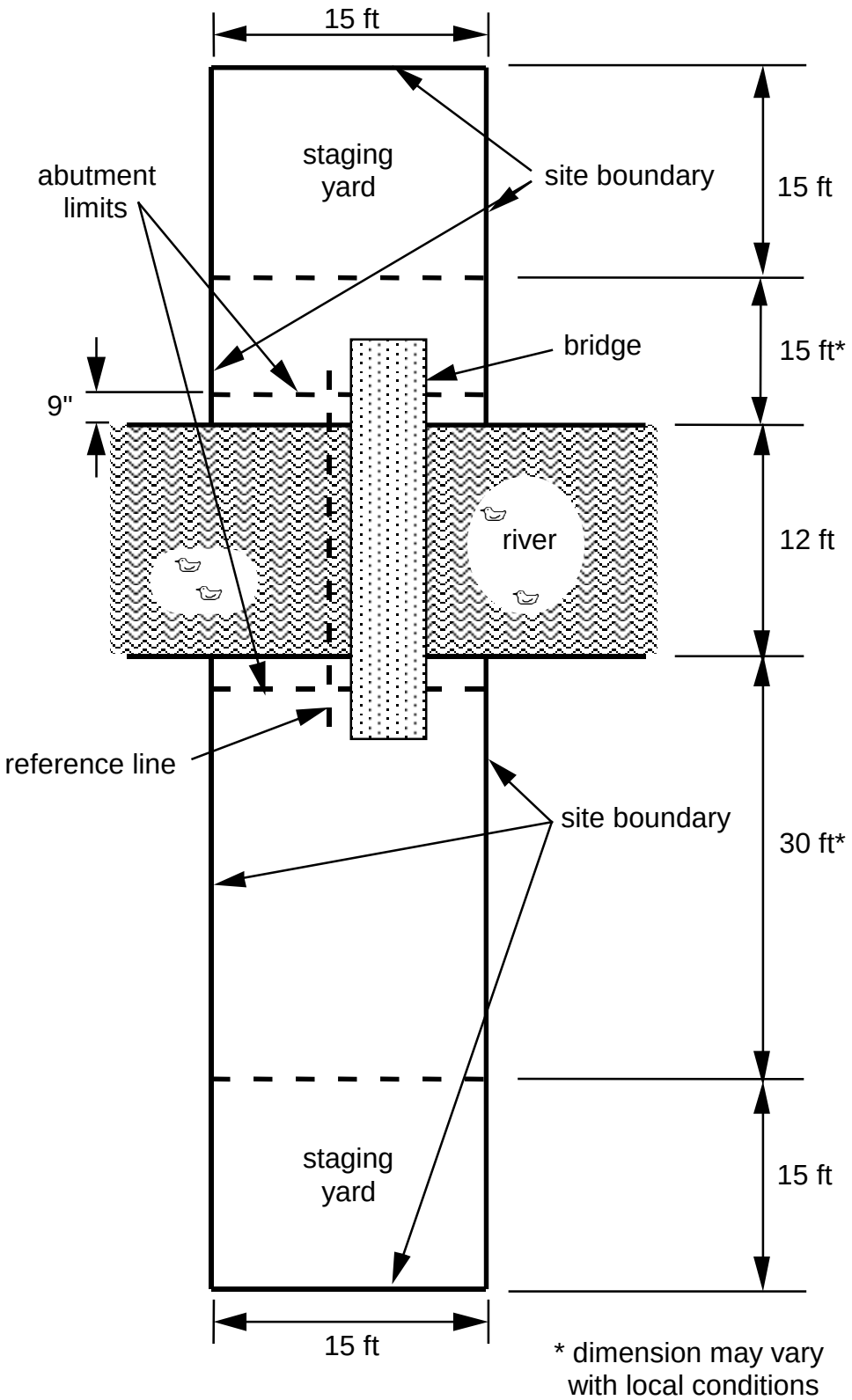
11. The temporary pier, if used, may not be moved by a builder who is also moving or supporting a portion of the bridge at the same time.

12. The temporary pier may be moved only twice during timed construction: first from the staging yard to a useful location, and then returned to the staging yard.

13. The temporary pier must be removed without lifting the bridge.

B. Team

Participation is limited to students (**p. 1**). The construction team, also referred to as builders, consists of all participants who are within the construction site at any time during timed construction. There can be no more than ten participants on the construction team.



Site Plan

C. Tools and Safety Equipment

Competitors provide their own tools, hardhats and safety glasses or goggles. See paragraphs IX.A.4 and .5 (**p. 10, 11**).

D. Temporary Pier

A temporary pier is a support in the river or on the ground, and is provided by the competitors. The use of a temporary pier is optional and adds to the cost of the bridge. Only one temporary pier is permitted. See sections VII.B (**p. 7**), VIII.A (**p. 9**) and IX.A (**p. 10,11**) for rules governing the temporary pier.

E. Construction Site

See the figure titled "Site Plan" (**p. 12**) for layout of the construction site. The reference line is provided to guide construction. It is perpendicular to the banks of the river and is located near the center of the construction site (the bridge is not required to be centered on the reference line).

Only builders and judges are permitted in the construction site during timed construction. Only judges are permitted near the construction site; coaches, managers and other spectators must observe from a safe distance that does not obstruct judges.

F. Start

Before construction begins, all of the following items, and nothing else, are in the staging yards: bridge members, fasteners, tools, the temporary pier (if used) and builders. Builders will be wearing hardhats and safety glasses or goggles, as well as optional clothing such as pouches. Bridge members, tools and fasteners must be on the ground. Bridge members must not be connected nor in contact with one another. Tools and fasteners must not be in contact with bridge members.

During timed construction, no additional bridge members, fasteners, tools, piers or builders may be brought into the construction site, nor may anything be removed from the construction site.

Timing and construction begin when the builders signify that they are ready and the judge declares the start.

G. Time

Time is kept from the start to finish of construction. The clock will be stopped:

1. if a builder or judge sees a condition that could cause injury, or

2. when a safety regulation has been violated or work has been accomplished by committing and "accident." See sections IX.A (**p. 10 and 11**) and IX.I (**p. 14**).

Construction ceases while the clock is stopped. The clock is restarted after the situation has been corrected.

H. Finish

Construction ends when the bridge has been completed by connecting all the members, and all tools, the temporary pier (if used) and builders are back in the staging yards, and the builders signify that they are finished. Installation of decking is not included in timed construction.

After construction is finished the bridge may not be modified except as provided by section "X.B Load Tests: Repairs" (**p. 16**).

I. Accidents

In general, the clock is not stopped when an "accident" occurs. If an accident is continuous (for example, a builder stands in the river) it will be counted as multiple incidents. Builders involved in accidents may continue to build, and components involved in accidents may be recovered and 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 resuming timed construction, the builders, tools, members, temporary pier and fasteners will be returned to the positions they occupied before the accident.

Types of accidents and the corresponding time penalties, which will be added to the construction time, are:

1. A builder throws something. Penalty is one minute (60 seconds) per incident. Also see paragraph IX.A.2 (**p. 10**).

2. A builder touches the river. Penalty is 1/2 minute (30 seconds) per incident. Exception: Builders may step in the river without penalty to place or remove the temporary pier or to retrieve a dropped member, tool, nut, bolt or hardhat.

3. A portion of the bridge touches the river or the ground outside a staging yard. Penalty is 1/3 minute (20 seconds) per incident. Exception: No penalty is assessed when the ground is touched by the bottom of a bearing plate. Also see paragraph VII.B.4 (**p. 7**).

4. A tool, nut, bolt or hardhat touches the river or the ground outside a staging yard. Penalty is 1/6 minute (10 seconds) per incident. Exception: a tool used exclusively for measuring may touch the ground during use while being held by a builder.

5. A builder steps outside the boundary of the construction site. Penalty is 1/6 minute (10 seconds) per incident.

X. LOAD TESTS

A. Safety Precautions

The judge will halt any activity that is hazardous.

A bridge could suddenly collapse or sway in any direction during load tests. Therefore, minimize the number of people near the bridge while it is being tested. Usually, the load may be placed on the bridge by only two competitors.

While participating in load testing, **competitors must wear hardhats, safety glasses or goggles, gloves and leather construction boots**. This safety equipment is provided by the competitors. Similar equipment is recommended for judges who will be near the bridge during load testing.

During testing, safety supports must be in place below the bottom of the decking. The safety supports should be of sufficient height, strength, number and extent that none of the load will fall more than three inches if the bridge collapses. The safety support should extend beyond the end of the bridge to arrest the load if it slides off the overhanging span.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a portion of the decking that is cantilevered laterally over its support.

When any portion of the load is on the bridge, no one is permitted to crawl, reach or step under the bridge. If such an action is necessary, the load must first be removed.

B. Repairs

A bridge will not be tested in a condition that compromises its strength or stability. Therefore, prior to load testing, repairs may be made with the permission and supervision of a judge, according to the following provisions:

1. If a nut falls off its bolt while the bridge is being transported or prepared for load testing, the nut will be replaced (finger tight) and a penalty of 2 minutes (120 seconds) will be added to construction time.

2. Construction errors will be repaired but a time penalty will be assessed in an amount, to be determined by the judge, that will exceed the incremental time required for careful initial construction.

C. Preparation

The provisions of this section are illustrated by the figure titled “Location of Targets and Decking” (**p. 17**).

Position the bridge in convenient proximity to load testing equipment.

Load tests are conducted without the temporary pier.

Place shims under the bearing plates of the bridge as necessary to compensate for sloping and/or rough ground surface. Shims may not be used to compensate for imprecise construction or fabrication of the bridge.

By a random process, the judge selects a side of the bridge and an end of the bridge. In load test 1 the lateral load will be applied on the selected side. In load test 3 the weight will be applied on the selected end. Lateral and vertical deflection measurements will be made on the quadrant of the bridge defined by the selected side and end.

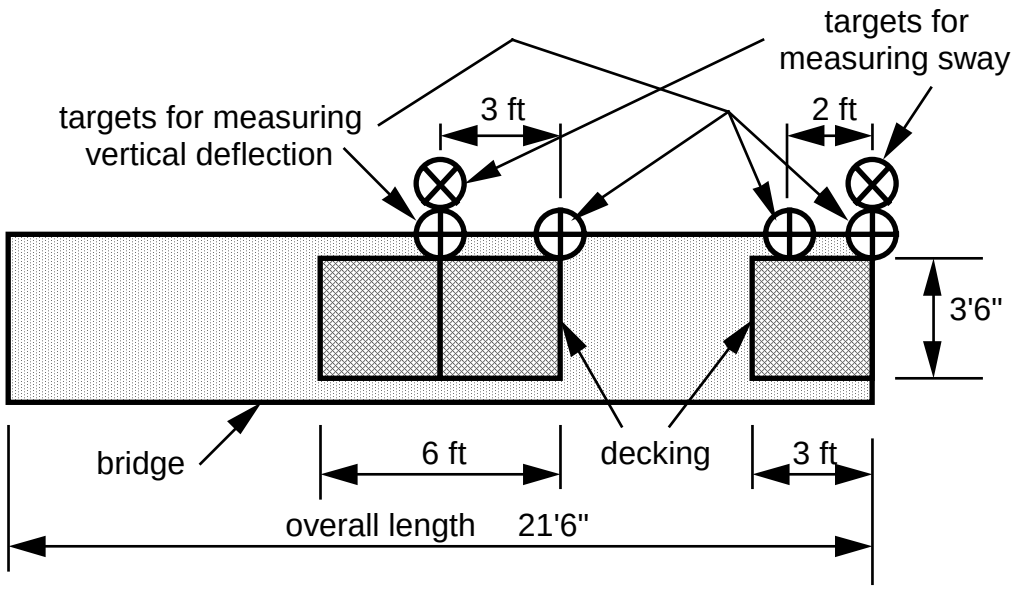
Safety supports are placed under the level of the decking so that no portion of the load will drop more than three inches if the bridge collapses. The safety support should extend beyond the end of the bridge that will be loaded.

Sway is translation in any horizontal direction. Two targets are established for sway measurements: one at the center of the span and the other at the end of the bridge. Both targets are located near the level of the decking.

Two targets are established for measuring vertical deflection of the central span. These targets are located at the level of the bottom of the decking where it is supported by the bridge, one at the center of the span and the other three feet from the center of the span.

Two targets are established for measuring vertical deflection of the cantilever span. These targets are located at the level of the bottom of the decking where it is supported by the bridge, one at the end of the bridge and the other two feet from the end.

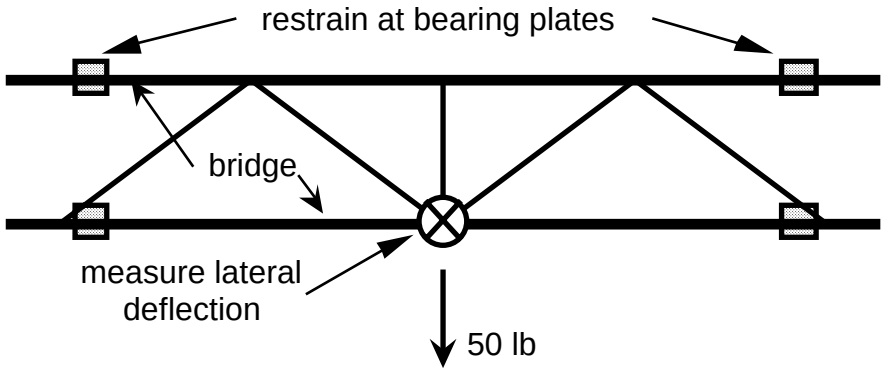
A BRIDGE THAT COLLAPSES DURING LOADING, DEFLECTION MEASUREMENTS OR UNLOADING MUST BE DISQUALIFIED.



Location of Targets and Decking (Plan)

D. Load Test 1 - Lateral

Load test 1 is conducted without decking but with restraint at the bearing plates to prevent the bridge from sliding or tipping. As shown in the figure titled “Load Test 1” (**p. 17**), apply a 50 pound lateral force as close as practical to midspan and to the level of the deck. To pass load test 1, the sway at midspan of the bridge must not exceed 1.0”. If the bridge does not pass load test 1 it is disqualified; do not conduct any other load test. Remove the lateral load; it is not part of the remaining load tests.



Load Test 1 (Plan)

E. Load Test 2 - Center Span

Place two units of decking symmetrically about the middle of the center span and extending 6 feet in the span direction. Place one unit of decking at the end of the bridge selected for loading.

Position measuring devices on the four targets for vertical deflection and either initialize to zero or record initial readings.

Uniformly distribute load on the two units of decking on the center span, as shown in the figure titled “Load Test 2” (**p. 18**).

As the load is being placed, observe sway and deflection. Stop loading and disqualify the bridge if

a. sway at the end exceeds 1/2 inch, or
b. sway at the center of the span exceeds 1 inch, or
c. vertical deflection at any deflection target exceeds 2 inches, or
d. any part of the bridge, other than its bearing plates, comes to bear on the ground.

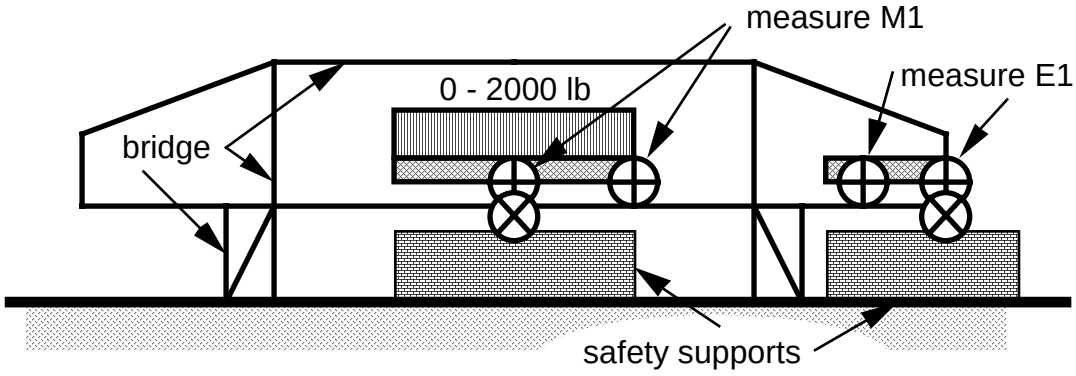
If 2000 pounds of load (in addition to decking) was successfully placed without exceeding sway or deflection limits, record the following measurements:

M1 = larger absolute value of the vertical distances of the two central span deflection targets from their positions before any portion of the load was placed.

E1 = larger absolute value of the vertical distances of the two cantilever span deflection targets from their positions before any portion of the load was placed.

If a sway or deflection limit was exceeded, remove all load and disqualify the bridge. Do not proceed to the next test.

In preparation for the next load test, record the vertical deflections at both targets on the cantilever span.



Load Test 2 (Side View)

F. Load Test 3 - Overhang

With the first 2000 pound load remaining in place on the center span, uniformly distribute additional load over the unit of decking on the overhanging end of the bridge, as shown in the figure titled “Load Test 3” (**p. 19**).

As the load is being placed, observe sway and deflection. Stop loading and disqualify the bridge if

a. sway at the end exceeds 1/2 inch measured from the position at the beginning of load test 2, or

b. sway at the center of the span exceeds 1 inch measured from the position at the beginning of load test 2, or

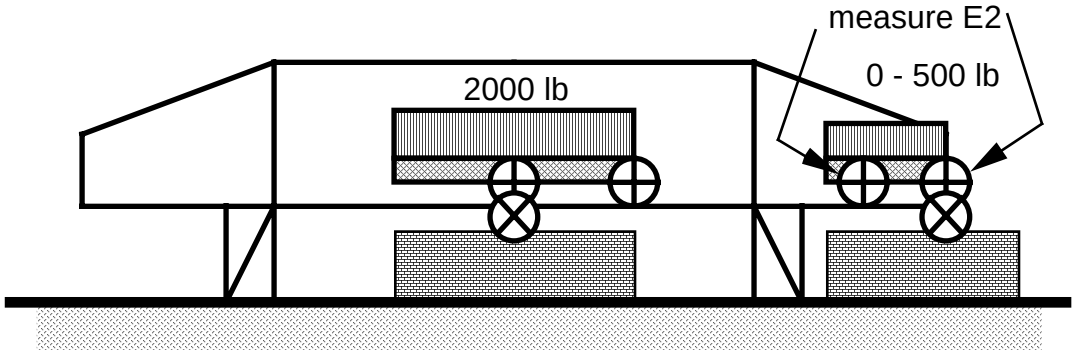
c. vertical deflection at any deflection target exceeds 2 inches measured from the position at the beginning of load test 2, or

d. any part of the bridge, other than its bearing plates, comes to bear on the ground.

If 500 pounds of load (in addition to decking) was successfully placed on the overhang without exceeding sway or deflection limits, record the following measurement:

E2 = larger absolute value of the vertical distances of the two cantilever span deflection targets from their positions at the end of load test 2 but before any load was placed on the overhang. That is, E2 measures deflection that occurred while the load on the overhang was being placed.

If a sway or deflection limit was exceeded, remove all load and disqualify the bridge.



Load Test 3 (Side View)

G. Unloading

Unload the overhang first, then the center span. The bridge must be disqualified if it collapses during unloading.

H. Computing Aggregate Deflection

Compute and record: Aggregate deflection = M1 + E1 + (5 x E2)

XI. EQUIPMENT PROVIDED BY HOST

The following equipment will be provided at the contest site by the host. Competitors should acquire similar equipment for use in practice and testing before the competition.

A. Lateral Load Device

Capable of applying 50 pound force in the horizontal direction.

B. Equipment for Measuring Sway

Sway is horizontal translation and is measured by any accurate method. A suggested method is to suspend plumb bobs from the sway target points and measure sway from points marked on the ground.

C. Equipment for Measuring Deflection

Deflection is vertical translation and is measured at four points by any accurate method.

D. 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 2'11-3/4" x 1" and the weight is approximately 50 pounds. However, the host may provide a different type of decking with 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 of the grating that are perpendicular to the length.

E. Load

2500 pounds total. The load should be supplied in uniform pieces of size and weight that may 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.

F. Safety Supports

The safety supports must be used during load testing and are intended to limit the consequences of a bridge collapsing. The safety supports should be of sufficient height, strength, number and extent so that none of the load will fall more than three inches if the bridge collapses. Safety supports may be steel, timbers, sand bags or masonry units.

XII. INTERPRETATION OF RULES

Competitors, judges and host personnel who have questions are requested to consult web site **http://www.aisc.org/steelbridge.html** and to reread this *Rules* booklet carefully in its entirety. If questions remain unanswered, they may be submitted by e-mail to Mr. Fromy Rosenberg (rosenber@aiscmail.com). Questions and answers will be posted on the web site.

XIII. JUDGING

The host 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, rating and disqualification are the sole responsibility of the judges and will be final. The host will assure that the judges are fully informed of the rules and procedures, and fully equipped for their tasks. The host and judges will follow directions in the *Guide for Hosts and Judges* provided by AISC.

XIV. PROTESTS AND APPEALS

A. Before the Contest

Each team will designate a student as team captain. The host will identify the head judge.

B. During the Contest

A penalty, disqualification, measurement, score, or condition of competition may be protested only by a team captain and only to the head judge. The protest must be made as soon as possible after the situation becomes apparent. The head judge will not hear the protest if he or she is approached by students other than the team captain. As soon as possible after a protest is made, the head judge will interrupt the contest if necessary, gather the other judges and the captains of the teams involved, and hear the protest. The decision of the head judge is final.

Participants are reminded that civility and ethical behavior are expected during the contest and particularly concerning protests.

C. After the Regional Contest

If a team wants to appeal the decision of the head judge regarding a protest it may do so in a letter mailed to Mr. Fromy Rosenberg (AISC, Suite 3100, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to ASCE Student Activities Coordinator (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The letter should include the name of the college or university making the appeal; the names, addresses and telephone numbers of the faculty adviser and one team member; brief description of the problem, the action taken at the contest to deal with it, and the action that the appealing team feels should have been taken; and computation showing how the appealing team's rankings would have been improved if a different action had been taken.

Appeals must be made in writing. Only appeals received within one week after the regional contest will be considered.

The only redress that may be made is an invitation to participate in the national competition if the Rules Committee is convinced that the appeal is valid and that the appealing team should have qualified. Decisions and rankings made by regional judges will not be overturned.

D. After the National Contest

Appeals will not be accepted. However, AISC welcomes written suggestions for improving future competitions.

XV. TIPS FOR COMPETITORS

1. Strive for challenging but realistic goals for design and construction. The following statistics from the 2001 National Student Steel Bridge Competition suggest the levels of performance that are possible. However, when reviewing these statistics keep in mind that the rules and scoring for 2002 differ from those for 2001.

	Winning bridge in category	Winning bridge, overall
Weight (pounds)	101	184
Construction time (minutes)	1.38	1.77
Aggregate deflection (inches)	1.11	1.75

2. It is strongly recommended that bridges be load tested before competition, if it can be done safely, so that weaknesses and instability can be corrected.

3. Start work on the design early, leaving adequate time to procure materials, fabricate the bridge, load test it and practice construction.

4. Design a bridge that may be fabricated, erected and load tested safely, using available materials, tools and facilities.

5. Structural analysis may fail to disclose instability, such as buckling of slender compression members, sway, and torsion of under-deck trusses of triangular cross-section.

6. Allow tolerances for all limiting dimensions in order to accommodate imprecise measurement, fabrication, thermal expansion, elastic and inelastic deformation, wear, etc. For example, if a bridge is required to provide at least 18 inches of clearance, and it is designed to provide exactly that clearance, then there is a high probability that the actual as-built clearance will be less than the specified minimum. That probability of error may be reduced by designing the bridge to provide slightly more than the required minimum clearance.

7. When fabricating your bridge, use safe tools, operate them carefully and with adequate supervision.

8. Follow all safety regulations and guidelines during construction practice and loading.

9. Make sure that the temporary pier is stable and strong enough (with a generous factor of safety) so that it will not tip or break, even if the bridge collapses.

10. When practicing construction, wear hardhats and safety glasses or goggles both for safety and to accustom yourself to contest conditions.

11. When load testing your bridge use safety supports under the decking, sufficient in height, strength, number and extent to prevent the load from dropping more than three inches if the bridge collapses. This will reduce risk of injury and limit damage to the bridge if it collapses. Keep hands and feet out from under the bridge.

12. When load testing your bridge wear hardhats, safety glasses or goggles, gloves and leather construction boots.

13. Don't stand, sit or lie on your bridge.

14. To expedite the competition have a preset plan for unloading and staging components of your bridge.

15. When packing for the competition, remember to bring hardhats, safety glasses or goggles, gloves and construction boots.

XVI. SCORE SHEET

A. Construction Speed and Time Penalties

Clock time = _____ minutes

Time penalties, see "IX.I Construction: Accidents" (**p. 14, 15**):

item 1: violations _____ x 1 = + _____ minutes
item 2: violations _____ x 1/2 = + ____ minutes
item 3: violations _____ x 1/3 = + ____ minutes
items 4,5: violations _____ x 1/6 = + ____ minutes

Time penalty, see "X.B Load Tests: Repairs" (**p. 16**) + _____ minutes

CONSTRUCTION TIME (add) = _____ minutes
Lowest time wins.

B. Lightness and Weight Penalties

Bridge weight = pounds

Weight penalties, see "VII.B Dimensions and Support: Usability" (**p. 6, 7**)

Number violations ≤ 1 inch _____ x 200 pounds = + _____ pounds
Number violations 1 - 2 inch ____ x 400 pounds = + _____ pounds
Number violations 2 - 3 inch ____ x 600 pounds = + _____ pounds

See "VIII.B Material & Components: Durability & Constructability" (**p. 9, 10**)

Number of violations _____ x 10 pounds = + _____ pounds
Wt. of parts in violation _____ pounds x 5 = + _____ pounds

TOTAL WEIGHT (add) = _____ pounds
Lowest weight wins.

C. Aesthetics

Full name of college or university appears on bridge or on attached banner or placard in letters at least 2 inches high.

Other items that may be considered:

General appearance	Finish
Balance and proportion	Elegance

Judges should not declare ties in aesthetics

AESTHETICS SCORE = _____

D. Stiffness

AGGREGATE DEFLECTION: M1 + E1 + (5 x E2) = _____ inches
Lowest deflection wins.

E. Construction Economy

Number builders _____ x Const. Time (part A) _____ x 30 = _____ thousand $

If temporary pier is used, 200 = + _____ thousand $

C_c = CONSTRUCTION COST (add) = _____ thousand $
Lowest cost wins.

F. Structural Efficiency

W = larger of total weight (part B) or 100 = _____ pounds

Δ = larger of aggregate deflection (part D) or 1.00 = x _____ inches

D = maximum height - minimum clearance = x _____ inches

C_s = STRUCTURAL COST (multiply) = _____ thousand $
Lowest cost wins.

G. Overall Performance

C_c (from part E) _____ + C_s (from part F) _____ = _____
Lowest total wins.

H. Ranks

Disqualified bridges will not be ranked.

Aesthetics is the tie-breaker for all categories

Construction Speed _____ Lightness _____

Aesthetics _____ Stiffness _____

Construction Economy _____ Structural Efficiency _

Overall Performance _____

This Score Sheet implements section "VI Scoring" (**p. 4,5**).

RULES

AISC STUDENT STEEL BRIDGE

COMPETITION

2001

Version 1.1

31 July 2000

TABLE OF CONTENTS

I. INTRODUCTION

The Student Steel Bridge Competition is sponsored by the American Institute of Steel Construction and co-sponsored by the American Society of Civil Engineers, the American Iron and Steel Institute, the James F. Lincoln Arc Welding Foundation, the National Steel Bridge Alliance, Nucor Corporation and Chaparral Steel. This inter-collegiate challenge requires Civil Engineering students to design, fabricate and construct a steel bridge.

Safety is of primary importance. The AISC requests that competitors, hosts and judges take all necessary precautions to prevent injury.

The competition rules, particularly the scoring, have been changed for 2001 in order to improve the contest and assure that competitors design and build new bridges.

Students design the bridge themselves but may seek advice from faculty and other consultants.

Ideally, students should fabricate the entire bridge themselves. However, appropriate shop facilities and supervision may not be available at every college and university. Therefore, the services of a commercial fabricator may be used provided that students observe the operations. Students are encouraged to maximize their personal involvement in fabricating their bridge.

There are two levels of competition: regional and national. Regional winners and runners-up are invited to compete at the national level. These *Rules* govern competition at both regional and national levels. A university may enter more than one bridge in regional competition but only the best one may qualify for national competition.

This booklet describes the contest and states the official rules for this year. It is distributed to universities throughout the country. A companion booklet, *Guide for Hosts and Judges*, is distributed to hosts and provides directions for conducting a competition.

The rules are intended to be prescriptive but may require some interpretation. The procedure for requesting clarification of the rules is described in section “XI Interpretation of Rules” (**p. 20**).

The ASCE student chapters and clubs entering the contest are required to be, or to become, current with their chapter or club dues. Teams may consist only of undergraduate and/or graduate students.

II. EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication and construction. Participating students gain practical experience in structural design, fabrication processes, construction planning, organization and teamwork.

The "Problem Statement" describes challenges encountered in a representative structural engineering project. The competition is a scaled simulation of that project.

Standards for strength, durability, constructability, usability, functionality and safety reflect the volumes of regulations that govern the design and construction of full-scale bridges. Criteria for excellence are represented by the award categories of stiffness, lightness, construction speed, aesthetics, efficiency and economy. As with a full-scale construction project, safety is the primary concern.

The rules of the competition accommodate a large 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.

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

III. RULE CHANGES

The following list covers some of the major changes from the 2000 rules. Minor changes are not listed. Contestants and judges are cautioned to read this entire *Rules* booklet carefully and disregard rules from previous years.

1. Computation of scores and rankings is changed. In particular, the height of a bridge will affect its score.

2. Span and minimum deck elevation are decreased. Length of cantilever, overall length, and maximum height are increased.

3. "Nut," "tool," and "temporary pier" are defined more precisely.

4. Tables, racks and other staging yard furniture are effectively eliminated.

5. Connection requirement is changed.

6. Limits are imposed on leaning and on support of builders.

7. Resistance to lateral load will be measured.

8. The construction team cannot have more than ten builders.

IV. PROBLEM STATEMENT

The main span of a century-old bridge that crosses a navigable river must be replaced. The bridge carries truck traffic serving the farms and agricultural processing industries that are the basis for the economy of this rural region, as well as providing access and emergency services to residences. A quick replacement is necessary because no other river crossing is available for miles.

The State Department of Transportation has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered, but the State DOT has specified steel as the material because of its durability and fast erection. The bridge must provide clearance for recreational navigation on the river and for access roads along the river banks. The bridge must be able to carry specified patterns of loads without exceeding sway and deflection limits. Based on past experience with performance and maintenance, the DOT prefers bridges that are relatively light and stiff, with low profiles. The new bridge must accommodate modular decking, which the DOT salvaged from another bridge. Decking units may not be modified.

Flood control and environmental concerns prohibit permanent piers in the river although a temporary pier would be allowed to facilitate construction. Soil conditions restrict the weight that may be lifted by cranes.

Your company's design/build proposal is among those that the State DOT has deemed responsive. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. The DOT will evaluate the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy and aesthetics. The contract will be awarded to the company that submits the best model. This is an opportunity to become leaders in the bridge replacement market.

V. SAFETY

Safety has the highest priority. Judges are empowered to halt any activity that they deem hazardous. Judges are directed to disqualify bridges that cannot be safely constructed or load tested using the equipment provided by the host, as described in this booklet. Collapse, sway or deflection in excess of limits specified in this booklet is incontrovertible evidence of an unsafe bridge and will result in disqualification. A disqualified bridge is not eligible for awards in any category and must be withdrawn from all subsequent participation in the contest.

VI. SCORING

A university may enter several bridges in a regional competition. However, if both first and second places are won by the same university, then only the best one of that university's bridges will be invited to participate in the national contest, together with the highest ranked bridge entered by another university.

Categories of competition are construction speed, lightness, aesthetics, stiffness, construction economy, and structural efficiency. In addition, overall performance is rated. Bridges that have been disqualified are not eligible for awards in any categories.

A. Construction Speed

The bridge with the lowest construction time will win in this category. Construction time is the clock time required to assemble the bridge, regardless of number of builders, plus time penalties prescribed in section "IX.I Construction: Accidents" (**p. 14**).

B. Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in sections "VII.B Dimensions and Support: Usability" (**p. 8**) and "VIII.B Material and Components: Durability and Constructability" (**p. 9**). Decking, tools and the temporary pier are not included in total weight.

C. Aesthetics

The full name of the college or university must appear on the bridge, or on a banner or placard attached to the bridge, in letters at least 2 inches high. The banner or placard is included in total weight but need not be installed during timed construction. It should be in place on the bridge during aesthetics judging and at other times when the bridge is on display.

In addition to the college or university name, other factors that may be considered include general appearance, balance and proportion of the design, elegance, and finish. Quality of fabrication should not be considered because some bridges may be fabricated professionally while others are student work.

Teams are encouraged, but not required, to prepare a poster illustrating and briefly describing their design and fabrication processes. The poster should be designed to be displayed within the floor area occupied by the bridge since space may be limited at the national competition.

Aesthetics is the tie-breaker for overall performance and for all other categories of competition. Judges should not declare ties in aesthetics.

D. Stiffness

The bridge with the lowest aggregate deflection will win in the stiffness category. Aggregate deflection is determined from measurements as prescribed in section "X Load Tests" (**p. 14**).

E. 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 = Construction time (minutes, including penalties)
x Number of builders (persons) x 50 (thousand $ / person-minute)
+ 500 (thousand $) if a temporary pier is used.

The number of builders includes all participants who are within the construction site at any time during timed construction.

F. Structural Efficiency

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

$C_s = W \times \Delta \times D$, where

W = the larger of total weight OR 100 pounds.
Δ = the larger of aggregate deflection OR 1.000 inch.
D = maximum height of the bridge minus minimum clearance.

Total weight is the weight of the bridge plus weight penalties prescribed in sections "VII.B Dimensions and Support: Usability" (**p. 8**) and "VIII.B Material and Components: Durability and Constructability" (**p. 9**). Decking, tools and the temporary pier are not included in total weight.

Aggregate deflection is determined from measurements as prescribed in section "X Load Tests" (**p. 14**).

Maximum height of the bridge is the vertical distance from the ground or river surface to the highest point on the bridge structure (not including decking).

Minimum clearance is the smallest of the following three quantities: 18 inches OR vertical distance from the river surface to the lowest point on the bridge structure over the river OR vertical distance from the ground surface to the lowest point on the bridge structure over the access roads.

G. Overall Performance

The overall performance rating of a bridge is the product of construction cost and structural cost ($C_c \times C_s$). The bridge with the lowest cost product will win the overall competition.

VII. DIMENSIONS AND SUPPORT

A. Functionality and Safety

If any of the following regulations is violated, the bridge must be disqualified. The figures titled "Spans and Clearance" (**p. 7**) and "Deck Support, Roadway and Bearing" (**p. 7**) illustrate some of the requirements.

1. The bridge must span the river, which is 13 feet wide, without touching it. No part or accessory of the completed bridge may touch the river. Also see paragraph VII.B.1 (**p. 8**).

2. The overall length of the bridge must be at least 23 feet.

3. The bridge must provide continuous rigid support for the decking along both of the edges that run in the longitudinal direction of the bridge. The support must be continuous and rigid for the overall length of the bridge. This is easily verified by sliding a piece of decking along the full overall length of the bridge. Also see paragraph VII.B.3 (**p. 8**).

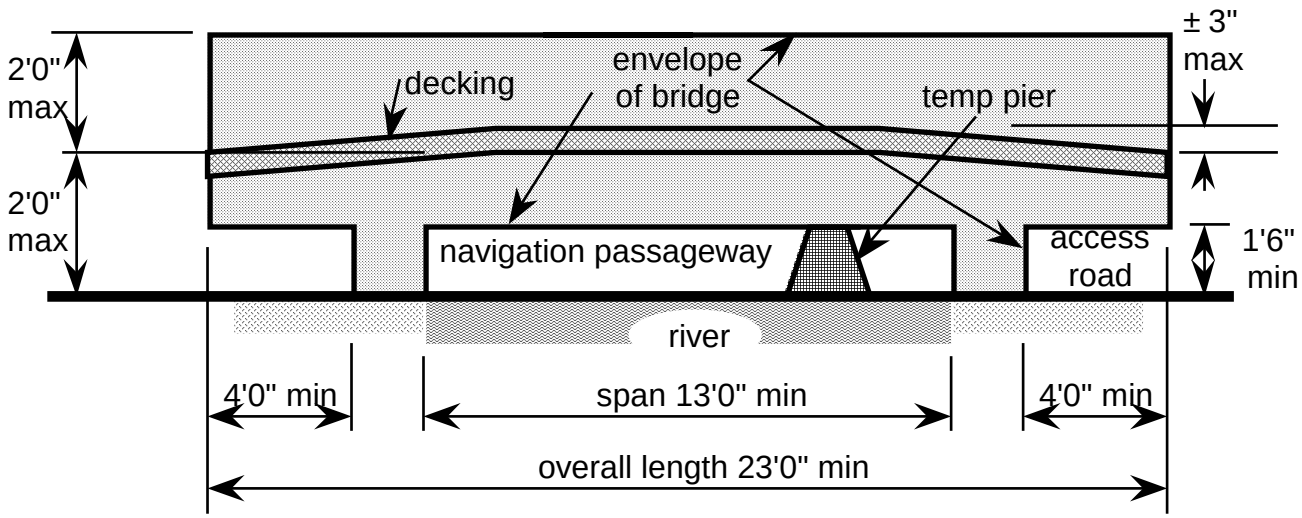
4. The edges of the decking that run in the longitudinal direction of the bridge may be cantilevered over their supports no more than 6 inches on each side.

5. The decking may not be attached nor anchored to the bridge.

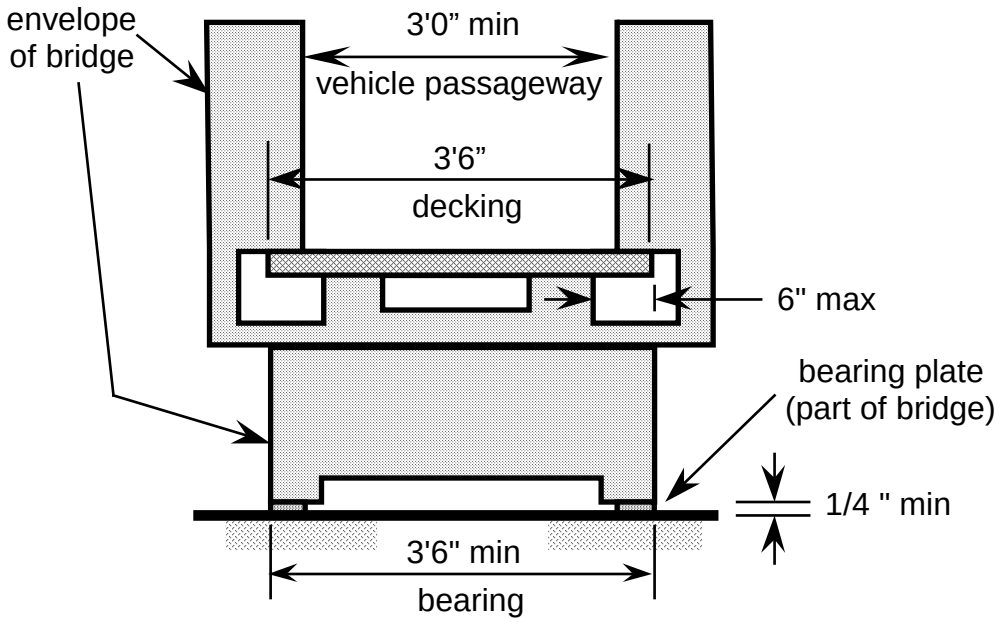
6. The bridge must provide access for placing the decking and load. Although decking is nominally 42 inches wide and 1 inch thick, actual widths range from 41.75 to 42.25 inches and thickness may be as large as 1.25 inches. Also see paragraph VII.B.4 (**p. 8**).

7. On each side of the river the bridge must bear on the ground over a width of at least 3'6". Bearing is not required to be continuous over that width. Also see paragraph VII.B.8 (**p. 8**).

8. The bridge may not be anchored or tied to the ground.



Spans and Clearance (Side View)



Deck Support, Roadway and Bearing (End View)

Hollow circular and oval tube and other curvilinear closed shapes

Fabricated sections including closed curvilinear components

Example Unacceptable Member Cross-Sections

B. Usability

A penalty of 200 pounds will be added to the weight of the bridge for each of the following rules that is violated. A penalty will be assessed for each rule that is violated, rather than for every violation of that rule. The figures titled “Spans and Clearance” (**p. 7**) and “Deck Support, Roadway and Bearing” (**p. 7**) illustrate some of the requirements. Dimensions will be checked without load on the bridge.

1. A rectangular navigation passageway must be provided under the bridge. The navigation passageway must be at least 1’6” high, measured from the surface of the river, and it must be at least 13’0” wide, coinciding with the width of the river. Also see paragraph VII.A.1 (**p. 6**).

2. At each end of the bridge there must be clearance for an access road running along the bank of the river. This clearance must completely traverse the width of the bridge; it must be at least 1’6” high, measured from the surface of the ground; it must be at least 4’0” wide, measured from the end of the bridge; and it must extend to the end of the bridge.

3. Decking must be supported without overlaps, gaps, abrupt elevation differences exceeding 1/4 inch, or protrusions exceeding 1/4 inch in height. Also see paragraph VII.A.3 (**p. 6**).

4. A vehicle passageway at least 3’0” wide must completely traverse the bridge from end to end, and must extend upward from the decking through the top of the bridge. Also see paragraph VII.A.6 (**p. 6**).

5. The top surface of the decking supports must be no more than 2’0” above the surface of the ground and river at any point. Note that the surfaces of the ground and river have the same elevation.

6. The absolute value of camber of the decking supports may not exceed 3 inches.

7. No part of the bridge may extend more than 2'0" above the top surface of the decking support at any point.

8. At each point where it bears on the ground the bridge will include a solid bearing plate at least 1/4 inch thick, 2 inches long and 2 inches wide. Also see paragraph VII.A.7 (**p. 6**). Bearing plates are part of the bridge.

9. A temporary pier, if used, must be made of steel and/or wood.

10. A temporary pier, if used, may not exceed overall dimensions of 4’0” (horizontal) x 4’0” (horizontal) x 2’0” (vertical). That is, it must fit in a three-dimensional prismatic box of those dimensions.

11. Only one temporary pier is permitted. The use of a temporary pier is optional and adds to the construction cost of the bridge.

VIII. MATERIAL AND COMPONENTS

A. Safety

If either of the following regulations is violated, the bridge must be disqualified.

1. A bridge member may not weigh more than 40 pounds. See section VIII.B (**p. 9**) for definition of "bridge member."

2. A temporary pier, if used, must not weigh more than 40 pounds. See section IX.D (**p. 11**) for definition of "temporary pier."

B. Durability and Constructability

Violation of each of the following rules will result in a weight penalty being added to the weight of the bridge. The penalty for each violation is 10 pounds plus 5 times the weight of the non-conforming components.

1. A bridge may be constructed only of structural steel. For the purposes of this contest, structural steel is defined as an iron alloy that is strongly attracted to a magnet. Exceptions: Paint, banners, placards and other purely decorative items.

2. A bridge may be constructed only of components conforming to the following definitions of bridge members and fasteners.

   a. A bridge member is a rigid component that retains its shape, dimensions and rigidity during timed construction and in the completed bridge.

   b. A fastener consists of two parts, namely one steel bolt and one matching solid steel nut, neither of which may be attached to a member or to one another before the start of timed construction.

3. A bridge member may not have a cross-section that is both closed (hollow) and curvilinear. For example, a bridge member may not be fabricated from pipe, conduit, circular tube or oval tube. The figure titled "Example Unacceptable Member Cross-Sections" (**p. 7**) shows examples of unacceptable cross-sections. Exception: washers, bushings and similar short sections pertaining to connections.

4. A bridge member may not exceed overall dimensions of 4'0" x 6" x 6." That is, it must fit in a prismatic box of those dimensions.

5. A bridge member must be rigid. That is, hinged, jointed, articulated and telescoping members are prohibited, as are those with moving parts. This prohibition includes members with parts that are intended to slide, rotate, deflect or bend relative to the member during construction, such as cams, latches, sliding pins, springs, and snap-lock devices. Cables and strapping are prohibited, as are similar materials that would not be damaged by coiling and uncoiling.

6. A bridge member may consist of several parts rigidly joined together (e.g. welded, bolted, screwed) before timed construction begins. Those parts must

remain rigidly joined throughout the construction process and in the completed bridge.

7. A bolt may not exceed 3 inches in overall length. It must be straight, threaded and have a hexagonal or square head that will accept a wrench. Eye bolts are not permitted.

8. A nut must be threaded internally to fit its bolt, and the threads must be continuous around the complete circumference of the hole in the nut. A nut may not have moving parts.

9. All connections of bridge members to the bridge or to other bridge members must be made during timed construction.

10. Each member must be connected to every other member that it touches by at least one fastener installed during timed construction so that the connection cannot be taken apart without first unscrewing the nut from the bolt and then removing both the nut and the bolt from the connection.

IX. CONSTRUCTION

A. Safety

If any of the following safety regulations is violated during timed construction, the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools and bridge components will be returned to the positions they occupied before the violation. Then the builders will be asked to resume construction using safe procedures. A bridge that cannot be constructed safely must be disqualified.

1. If a temporary pier is used, it must conform to the description given in section IX.D (**p. 11**).

2. The temporary pier must not break nor collapse during construction.

3. Only tools that are hand-held during use are permitted. Field welding and tools requiring external power connections are prohibited. Tools may not be used to support or elevate builders.

4. All builders must wear hardhats and safety glasses or goggles during timed construction.

5. A builder may not use the bridge, a portion of the bridge, a tool or the temporary pier to support the builder's body weight. For example, standing, sitting or kneeling on those objects is prohibited. However, a builder may lean on the bridge or temporary pier if the heels and toes of both of the builder’s feet remain on the ground.

6. A builder may not depend on another builder or builders for support or balance.

7. A builder may not cross the river by jumping, by temporary scaffolding, by crossing the bridge, or by any other means.

8. Outside the staging yard, moving a portion of the bridge requires the effort of as many builders as there are members in that portion of the bridge. The term "portion of the bridge" includes, but is not limited to, single and multiple bridge members, bridge members that are connected together, and the entire bridge. The word "moving" includes, but is not limited to, lifting, carrying, lowering, rolling, turning, sliding and tipping, as well as causing translation and/or rotation of one portion of the bridge relative to another. Exception: small movement (maximum 3 inches) of a portion of the bridge by as few as one builder will be allowed as necessary to facilitate connections.

9. Outside the staging yard, any portion of the bridge that is not moving must either be supported by as many builders as there are bridge members in that portion of the bridge, or must be supported without the assistance of builders by any combination of the following: the portion itself, other portions of the bridge, and temporary pier.

10. The temporary pier, if used, may not be moved by a builder who is also moving or supporting a portion of the bridge at the same time.

11. The temporary pier may be moved only twice during timed construction: first from the staging yard to a useful location, and then returned to the staging yard.

12. The temporary pier must be removed without lifting the bridge.

B. Team

Participation is limited to students. The construction team, also referred to as builders, consists of all participants who are within the construction site at any time during timed construction. There can be no more than ten participants on the construction team.

C. Tools and Safety Equipment

Competitors provide their own tools, hardhats and safety glasses or goggles. See paragraphs IX.A.3 and .4 (**p. 10**).

D. Temporary Pier

A temporary pier is a support in the river or on the ground, and is provided by the competitors. The use of a temporary pier is optional and adds to the cost of the bridge. Only one temporary pier is permitted. See sections VII.B (**p. 8**), VIII.A (**p. 9**) and IX.A (**p. 11**) for rules governing the temporary pier.

E. Construction Site

See the figure titled “Site Plan” (**p. 13**) for layout of the construction site. The reference line is provided to guide construction. It is perpendicular to the banks of the river and is located near the center of the construction site (the bridge is not required to be centered on the reference line).

Only builders and judges are permitted in the construction site during timed construction. Only judges are permitted near the construction site; coaches, managers and other spectators must observe from a safe distance that does not obstruct judges.

F. Start

Before construction begins, all of the following items, and nothing else, are in the staging yards: bridge members, nuts and bolts, tools, the temporary pier (if used) and builders. Builders will be wearing hardhats and safety glasses or goggles, as well as optional clothing such as pouches. Bridge members, tools and fasteners must be on the ground. Bridge members must not be connected nor in contact with one another. Tools and fasteners must not be in contact with bridge members.

Timing and construction begin when the builders signify that they are ready and the judge declares the start.

G. Time

Time is kept from the start to finish of construction. The clock will be stopped:

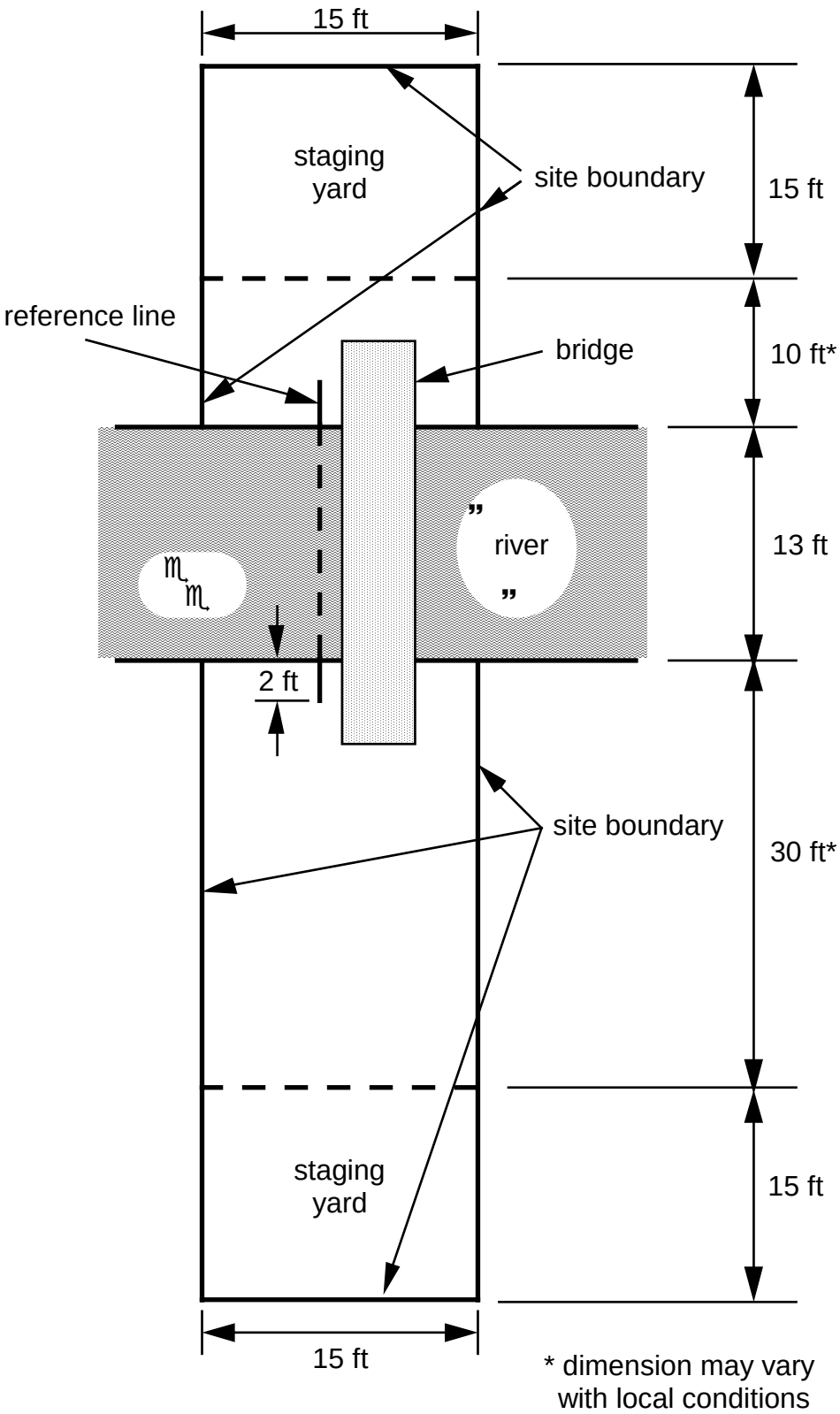
1. if a builder or judge sees a condition that could cause injury, or

2. when a safety regulation has been violated. See section IX.A (**p. 10 and 11**).

Construction ceases while the clock is stopped. The clock is restarted after the situation has been corrected.

H. Finish

Construction ends when the bridge has been completed over the river by connecting all the members, and all tools, the temporary pier (if used) and builders are back in the staging yards, and the builders signify that they are finished. Installation of decking is not included in timed construction.


15 ft
staging
yard
site boundary
15 ft
reference line
bridge
10 ft*
river
13 ft
2 ft
site boundary
30 ft*
staging
yard
15 ft
15 ft
* dimension may vary
with local conditions

Site Plan

I. Accidents

In general, the clock is not stopped when an "accident" occurs. Builders involved in accidents may continue to build, and components involved in accidents may be recovered and used. If an accident is continuous (for example, a builder stands in the river) it will be counted as multiple incidents. Types of accidents and the corresponding time penalties, which will be added to the construction time, are:

1. A builder touches the river. Penalty is 1/2 minute (30 seconds) per incident. Exception: Builders may step in the river without penalty to place or remove the temporary pier or to retrieve a dropped member, tool, nut, bolt or hardhat.

2. A builder throws something. Penalty is 1/2 minute (30 seconds) per incident.

3. A portion of the bridge touches the river or the ground outside a staging yard. Penalty is 1/3 minute (20 seconds) per incident. Exception: No penalty is assessed when the ground is touched by the bottom of a bearing plate that will be in contact with that place on the ground when the bridge is completed (see paragraph VII.B.8 (**p. 8**)).

4. A tool, nut, bolt or hardhat touches the river or the ground outside a staging yard. Penalty is 1/6 minute (10 seconds) per incident. Exception: a tool used exclusively for measuring may touch the ground during use while being held by a builder.

5. A builder steps outside the boundary of the construction site. Penalty is 1/6 minute (10 seconds) per incident.

X. LOAD TESTS

A. Safety Precautions

A bridge could suddenly collapse or sway in any direction during load tests. Therefore, minimize the number of people near the bridge while it is being tested. Usually, the load may be placed on the bridge by only two competitors.

While participating in load testing, **competitors must wear hardhats, safety glasses or goggles, gloves and leather construction boots**. This safety equipment is provided by the competitors. Similar equipment is recommended for judges who will be near the bridge during load testing.

During testing, safety supports must be in place below the bottom of the decking. The safety supports should be of sufficient height, strength, number and extent that none of the load will fall more than three inches if the bridge collapses. The safety support should extend beyond the end of the bridge to arrest the load if it slides off the overhanging span.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a portion of the decking that is cantilevered laterally over its support.

When any portion of the load is on the bridge, no one is permitted to crawl, reach or step under the bridge. If such an action is necessary, the load must first be removed.

B. Repairs

A bridge will not be tested in a condition that compromises its strength or stability. Therefore, prior to load testing, repairs may be made with the permission and supervision of a judge, according to the following provisions:

1. Damage occurring after construction will be repaired without penalty.

2. Construction errors will be repaired but a time penalty will be assessed in an amount, to be determined by the judge, that will exceed the incremental time required for careful initial construction.

C. Preparation

The provisions of this section are illustrated by the figure titled “Location of Targets and Decking” (**p. 16**).

Position the bridge in convenient proximity to load testing equipment.

Load tests are conducted without the temporary pier.

Place shims under the bearing plates of the bridge as necessary to compensate for sloping and/or rough ground surface. Shims may not be used to compensate for imprecise construction or fabrication of the bridge.

By a random process, the judge selects the side of the bridge to which lateral load will be applied in load test 1 and the end of the bridge that will be loaded in load test 3.

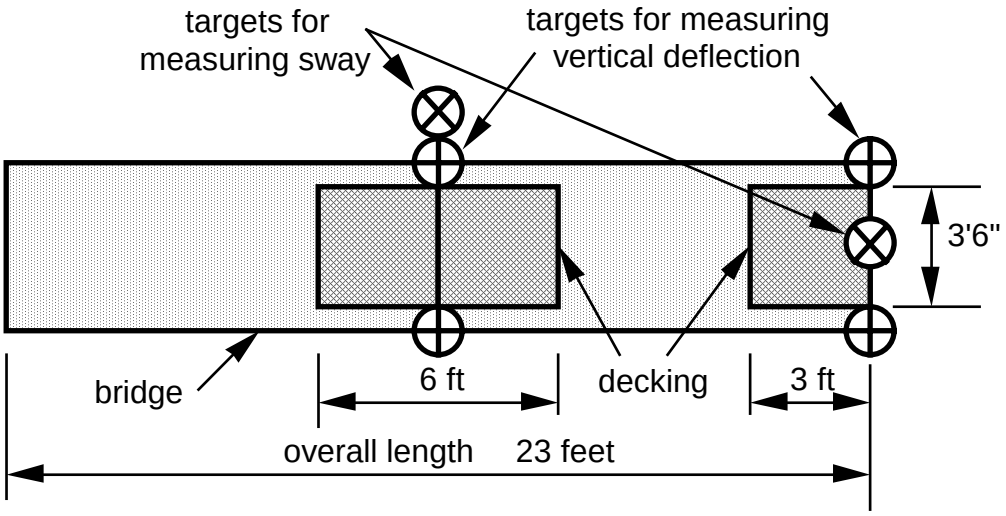
Safety supports are placed under the level of the decking so that no portion of the load will drop more than three inches if the bridge collapses. The safety support should extend beyond the end of the bridge that will be loaded.

Sway is translation in any horizontal direction. Two targets are established for sway measurements: one at the center of the span and the other at the end of the bridge that will be loaded. Both targets are located near the level of the decking.

Two targets are established for midspan vertical deflection measurements. These targets are located near the level of the decking on both sides of the bridge at the center of the span.

Two targets are established for end vertical deflection measurements. These targets are located near the level of the decking on both sides of the bridge at the end of the bridge that will be loaded.

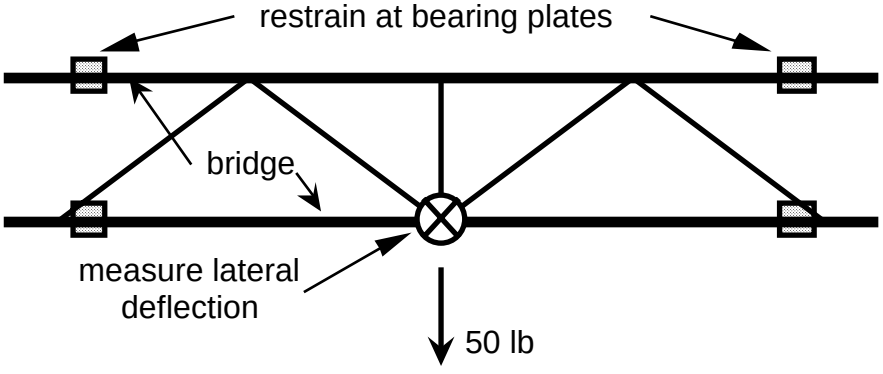
A BRIDGE THAT COLLAPSES DURING LOADING, DEFLECTION MEASUREMENTS OR UNLOADING MUST BE DISQUALIFIED.



Location of Targets and Decking (Plan)

D. Load Test 1 - Lateral

Load test 1 is conducted without decking but with restraint at the bearing plates to prevent the bridge from sliding or tipping. As shown in the figure titled “Load Test 1” (**p. 16**), apply a 50 pound lateral force as close as practical to midspan and to the level of the deck. To pass load test 1, the lateral deflection at midspan of the bridge must not exceed 1.0”. If the bridge does not pass load test 1 it is disqualified; do not conduct any other load test. Remove the lateral load; it is not part of the remaining load tests.



Load Test 1 (Plan)

E. Load Test 2 - Center Span

Place two units of decking symmetrically about the middle of the center span and extending 6 feet in the span direction. Place one unit of decking at the end of the bridge selected for loading.

Position measuring devices on the four targets for vertical deflection and either initialize to zero or record initial readings.

Uniformly distribute load on the two units of decking on the center span, as shown in the figure titled “Load Test 2” (**p. 17**).

As the load is being placed, observe sway and deflection. Stop loading and disqualify the bridge if

a. sway at the end exceeds 1/2 inch, or
b. sway at the center of the span exceeds 1 inch, or
c. vertical deflection at any deflection target exceeds 2 inches.

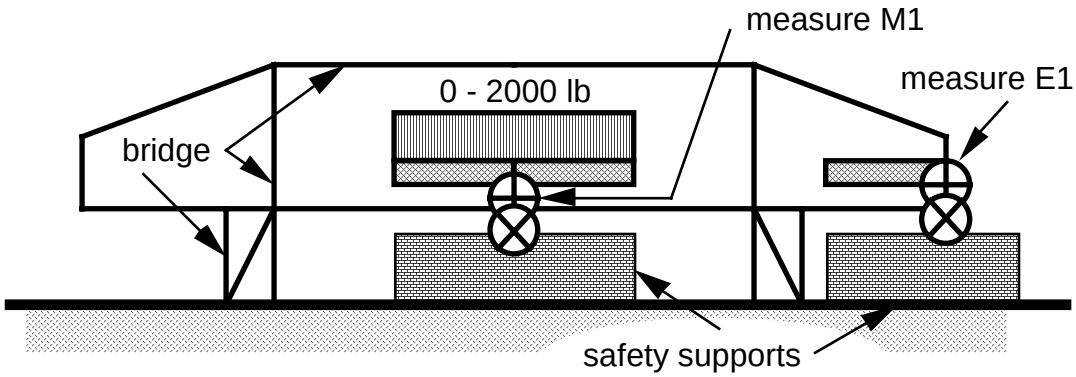
If 2000 pounds of load (in addition to decking) was successfully placed without exceeding sway or deflection limits, record the following measurements:

M1 = larger absolute value of the vertical distances of the two midspan deflection targets from their positions before any portion of the load was placed.

E1 = larger absolute value of the vertical distances of the two end deflection targets from their positions before any portion of the load was placed.

If a sway or deflection limit was exceeded, remove all load and disqualify the bridge. Do not proceed to the next test.

In preparation for the next load test, record the vertical deflections at both end deflection targets.



Load Test 2 (Side View)

F. Load Test 3 - Overhang

With the first 2000 pound load remaining in place on the center span, uniformly distribute additional load over the unit of decking on the overhanging end of the bridge, as shown in the figure titled “Load Test 3” (**p. 18**).

As the load is being placed, observe sway and deflection. Stop loading and disqualify the bridge if

a. sway at the end exceeds 1/2 inch measured from the position at the beginning of load test 2, or

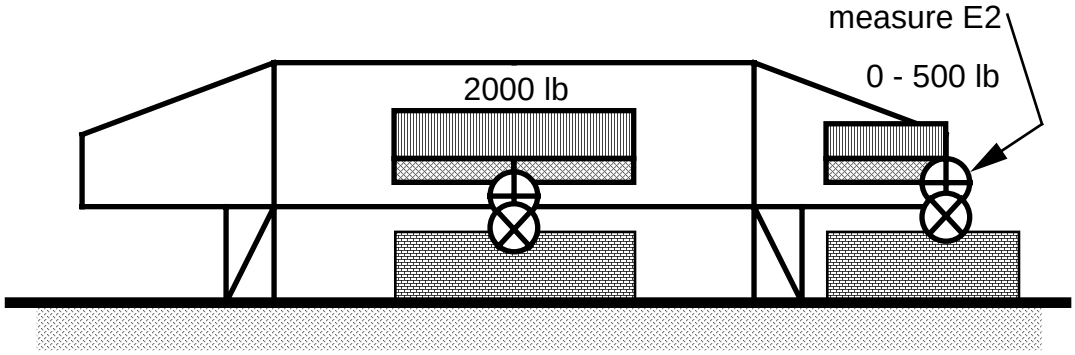
b. sway at the center of the span exceeds 1 inch measured from the position at the beginning of load test 2, or

c. vertical deflection at any deflection target exceeds 2 inches measured from the position at the beginning of load test 2.

If 500 pounds of load (in addition to decking) was successfully placed on the overhang without exceeding sway or deflection limits, record the following measurement:

E2 = larger absolute value of the vertical distances of the two end deflection targets from their positions at the end of load test 2 but before any load was placed on the overhang. That is, E2 measures deflection that occurred while the load on the overhang was being placed.

If a sway or deflection limit was exceeded, remove all load and disqualify the bridge.



Load Test 3 (Side View)

G. Unloading

Unload the overhang first, then the center span. The bridge must be disqualified if it collapses during unloading.

H. Computing Aggregate Deflection

Compute and record: Aggregate deflection = M1 + E1 + (5 x E2)

XI. EQUIPMENT PROVIDED BY HOST

The following equipment will be provided at the contest site by the host. Competitors should acquire similar equipment for use in practice and testing before the competition.

A. Lateral Load Device

Capable of applying 50 pound force in the horizontal direction.

B. Equipment for Measuring Sway

Sway is horizontal translation and is measured by any accurate method. A suggested method is to suspend plumb bobs from the sway target points and measure sway from points marked on the ground.

C. Equipment for Measuring Deflection

Deflection is vertical translation and is measured at four points by any accurate method.

D. Decking

Preferred decking is steel bar grating identified as W-19-4 (1 x 1/8). The dimensions of a piece of grating are approximately 3'6" x 2'11-3/4" x 1" and the weight is approximately 50 pounds. However, the host may provide a different type of decking with 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 of the grating that are perpendicular to the length.

E. Load

2500 pounds total. The load should be supplied in uniform pieces of size and weight that may 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.

F. Safety Supports

The safety supports must be used during load testing and are intended to limit the consequences of a bridge collapsing. The safety supports should be of sufficient height, strength, number and extent so that none of the load will fall more than three inches if the bridge collapses. Safety supports may be steel, timbers, sand bags or masonry units.

XII. INTERPRETATION OF RULES

Competitors, judges and host personnel who have questions are requested to consult web site http://www.engr.uaa.alaska.edu/nssbc/ and to reread this *Rules* booklet carefully in its entirety. If questions remain unanswered, they may be submitted by e-mail to Mr. Fromy Rosenberg (rosenber@aiscmail.com). Questions and answers will be posted on the web site.

XIII. JUDGING

The host 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, rating and disqualification are the sole responsibility of the judges and will be final. The host will assure that the judges are fully informed of the rules and procedures, and fully equipped for their tasks. The host and judges will follow directions in the *Guide for Hosts and Judges* provided by AISC.

XIV. PROTESTS AND APPEALS

A. Before the Contest

Each team will designate a student as team captain. The host will identify the head judge.

B. During the Contest

A penalty, disqualification, measurement, score, or condition of competition may be protested only by a team captain and only to the head judge. The protest must be made as soon as possible after the situation becomes apparent. The head judge will not hear the protest if he or she is approached by students other than the team captain. As soon as possible after a protest is made, the head judge will interrupt the contest if necessary, gather the other judges and the captains of the teams involved, and hear the protest. The decision of the head judge is final.

Participants are reminded that civility and ethical behavior are expected during the contest and particularly concerning protests.

C. After the Regional Contest

If a team wants to appeal the decision of the head judge regarding a protest it may do so in a letter mailed to Mr. Fromy Rosenberg (AISC, Suite 3100, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to ASCE Student Activities Coordinator (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The letter should include the name of the college or university making the appeal; the names, addresses and telephone numbers of the faculty adviser and one team member; brief description of the problem, the action taken at the contest to deal with it, and the action that the appealing team feels should have been taken; and computation showing how the appealing team's rankings would have been improved if a different action had been taken.

Appeals must be made in writing. Only appeals received within one week after the regional contest will be considered.

The only redress that may be made is an invitation to participate in the national competition if the Rules Committee is convinced that the appeal is valid and that the appealing team should have placed first or second in its region. Decisions and rankings made by regional judges will not be overturned.

D. After the National Contest

Appeals will not be accepted. However, AISC welcomes written suggestions for improving future competitions.

XV. TIPS FOR COMPETITORS

1. Strive for challenging but realistic goals for design and construction. The following statistics from the 2000 National Student Steel Bridge Competition suggest the levels of performance that are possible. However, when reviewing these statistics keep in mind that the rules and scoring for 2001 differ from those for 2000.

	Winning bridge in category	Winning bridge, overall
Weight (pounds)	107.5	112.0
Construction time (person-minutes)	18.30	33.43
Aggregate deflection (inches)	0.440	0.682

2. It is strongly recommended that bridges be load tested before competition, if it can be done safely, so that weaknesses and instability can be corrected.

3. Start work on the design early, leaving adequate time to procure materials, fabricate the bridge, load test it and practice construction.

4. Design a bridge that may be fabricated, erected and load tested safely, using available materials, tools and facilities.

5. Structural analysis may fail to disclose instability, such as buckling of slender compression members, sway, and torsion of under-deck trusses of triangular cross-section.

6. Allow tolerances for all limiting dimensions in order to accommodate imprecise measurement, fabrication, thermal expansion, elastic and inelastic deformation, wear, etc. For example, if a bridge is required to provide at least 18 inches of clearance, and it is designed to provide exactly that clearance, then there is a high probability that the actual as-built clearance will be less than the specified minimum. That probability of error may be reduced by designing the bridge to provide slightly more than the required minimum clearance.

7. When fabricating your bridge, use safe tools, operate them carefully and with adequate supervision.

8. Follow all safety regulations and guidelines during construction practice and loading.

9. Make sure that the temporary pier is stable and strong enough (with a generous factor of safety) so that it will not tip or break, even if the bridge collapses.

10. When practicing construction, wear hardhats and safety glasses or goggles both for safety and to accustom yourself to contest conditions.

11. When load testing your bridge use safety supports under the decking, sufficient in height, strength, number and extent to prevent the load from dropping more than three inches if the bridge collapses. This will reduce risk of injury and limit damage to the bridge if it collapses. Keep hands and feet out from under the bridge.

12. When load testing your bridge wear hardhats, safety glasses or goggles, gloves and leather construction boots.

13. Don't stand, sit or lie on your bridge.

14. To expedite the competition have a preset plan for unloading and staging components of your bridge.

15. When packing for the competition, remember to bring hardhats, safety glasses or goggles, gloves and construction boots.

XVI. SCORE SHEET

A. Construction Speed and Time Penalties

Clock time = _____ minutes

Time penalties, see "IX.I Construction: Accidents" (**p. 14**):

items 1,2: violations _____ x 1/2 = + ___ minutes

item 3: violations _____ x 1/3 = + ___ minutes

items 4,5: violations _____ x 1/6 = + ___ minutes

CONSTRUCTION TIME (add) = _____ minutes
Lowest time wins.

B. Lightness and Weight Penalties

Bridge weight = pounds

Weight penalties, see "VII.B Dimensions and Support: Usability" (**p. 8**)

Number of violations _____ x 200 pounds = + _____ pounds

See "VIII.B Material and Components: Durability and Constructability" (**p. 9**)

Number of violations _____ x 10 pounds = + _____ pounds

Wt. of parts in violation _____ pounds x 5 = + _____ pounds

TOTAL WEIGHT (add) = _____ pounds
Lowest weight wins.

C. Aesthetics

Full name of college or university appears on bridge or on attached banner or placard in letters at least 2 inches high.

Other items that may be considered:

General appearance	Finish
Balance and proportion	Elegance

Judges should not declare ties in aesthetics

AESTHETICS SCORE = _____

D. Stiffness

AGGREGATE DEFLECTION: M1 + E1 + (5 x E2) = _____ inches
Lowest deflection wins.

E. Construction Economy

Number builders _____ x Const. Time (part A) _____ x 50 = _____ thousand $

If temporary pier is used, 500 = + _____ thousand $

C_c = CONSTRUCTION COST (add) = _____ thousand $
Lowest cost wins.

F. Structural Efficiency

W = larger of total weight (part B) or 100 = _____ pounds

Δ = larger of aggregate deflection (part D) or 1.00 = x _____ inches

D = maximum height - minimum clearance = x _____ inches

C_S = STRUCTURAL COST (multiply) = _____
Lowest cost wins.

G. Overall Performance

C_c (from part E) _____ x C_S (from part F) _____ = _____
Lowest cost product wins.

H. Ranks

Disqualified bridges will not be ranked.

Aesthetics is the tie-breaker for all categories

Construction Speed _____ Lightness _____

Aesthetics _____ Stiffness _____

Construction Economy _____ Structural Efficiency _

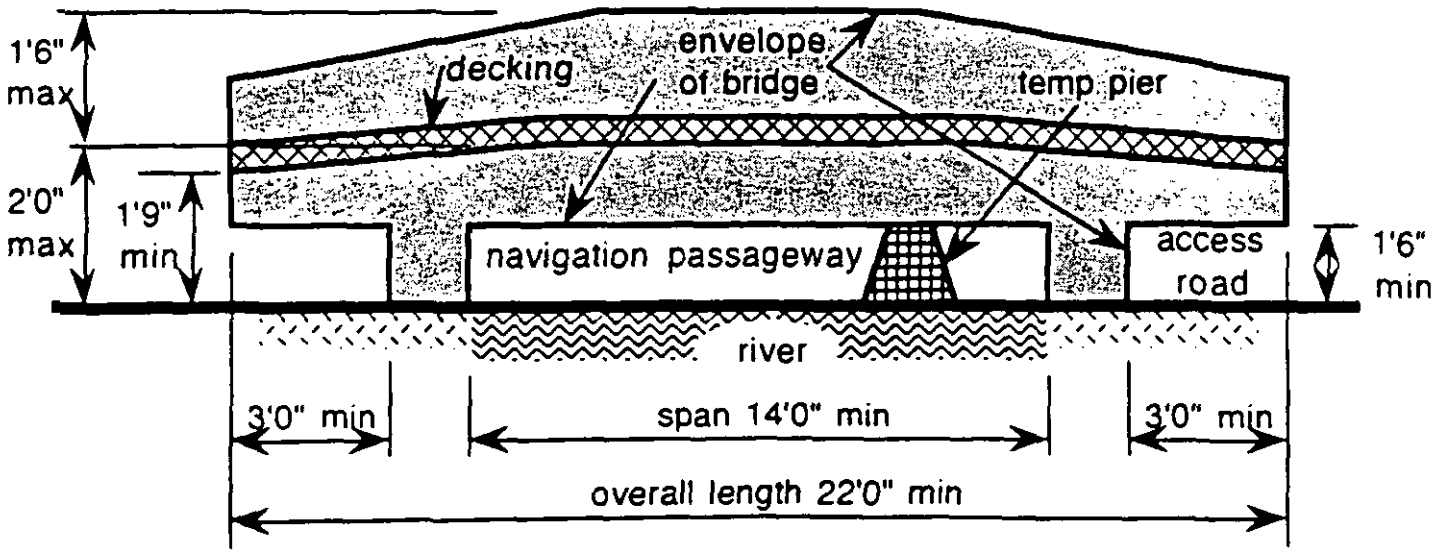
Overall Performance _____

This Score Sheet implements section "VI Scoring" (**p. 4,5**).

2000 STUDENT STEEL BRIDGE

Competition

For Student Chapters Of
The American Society Of Civil Engineers



Spans and Clearance (Side View)

Special thanks to: Steel Erectors Association of America

COSPONSORS

NSBA National Steel Bridge Alliance

ASCE American Society of Civil Engineers

txi Chaparral Steel Structural Business Unit

American Iron and Steel Institute

NUCOR

RULES

AISC STUDENT STEEL BRIDGE COMPETITION

2000

5000

TABLE OF CONTENTS

2000

I. INTRODUCTION

The Student Steel Bridge Competition is sponsored by the American Institute of Steel Construction and co-sponsored by the American Society of Civil Engineers, the American Iron and Steel Institute, the James F. Lincoln Arc Welding Foundation, the National Steel Bridge Alliance, Nucor Corporation and Chaparral Steel. This inter-collegiate challenge requires Civil Engineering students to design, fabricate and construct a steel bridge.

Safety is of primary importance. The AISC requests that competitors, hosts and judges take all necessary precautions to prevent injury.

The competition rules have been changed for 2000 in order to improve the contest and to assure that competitors design and build new bridges.

Students design the bridge themselves but may seek advice from faculty and other consultants.

Ideally, students should fabricate the entire bridge themselves. However, appropriate shop facilities and supervision may not be available at every college and university. Therefore, the services of a commercial fabricator may be used provided that students observe the operations. Students are encouraged to maximize their personal involvement in fabricating their bridge.

There are two levels of competition: regional and national. Regional winners and runners-up are invited to compete at the national level. These *Rules govern competition at both regional and national levels. A university* may enter more than one bridge in regional competition but only the best one may qualify for national competition.

This booklet describes the contest and states the official rules for this year. It is distributed to universities throughout the country. A companion booklet, *Guide for Hosts and Judges*, is distributed to hosts and provides directions for conducting a competition.

The rules are intended to be prescriptive but may require some interpretation. The host should promptly inform all competitors and judges of questions and interpretations concerning the rules and other aspects of the competition. Interpretations must be in writing.

II. EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication and construction. Participating students gain practical experience in structural design, fabrication processes, construction planning, organization and teamwork.

The "Problem Statement" describes challenges encountered in a representative structural engineering project. The competition is a scaled simulation of that project.

Standards for strength, durability, constructability, usability, functionality and safety reflect the volumes of regulations that govern the design and construction of full-scale bridges. Criteria for excellence are represented by the award categories of stiffness, lightness, construction speed, aesthetics, efficiency and economy. As with a full-scale construction project, safety is the primary concern.

The rules of the competition accommodate a large 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.

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

III. RULE CHANGES

The 2000 Student Steel Bridge Contest will be very different from previous years, providing a fresh challenge for contestants, safer loading, and simplified rules. Contestants and judges are cautioned to read this entire *Rules* booklet carefully and disregard rules from previous years.

IV. PROBLEM STATEMENT

The main span of a century-old bridge that crosses a navigable river must be replaced. The bridge carries truck traffic serving the farms and agricultural processing industries that are the basis for the economy of this rural region, as well as providing access and emergency services to residences. A quick replacement is necessary because no other river crossing is available for miles.

The State Department of Transportation has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered, but the State has specified steel as the material because of its durability and fast erection. The bridge must be able to carry specified patterns of loads without exceeding sway and deflection limits. The bridge must provide clearance for recreational navigation on the river and for access roads along the river banks. Flood control and environmental concerns prohibit permanent piers in the river although a temporary pier would be allowed to facilitate construction.

The new bridge must accommodate modular decking, which the State DOT salvaged from another bridge. Decking units may not be modified.

Soil conditions restrict the weight that may be lifted by cranes.

Your company's design/build proposal is among those that the State DOT has deemed responsive. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. The DOT will evaluate the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy and aesthetics. The contract will be awarded to the company that submits the best model. This is an opportunity to become leaders in the bridge replacement market.

V. SAFETY

Safety has the highest priority. Judges are directed to disqualify bridges that cannot be safely constructed or load tested using the equipment provided by the host, as described in this booklet. Collapse, sway or deflection in excess of limits specified in this booklet is incontrovertible evidence of an unsafe bridge and will result in disqualification. A disqualified bridge is not eligible for awards in any category and must be withdrawn from all subsequent participation in the contest.

VI. SCORING

A university may enter several bridges in a regional competition. However, if both first and second places are won by the same university, then only the best one of that university's bridges will be invited to participate in the national contest, together with the highest ranked bridge entered by another university.

Categories of competition are lightness, construction speed, stiffness, efficiency, economy and aesthetics. In addition, overall performance is rated. Bridges that have been disqualified are not eligible for awards in any categories.

A. Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in sections "VII.B Dimensions and Support: Usability" (**p. 8**) and "VIII.B Material and Components: Durability and Constructability" (**p. 9**). Decking, tools and the temporary pier are not included in total weight.

B. Construction Speed

The bridge with the lowest construction time will win in this category. Construction time is the product of the size of the construction team and the duration of construction plus time penalties prescribed in section "IX.I Construction: Accidents" (**p. 14**). The construction team includes all participants who are within the construction site at any time during timed construction.

C. Stiffness

The bridge with the lowest aggregate deflection will win in the stiffness category. Aggregate deflection is determined from measurements as prescribed in section "X Load Tests" (**p. 15**).

D. Efficiency

The bridge with the smallest sum of normalized total weight and aggregate deflection (SNWD) will win in the efficiency category. The sum of normalized weight and aggregate deflection is computed as

SNWD = Total weight (lb) + (300 x Aggregate deflection (in))

E. Economy

The bridge with the lowest cost (C) will win in the economy category. Cost is computed as

C = Total weight (lb) x 1000 ($/lb)
+ Construction time (person-min) x 5000 ($/person-minute)
+ $50,000 if a temporary pier is used.

F. Aesthetics

The full name of the college or university must appear on the bridge, or on a banner or placard attached to the bridge, in letters at least 2 inches high. If used, the banner or placard must be installed before the end of timed construction and is included in total weight.

In addition to the college or university name, other factors that may be considered include general appearance, balance and proportion of the design, elegance, finish, construction organization and teamwork. Quality of fabrication should not be considered because some bridges may be fabricated professionally while others are student work.

G. Overall Performance

The overall performance rating of a bridge is determined by adding the ranks of the bridge in the construction speed, stiffness, efficiency and economy categories. Note that the lightness rank is not included in the sum because lightness affects both efficiency and economy, which do appear in the sum. The bridge with the lowest score will win the overall competition. In the case of a tie, judges will use aesthetics as the tie breaker.

VII. DIMENSIONS AND SUPPORT

A. Functionality and Safety

If any of the following regulations is violated, the bridge must be disqualified. The figures titled "Spans and Clearance" (**p. 7**) and "Deck Support, Roadway and Bearing" (**p. 7**) illustrate some of the requirements.

1. The bridge must span the river, which is 14 feet wide, without touching it. No part or accessory of the completed bridge may touch the river. Also see paragraph VII.B.1 (**p. 8**).

2. The overall length of the bridge must be at least 22 feet.

3. The bridge must provide continuous rigid support for the decking along both of the edges that run in the longitudinal direction of the bridge. The support must be continuous and rigid for the overall length of the bridge. This is easily verified by sliding a piece of decking along the full overall length of the bridge. Also see paragraph VII.B.3 (**p. 8**).

4. The edges of the decking that run in the longitudinal direction of the bridge may be cantilevered over their supports no more than 6 inches on each side.

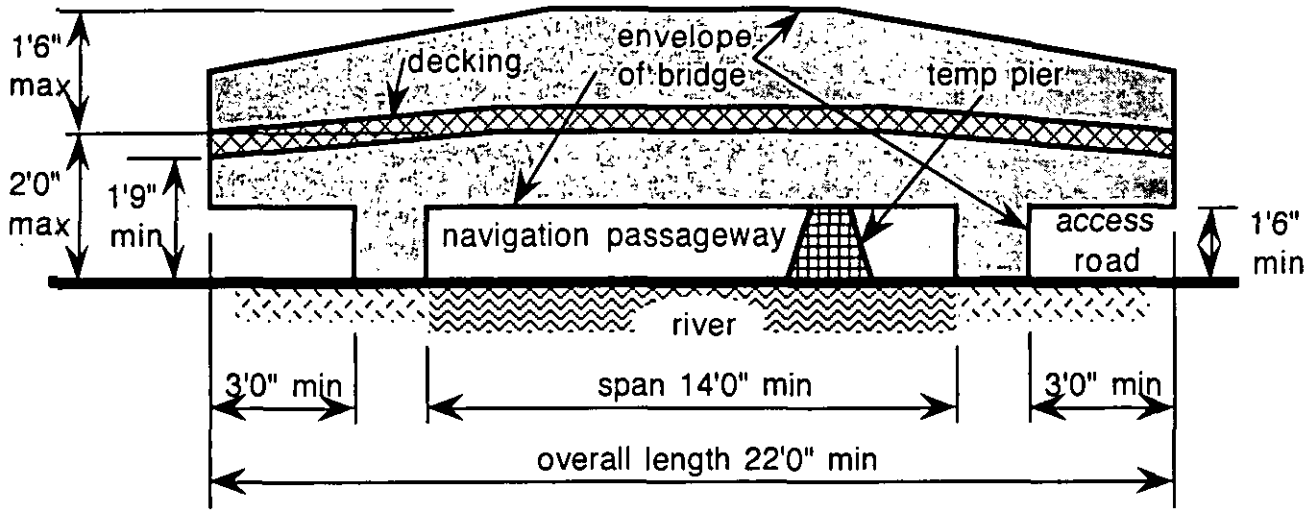
5. The decking may not be attached nor anchored to the bridge.

6. The bridge must provide access for placing the decking and load. Although decking is nominally 42 inches wide and 1 inch thick, the bridge must accommodate widths ranging from 41.75 to 42.25 inches and thickness up to 1.25 inches. Also see paragraph VII.B.4 (**p. 8**).

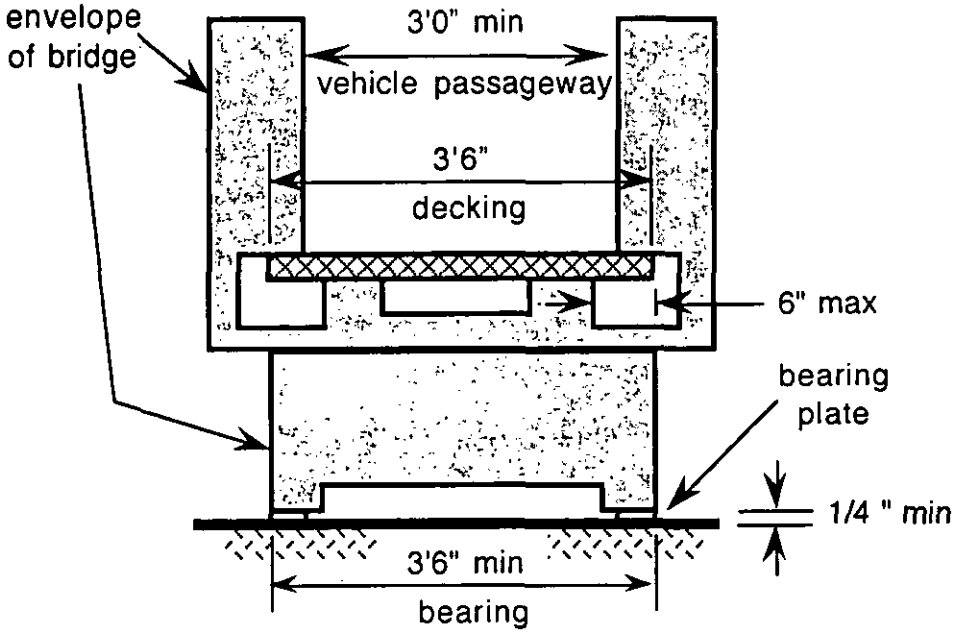
7. No part of the bridge may extend so high that it cannot be constructed in the building in which the contest is conducted. Also see paragraph VII.B.6 (**p. 8**).

8. On each side of the river the bridge must bear on the ground over a width of at least 3'6". Bearing is not required to be continuous over that width. Also see paragraph VII.B.7 (**p. 8**).

9. The bridge may not be anchored or tied to the ground.



Spans and Clearance (Side View)



Deck Support, Roadway and Bearing (End View)

Hollow circular and oval tube and other curvilinear closed shapes

Fabricated sections including closed curvilinear components

Example Unacceptable Member Cross-Sections

B. Usability

Violation of the each of the following rules will result in a weight penalty of 50 pounds being added to the weight of the bridge. A penalty will be assessed for each violation. The figures titled "Spans and Clearance" (**p. 7**) and "Deck Support, Roadway and Bearing" (**p. 7**) illustrate some of the requirements. Dimensions will be checked without load on the bridge.

1. A rectangular navigation passageway must be provided under the bridge. The navigation passageway must be at least 1'6" high, measured from the surface of the river, and it must be at least 14'0" wide, coinciding with the width of the river. Also see paragraph VII.A.1 (**p. 6**).

2. At each end of the bridge there must be clearance for an access road running along the bank of the river. This clearance must completely traverse the width of the bridge; it must be at least 1'6" high, measured from the surface of the ground; it must be at least 3'0" wide, measured from the end of the bridge; and it must extend to the end of the bridge.

3. Decking must be supported without overlaps, gaps, abrupt elevation differences exceeding 1/4 inch, or protrusions exceeding 1/4 inch in height. Also see paragraph VII.A.3 (**p. 6**).

4. A vehicle passageway at least 3'0" wide must completely traverse the bridge from end to end, and must extend upward from the decking through the top of the bridge. Also see paragraph VII.A.6 (**p. 6**).

5. The top surface of the decking supports must be no less than 1'9" nor more than 2'0" above the surface of the ground and river at any point. Note that the surfaces of the ground and river have the same elevation.

6. No part of the bridge may extend more than 1'6" above the top surface of the decking support at any point. Also see paragraph VII.A.7 (**p. 6**).

7. At each point where it bears on the ground the bridge will include a solid bearing plate at least 1/4 inch thick, 2 inches long and 2 inches wide. Also see paragraph VII.A.8 (**p. 6**).

VIII. MATERIAL AND COMPONENTS

A. Safety

If the following regulation is violated, the bridge must be disqualified.

1. A bridge member may not weigh more than 40 pounds. See section VIII.B (**p. 9**) *for definition of "bridge member."*

B. Durability and Constructability

Violation of each of the following rules will result in a weight penalty being added to the weight of the bridge. The penalty for each violation is 10 pounds plus 5 times the weight of the non-conforming components.

1. A bridge may be constructed only of structural steel. For the purposes of this contest, structural steel is defined as an iron alloy that is strongly attracted to a magnet. Exceptions: Paint, banners, placards and other purely decorative items.

2. A bridge may be constructed only of components conforming to the following definitions of bridge members and fasteners.

   a. A bridge member is a rigid component that retains its shape, dimensions and rigidity during timed construction and in the completed bridge.

   b. A fastener consists of two parts, namely a steel bolt and a matching steel nut, neither of which may be attached to a member or to one another before the start of timed construction.

3. A bridge member may not have a cross-section that is both closed (hollow) and curvilinear. For example, a bridge member may not be fabricated from pipe, conduit, circular tube or oval tube. The figure titled "Example Unacceptable Member Cross-Sections" (**p. 7**) shows examples of unacceptable cross-sections. Exception: washers, bushings and similar short sections pertaining to connections.

4. A bridge member may not exceed overall dimensions of 4'0" x 6" x 6." That is, it must fit in a prismatic box of those dimensions.

5. A bridge member must be rigid. That is, hinged, jointed, articulated and telescoping members are prohibited, as are those with moving parts. This prohibition includes members with parts that are intended to slide, rotate, deflect or bend relative to the member during construction, such as cams, latches, sliding pins, springs, and snap-lock devices. Cables and strapping are prohibited, as are similar materials that would not be damaged by coiling and uncoiling.

6. A bridge member may consist of several parts rigidly joined together (e.g. welded, bolted, screwed) before timed construction begins. Those parts must remain rigidly joined throughout the construction process and in the completed bridge. For example, if a bridge member incorporates a turnbuckle, that turnbuckle may not be turned after the start of timed construction.

7. A bolt may not exceed 3 inches in length. It must be straight, threaded and have a hexagonal or square head that will accept a wrench. Eye bolts are not permitted.

8. A nut must be threaded internally to fit its bolt.

9. All connections of bridge members to the bridge or to other bridge members must be made during timed construction.

10. Every connection of a bridge member to the bridge or to another bridge member must be secured during timed construction by at least one fastener so that the connection cannot be taken apart without first unscrewing the nut from the bolt and then removing both the nut and the bolt from the connection.

IX. CONSTRUCTION

A. Safety

If any of the following safety regulations is violated during timed construction, the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools and bridge components will be returned to the positions they occupied before the violation. Then the builders will be asked to resume construction using safe procedures. A bridge that cannot be constructed safely must be disqualified.

1. If a temporary pier is used, it may not weigh more than 40 pounds.

2. The temporary pier must not break nor collapse during construction.

3. Only hand-held tools are permitted. Tools must be powered manually or by internal batteries. Field welding and tools requiring external power connections are prohibited. Hoisting devices are prohibited (all lifting will be done without the aid of tools). Stools, ladders and similar objects for elevating builders are prohibited.

4. All builders must wear hardhats and safety glasses during timed construction.

5. A builder may not use the bridge, a portion of the bridge, or the temporary pier to support the builder's body weight. For example, standing, sitting or kneeling on those objects is prohibited. However, a builder may lean on the bridge or temporary pier if both feet remain on the ground.

6. A builder may not cross the river by jumping, by temporary scaffolding, by crossing the bridge, or by any other means.

7. Moving a portion of the bridge requires the effort of as many builders as there are members in that portion of the bridge. The term "portion of the bridge" includes, but is not limited to, single and multiple bridge members, bridge members that are connected together, and the entire bridge. The word "moving" includes, but is not limited to, lifting, carrying, lowering, rolling, turning, sliding and tipping, as well as causing translation and/or rotation of one portion of the bridge relative to another.

8. Outside the staging yard, any portion of the bridge that is not moving must either be supported by as many builders as there are bridge members in that portion of the bridge, or must be supported without the assistance of builders by any combination of the following: the portion itself, other portions of the bridge, tools, and temporary pier.

9. The temporary pier, if used, may not be moved by a builder who is also moving or supporting a portion of the bridge at the same time.

10. The temporary pier must be removed without lifting the bridge.

B. Team

Participation is limited to students. The construction team, also referred to as builders, consists of all participants who are within the construction site at any time during timed construction.

C. Tools

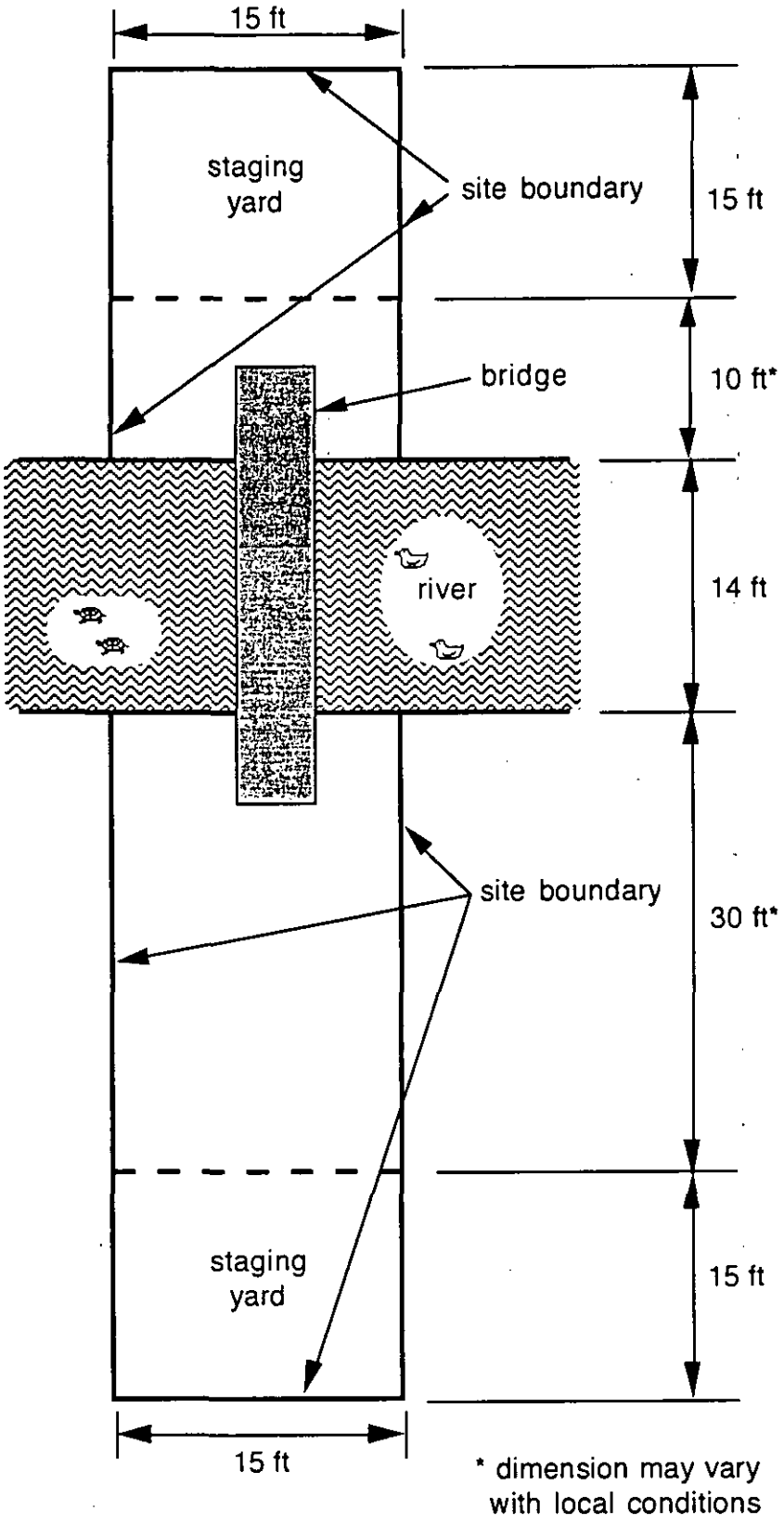
Competitors provide their own tools. Hardhats and safety glasses are considered to be tools. See paragraphs IX.A.3 and .4 (**p. 10**).

D. Construction Site

See the figure titled "Site Plan" (**p. 12**) for layout of the construction site. Only builders and judges are permitted in the construction site during timed construction. Only judges are permitted near the construction site; coaches, managers and other spectators must observe from a safe distance that does not obstruct judges.

E. Temporary Pier

A temporary pier is a support in the river or on the ground, and is provided by the competitors. A temporary pier may be any material but must provide sufficient strength and stability to support the bridge. The use of a temporary pier is optional and adds to the cost of the bridge. Only one temporary pier is permitted.


15 ft
staging yard
site boundary
15 ft
bridge
10 ft*
river
14 ft
site boundary
30 ft*
staging yard
15 ft
15 ft
* dimension may vary with local conditions

Site Plan

F. Start

Before construction begins, all bridge members, fasteners, tools, the temporary pier (if used) and builders are in the staging yards. Bridge members must not be connected or in contact with one another. There must be at least one bridge member in each staging yard. Timing and construction begin when the builders signify that they are ready and the judge declares the start.

G. Time

Time is kept from the start to finish of construction. The clock will be stopped:

1. if a builder or judge sees a condition that could cause injury, or

2. when a safety regulation has been violated. See section IX.A (**p. 10 and 11**).

Construction ceases while the clock is stopped. The clock is restarted after the situation has been corrected.

H. Finish

Construction ends when the bridge has been completed over the river by connecting all the members, and all tools, the temporary pier (if used) and builders are back in the staging yards, and the builders signify that they are finished. Installation of decking is not included in timed construction.

I. Accidents

In general, the clock is not stopped when an "accident" occurs. Builders involved in accidents may continue to build, and components involved in accidents may be recovered and used. If an accident is continuous (for example, a builder stands in the river) it will be counted as multiple incidents. Types of accidents and the corresponding time penalties, which will be added to the construction time, are:

1. A builder touches the river. Penalty is 3 person-minutes per incident. Exception: Builders may step in the river without penalty to place or remove the temporary pier or to retrieve a dropped member, tool or fastener.

2. A builder throws something. Penalty is 3 person-minutes per incident.

3. A portion of the bridge touches the river or the ground outside a staging yard. Penalty is 2 person-minutes per incident. Exception: No penalty is assessed when the ground is touched by the bottom of a bearing plate that will be in contact with that place on the ground when the bridge is completed (see paragraph VII.B.7 **p. 8**).

4. A tool, nut or bolt touches the river or the ground outside a staging yard. Penalty is 1 person-minute per incident. Exception: the temporary pier may touch the ground or river without penalty.

5. A builder steps outside the boundary of the construction site. Penalty is 1 *person-minute per incident*.

X. LOAD TESTS

A. Safety Precautions

A bridge could suddenly collapse or sway in any direction during load tests. Therefore, minimize the number of people near the bridge while it is being tested. Usually, the load may be placed on the bridge by only two competitors.

During testing, safety supports must be in place below the bottom of the decking. The safety supports should be of sufficient height, strength, number and extent that none of the load will fall more than three inches if the bridge collapses. The safety support should extend beyond the end of the bridge to arrest the load if it slides off the overhanging span.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a portion of the decking that is cantilevered laterally over its support.

When any portion of the load is on the bridge, no one is permitted to crawl, reach or step under the bridge. If such an action is necessary, the load must first be removed.

While participating in load testing, competitors must wear hardhats, safety glasses, gloves and leather construction boots. This safety equipment is provided by the competitors. Similar equipment is recommended for judges who will be near the bridge during load testing.

B. Repairs

A bridge will not be tested in a condition that compromises its strength or stability. Therefore, immediately prior to load testing, repairs may be made with the permission and supervision of a judge, according to the following provisions:

1. Damage occurring after construction will be repaired without penalty.

2. Construction errors will be repaired but a time penalty will be assessed in an amount, to be determined by the judge, that will exceed the incremental time required for careful initial construction.

C. Preparation

The provisions of this section are illustrated by the figure titled "Location of Targets and Decking" (**p. 17**).

Position the bridge in convenient proximity to load testing equipment.

Load tests are conducted without the temporary pier.

Place shims under the bearing plates of the bridge as necessary to compensate for sloping and/or rough ground surface. Shims may not be used to compensate for imprecise construction or fabrication of the bridge.

By a random process, the judge selects the end of the bridge on which the second load will be placed.

Safety supports are placed under the level of the decking so that no portion of the load will drop more than three inches if the bridge collapses. The safety support should extend beyond the end of the bridge that will be loaded.

Sway is translation in any horizontal direction. Two targets are established for sway measurements. These targets are located near the level of the decking at the ends of the bridge.

Two targets are established for midspan vertical deflection measurements. These targets are located near the level of the decking on both sides of the bridge at the center of the span.

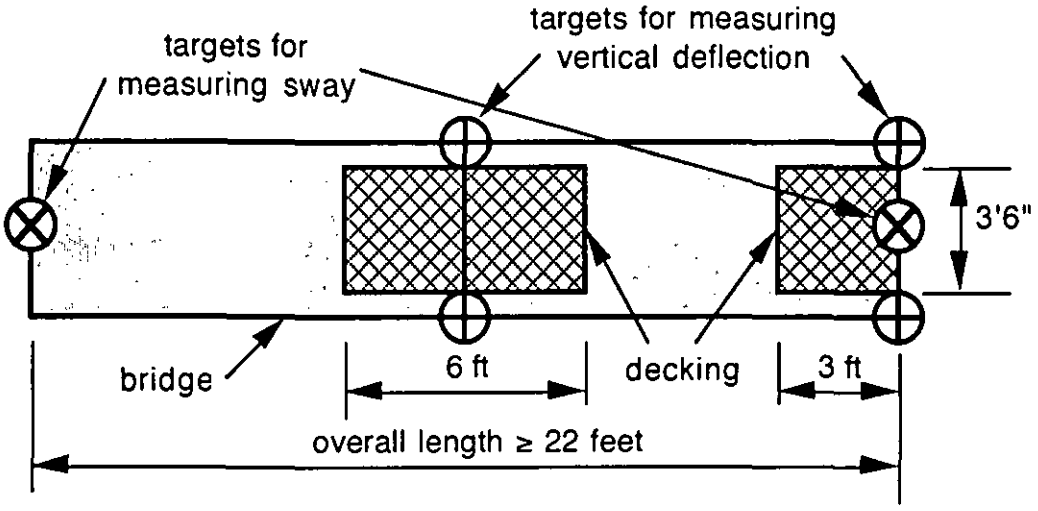
Two targets are established for end vertical deflection measurements. These targets are located near the level of the decking on both sides of the bridge at the end of the bridge that will be loaded.

Two units of decking are placed symmetrically about the middle of the center span and extending 6 feet in the span direction.

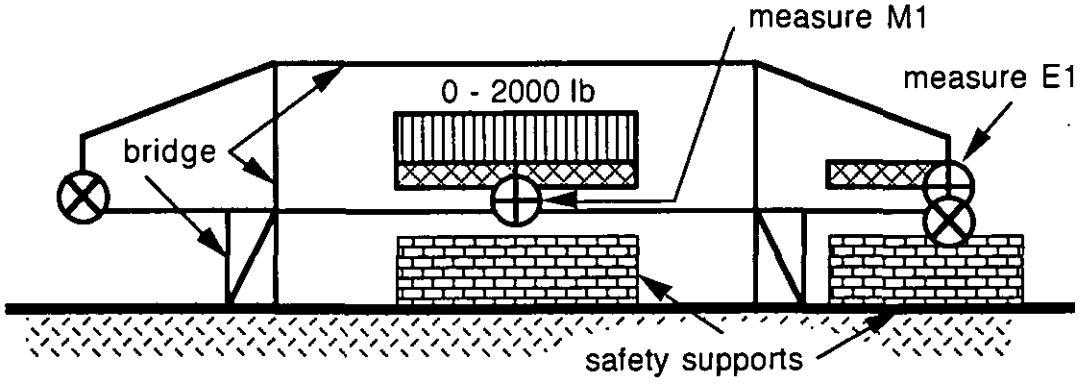
One unit of decking is placed at the end of the bridge selected for loading.

Measuring devices are positioned on the targets and either initialized to zero or the initial reading recorded.

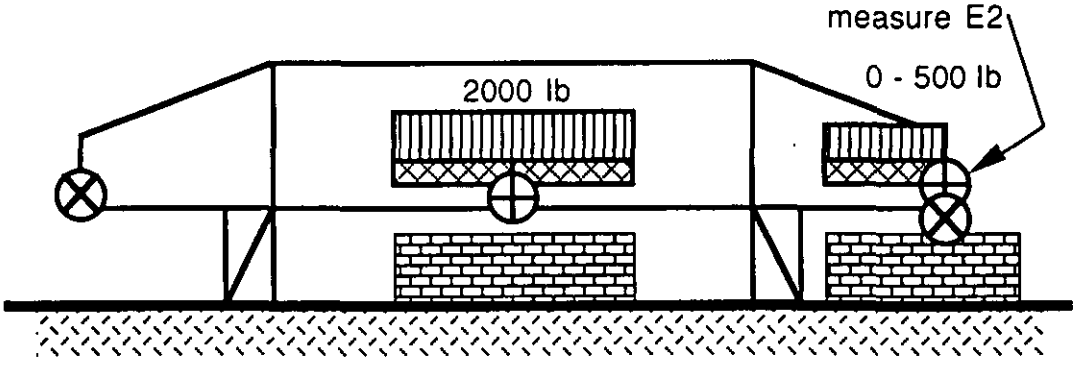
A BRIDGE THAT COLLAPSES DURING LOADING, DEFLECTION MEASUREMENTS OR UNLOADING MUST BE DISQUALIFIED.



Location of Targets and Decking (Plan)



First Load (Side View)



Second Load (Side View)

D. First Load: Center Span

Uniformly distribute load on the two units of decking on the center span, as shown in the figure titled "First Load" (**p. 17**).

As the load is being placed, observe sway and deflection. Stop loading and disqualify the bridge if sway at either end exceeds 1/2 inch, or if vertical deflection at any deflection target exceeds 2 inches.

If 2000 pounds of load (in addition to decking) was successfully placed without exceeding either limit, record the following measurements:

M1 = larger absolute value of the vertical distances of the two midspan deflection targets from their positions before any portion of the first load was placed.

E1 = larger absolute value of the vertical distances of the two end deflection targets from their positions before any portion of the first load was placed.

If either the sway or deflection limit was exceeded, remove all load and disqualify the bridge. Do not proceed to the second load.

In preparation for the second load, record the deflections at the end *deflection targets*.

E. Second Load: Overhang

With the first 2000 pound load remaining in place on the center span, uniformly distribute additional load over the unit of decking on the overhanging end of the bridge, as shown in the figure titled "Second Load" (**p. 17**).

As the second load is being placed, continue to observe sway and deflection with respect to initial positions before the first load was placed. Stop loading and disqualify the bridge if sway at either end exceeds 1/2 inch, or if vertical deflection at any deflection target exceeds 2 inches.

If 500 pounds of load (in addition to decking) was successfully placed on the overhang without exceeding either limit, record the following measurement:

E2 = larger absolute value of the vertical distances of the two end deflection targets from their positions with the first load in place but before any portion of the second load was placed. That is, E2 measures deflection that occurred while the second load was being placed.

If either the sway or deflection limit was exceeded, remove all load and disqualify the bridge.

F. Unloading

Unload the overhang first, then the center span. The bridge must be disqualified if it collapses during unloading.

G. Computing Aggregate Deflection

Compute and record: Aggregate deflection = M1 + E1 + (5 x E2)

XI. EQUIPMENT PROVIDED BY HOST

The following equipment will be provided at the contest site by the host. Competitors should acquire similar equipment for use in practice and testing before the competition.

A. Equipment for Measuring Sway

Sway is horizontal translation and is measured at both ends of the bridge by any accurate method. A suggested method is to suspend plumb bobs from the sway target points and measure sway from points marked on the ground.

B. Equipment for Measuring Deflection

Deflection is vertical translation and is measured at four points by any accurate method. Precision of 0.001 inch is recommended. LVDT's and dial gauges have been used successfully.

C. Decking

The decking is steel bar grating identified as W-19-4 (1 x 1/8). The dimensions of a piece of grating are approximately 3'6" x 2'11-3/4" x 1". 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 of the grating that are perpendicular to the length.

D. Load

2500 pounds total. The load should be supplied in uniform pieces of size and weight that may 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.

E. Shims

Shims are 2" x 2" steel plates that are inserted under the bearing plates of the bridge before loading as necessary to compensate for slope or roughness of the ground. If the ground in the testing area is rough or sloping, the host should provide an adequate supply of shims of various thickness. Shims may not be used to compensate for inaccurate fabrication or construction of bridges.

F. Safety Supports

The safety supports must be used during load testing and are intended to limit the consequences of a bridge collapsing. The safety supports should be of sufficient height, strength, number and extent so that none of the load will fall more than three inches if the bridge collapses. Safety supports may be steel, timbers, sand bags or masonry units.

XII. JUDGING

The host 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, rating and disqualification are the sole responsibility of the judges and will be final. The host will assure that the judges are fully informed of the rules and procedures, and fully equipped for their tasks. The host and judges will follow directions in the *Guide for Hosts and Judges* provided by AISC.

XIII. PROTESTS AND APPEALS

A. Before the Contest

Each team will designate a student as team captain. The host will identify the head judge.

B. During the Contest

A penalty, disqualification, measurement, score, or condition of competition may be protested only by a team captain and only to the head judge. The protest must be made as soon as possible after the situation becomes apparent. The head judge will not hear the protest if he or she is approached by students other than the team captain. As soon as possible after a protest is made, the head judge will interrupt the contest if necessary, gather the other judges and the captains of the teams involved, and hear the protest. The decision of the head judge is final.

Participants are reminded that civility and ethical behavior are expected during the contest and particularly concerning protests.

C. After the Regional Contest

If a team wants to appeal the decision of the head judge regarding a protest it may do so in a letter mailed to Mr. Fromy Rosenberg (AISC, Suite 3100, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to ASCE Student Activities Coordinator (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The letter should include the name of the college or university making the appeal; the names, addresses and telephone numbers of the faculty adviser and one team member; brief description of the problem, the action taken at the contest to deal with it, and the action that the appealing team feels should have been taken; and computation showing how the appealing team's rankings would have been improved if a different action had been taken.

Appeals must be made in writing. Only appeals received within one week after the regional contest will be considered.

The only redress that may be made is an invitation to participate in the national competition if the Rules Committee is convinced that the appeal is valid and that the appealing team should have placed first or second in its region. Decisions and rankings made by regional judges will not be overturned.

D. After the National Contest

Appeals will not be accepted. However, AISC welcomes written suggestions for improving future competitions.

XIV. TIPS FOR COMPETITORS

1. It is strongly recommended that bridges be load tested before competition, if it can be done safely, so that weaknesses and instability can be corrected.

2. Start work on the design early, leaving adequate time to procure materials, fabricate the bridge, load test it and practice construction.

3. Design a bridge that may be fabricated, erected and load tested safely, using available materials, tools and facilities.

4. Structural analysis may fail to disclose instability, such as buckling of slender compression members, sway, and torsion of under-deck trusses of triangular cross-section.

5. Allow tolerances for all limiting dimensions in order to accommodate imprecise measurement, fabrication, thermal expansion, elastic and inelastic deformation, wear, etc. For example, if a bridge is required to provide at least 12 inches of clearance, and it is designed to provide exactly that clearance, then there is a high probability that the actual as-built clearance will be less than the specified minimum. That probability of error may be reduced by designing the bridge to provide slightly more than the required minimum clearance.

6. When fabricating your bridge, use safe tools, operate them carefully and with adequate supervision.

7. Follow all safety regulations and guidelines during construction practice and loading.

8. Make sure that the temporary pier is stable and strong enough (with a generous factor of safety) so that it will not tip or break, even if the bridge collapses.

9. When practicing construction, wear hardhats and safety glasses both for safety and to accustom yourself to contest conditions.

10. When load testing your bridge use safety supports under the decking, sufficient in height, strength, number and extent to prevent the load from dropping more than three inches if the bridge collapses. This will reduce risk of injury and limit damage to the bridge if it collapses. Keep hands and feet out from under the bridge.

11. When load testing your bridge wear hardhats, safety glasses, gloves and leather construction boots.

12. Don't stand, sit or lie on your bridge.

13. To expedite the competition have a preset plan for unloading and staging components of your bridge.

14. When packing for the competition, remember to bring hardhats, safety glasses, gloves and construction boots.

XV. SCORE SHEET

A. Time Penalties

See "IX.I Construction: Accidents" (**p. 14**)

items 1,2: violations _____ x 3 = _____ person-min

items 3: violations _____ x 2 = + _____ person-min

items 4,5: violations _____ x 1 = + _____ person-min

TIME PENALTIES (add) _____ person-min

B. Weight Penalties

See "VII.B Dimensions and Support: Usability" (**p. 8**)

Number of violations _____ x 50 pounds = _____ pounds

See "VIII.B Material and Components: Durability and Constructability" (**p. 9**)

Number of violations _____ x *10 pounds* = + _____ *pounds*

Wt. of parts in violation _____ *pounds* x 5 = + _____ pounds

WEIGHT PENALTIES (add) _____ pounds

C. Construction Time

_____ builders x _____ min

+ time penalties = _____ = _____ person-min

D. Total Weight

Bridge weight _____ pounds

+ weight penalties _____ = _____ pounds

E. Aesthetics

Name of college or university appears on bridge or on attached banner or placard in letters at least 2 inches high.

Other items that may be considered:

General appearance	Finish
Balance and proportion	Elegance
Construction organization	Teamwork

AESTHETICS SCORE _____

F. Aggregate Deflection

Aggregate deflection: M1 + E1 + (5 x E2) = _____ inches

G. Efficiency

Total weight (lb) _____ = _____

Aggregate deflect. (in) _____ x 300 = +_____

SNWD (add) _____

H. Cost

Const. Time _____ x $5000 = $_____

Total Weight _____ x $1000 = +$_____

If temporary pier is used $50,000 = +$_____

TOTAL COST (add) $_____

I. Ranks

Disqualified bridges will not be ranked.

Lightness _____ Construction Speed _____

Aesthetics _____ Stiffness _____

Efficiency _____

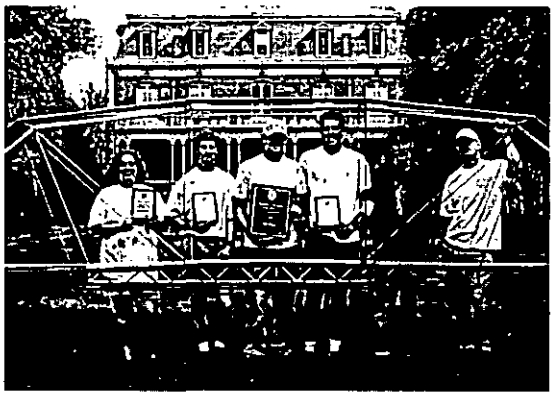
Economy _____

J. Overall Performance

Sum of ranks, except lightness and aesthetics.

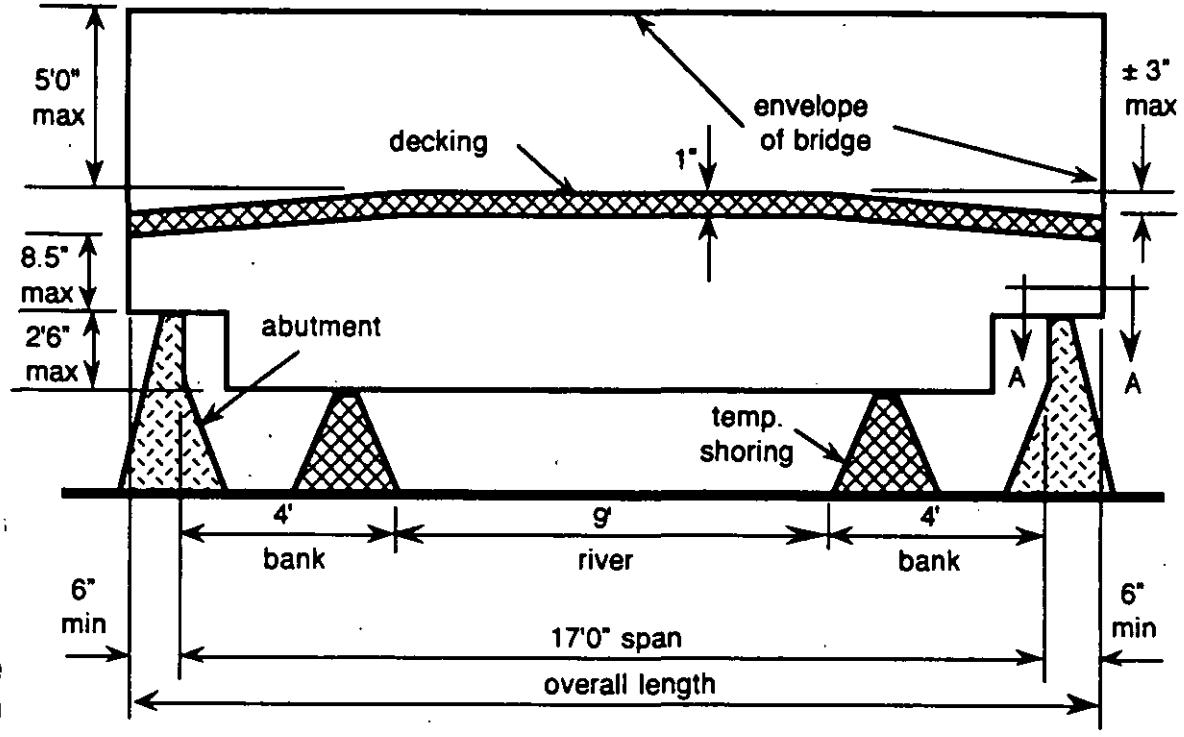
Construction speed + Stiffness + Efficiency + Economy = _____

Use aesthetics as tie breaker.



1999 STUDENT STEEL BRIDGE
Competition

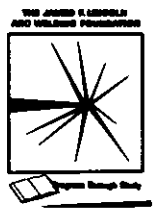
For Student Chapters Of
The American Society Of Civil Engineers



Side Elevation

Special thanks to: Steel Erectors Association of America

COSPONSORS



American Iron and
Steel Institute

RULES

AISC STUDENT STEEL BRIDGE COMPETITION

1999

TABLE OF CONTENTS

INTRODUCTION

The Student Steel Bridge Competition is sponsored by the American Institute of Steel Construction and co-sponsored by the American Society of Civil Engineers, the American Iron and Steel Institute, the James F. Lincoln Arc Welding Foundation and the National Steel Bridge Alliance. This inter-collegiate challenge requires Civil Engineering students to design, fabricate and construct a steel bridge.

Safety is of primary importance. The AISC requests that competitors, hosts and judges take all necessary precautions to prevent injury.

The competition rules have been changed for 1999 in order to improve the contest and to assure that competitors design and build new bridges.

Ideally, students should fabricate the entire bridge themselves. However, appropriate shop facilities and supervision may not be available at every college and university. Therefore, the services of a commercial fabricator may be used provided that students observe the operations. Students are encouraged to maximize their personal involvement in fabricating their bridge.

There are two levels of competition: regional and national. Regional winners and runners-up are invited to compete at the national level. These *Rules* govern competition at both regional and national levels. A university may enter more than one bridge in regional competition but only the best one may qualify for national competition.

This booklet describes the contest and states the official rules for this year. It is distributed to universities throughout the country. A companion booklet, *Guide for Hosts and Judges*, is distributed to hosts and provides directions for conducting a competition.

The rules are intended to be prescriptive but may require some interpretation. The host should promptly inform all competitors and judges of questions and interpretations concerning the rules and other aspects of the competition. Interpretations must be in writing.

EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication and construction. Participating students gain practical experience in structural design, fabrication processes, construction planning, organization and teamwork.

The "Problem Statement" describes challenges encountered in a representative structural engineering project. The competition is a scaled simulation of that project.

Standards for durability, constructibility, usability, strength and serviceability reflect the volumes of regulations that govern the design and construction of full-scale bridges. Criteria for excellence are represented by the award categories of stiffness, lightness, construction speed, aesthetics, efficiency and economy. As with a full-scale construction project, safety is the primary concern.

The rules of the competition accommodate a large 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.

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

RULE CHANGES

The following list covers some of the major changes from the 1998 rules. Minor changes and reorganization are not covered. Contestants are advised to read this entire *Rules* booklet carefully.

1. The span is decreased.

2. The widths of the river and of one bank are decreased.

3. The height limit is increased.

4. The limit on deck height above abutments is increased.

5. The depth limit is increased.

6. The height of the vehicle passageway is increased.

7. The bearing requirement is more specific.

8. A penalty is imposed for placing members, assemblies, fasteners and tools on the abutments, wingwalls and temporary shoring.

9. A cost is assessed for temporary shoring.

10. Use of round and oval tubing is penalized.

11. A bolt must be straight and must either utilize a nut or screw into a threaded hole.

12. Temporary shoring may not extend above the river.

13. Computation of efficiency score is changed.

14. The length of the load is decreased.

PROBLEM STATEMENT

A century-old bridge that crosses a river valley in a mountainous region must be replaced. The bridge carries heavy truck traffic to and from mines which are the basis for the economy of this rural region, as well as providing access and emergency services to residences. A quick replacement is necessary because no other river crossing is available for miles.

The State Department of Transportation has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered, but the State has specified steel as the material because of its durability and fast erection. The bridge must be able to carry specified patterns of traffic and wind loads without exceeding deflection limits. In order to expedite environmental approvals, no piers may be erected in the river, nor may temporary scaffolding or causeways be used in the river. However, temporary shoring may be erected on the banks. Construction barges and marine cranes are not feasible due to fast currents and flash floods.

The stone abutments of the existing bridge are in good condition and will serve for the new bridge, provided that no lateral thrust or uplift is applied to the abutments. The State DOT will not permit modification of the existing abutments. The new bridge, when complete, must be supported only by the existing abutments; for example, stays and anchorages to the river banks are prohibited.

The new bridge must accommodate modular decking, which the State DOT salvaged from another bridge. Decking units may not be modified.

Access to the construction site is limited by narrow, winding roads. This imposes restrictions on the size of components, and on the movements of construction equipment. Soil conditions restrict the weight that may be lifted by cranes.

Your company's design/build proposal is among those that the State DOT has deemed responsive. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. The DOT will evaluate the models by multiple criteria including durability, constructibility, usability, stiffness, construction speed, efficiency, economy and aesthetics. The contract will be awarded to the company that submits the best model. This is an opportunity to become leaders in the bridge replacement market.

SAFETY

Safety has the highest priority. Judges are directed to disqualify bridges that cannot be safely constructed or load tested using the abutments and other equipment provided by the host, as described in this booklet. Collapse or deflection in excess of limits specified in this booklet is incontrovertible evidence of an unsafe bridge and will result in disqualification. A disqualified bridge is not eligible for awards in any category, and must be withdrawn from all subsequent participation in the contest.

SCORING

A university may enter several bridges in a regional competition. However, if both first and second places are won by the same university, then only the best one of that university's bridges will be invited to participate in the national contest, together with the highest ranked bridge entered by another university.

Categories of competition are lightness, construction speed, stiffness, efficiency, economy and aesthetics. In addition, overall performance is rated. Bridges that have been disqualified are not eligible for awards in any categories.

Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in "Material and Components" and "Dimensions and Support." Decking and temporary shoring are not included in total weight.

Construction Speed

The bridge with the lowest construction time will win in this category. Construction time is the product of the size of the construction team and the duration of construction plus time penalties prescribed in "Construction: Accidents." The construction team includes everyone who handles the bridge or any of its components during timed construction.

Stiffness

The bridge with the lowest incremental vertical deflection will win in the stiffness category. Incremental vertical deflection is determined from load test 3.

Efficiency

The bridge with the smallest sum of normalized total weight and deflection (SNWD) will win in the efficiency category. The sum of normalized weight and deflection is computed as

SNWD = Total weight (lb) + (300 x Incremental vertical deflection (in))

Economy

The bridge with the lowest cost (C) will win in the economy category. Cost is computed as

C = Total weight (lb) x 1000 ($/lb)
+ Construction time (person-min) x 5000 ($/person-minute)
+ Number of temporary shoring units x 30,000 ($/unit)

Aesthetics

The full name of the college or university must appear on the bridge, or on a banner or placard attached to the bridge, in letters at least 2 inches high. If used, the banner or placard must be installed before the end of timed construction and is included in total weight.

In addition to the college or university name, other factors that may be considered include general appearance, balance and proportion of the design, elegance, finish, construction organization and teamwork. Quality of fabrication should not be considered because some bridges may be fabricated professionally while others are student work.

Overall Performance

The overall performance rating of a bridge is determined by adding the ranks of the bridge in the construction speed, stiffness, efficiency and economy categories. Note that the lightness rank is not included in the sum because lightness affects both efficiency and economy, which do appear in the sum. The bridge with the lowest score will win the overall competition. In the case of a tie, judges will use aesthetics as the tie breaker.

DIMENSIONS AND SUPPORT

Safety

If any of the following regulations is violated, the bridge must be disqualified. The figures titled "Side Elevation" and "Clearance and Deck Support" illustrate some of the requirements.

1. The bridge must provide rigid support for the decking along both of the edges that run in the longitudinal direction of the bridge. The support must be continuous for the central 6 feet of the bridge on which the load will be placed. Also see item 1 of the next section.

2. The bridge must span the abutments, which are fixed in place so that the clear distance between faces is 17 feet. Permanent shoring is not permitted.

3. The edges of the decking that run in the longitudinal direction of the bridge may be cantilevered over their supports no more than 6 inches.

4. Bearing areas at the four corners of the bridge must each extend behind the face of the abutment so that the bridge will remain supported by the abutments in the event that it is displaced either way in the direction of span. Also see item 4 of the next section.

5. No part of the bridge may extend so high that it cannot be constructed on the abutments in the building in which the contest is conducted. Also see item 5 of the next section.

6. No part of the bridge may be so low that it touches the river surface or bank with the bridge on the abutments. Also see item 6 of the next section.

7. The decking may not be attached nor anchored to the bridge.

8. The bridge may not be attached nor anchored to the abutments, and it may bear only on the top surface of the abutments.

9. The bridge may not be anchored, tied or braced to the ground.

Usability

Violation of the each of the following rules will result in a weight penalty of 50 pounds being added to the weight of the bridge. A penalty will be assessed for each violation. The figures titled "Side Elevation" and "Clearance and Deck Support" illustrate some of these rules. Dimensions will be checked without load on the bridge.

1. The bridge must provide support for the decking along both of the edges that run in the longitudinal direction of the bridge. The support must be continuous for the overall length of the bridge. This is easily verified by sliding a piece of decking along the full overall length of the bridge. Also see item 1 of the preceding section.

2. Although decking is nominally 42 inches wide and 1 inch thick, the bridge must accommodate widths ranging from 41.75 to 42.25 inches and thickness up to 1.25 inches.

3. Decking must be supported without gaps, overlaps or abrupt elevation differences between decking units. However, small elevation differences caused by decking resting on bolt heads are acceptable.

4. Each of the four bearing areas at the corners of the bridge must extend at least 6 inches behind the face of the abutment, be at least 2 inches wide and be fabricated of flat stock (e.g. plate, bar, strip, sheet) that is at least *1/8 inch thick The prescribed bearing area must be solid (i.e. no holes)* and the bottom surface that bears on the abutment must be flat and horizontal. Also see item 4 of the preceding section.

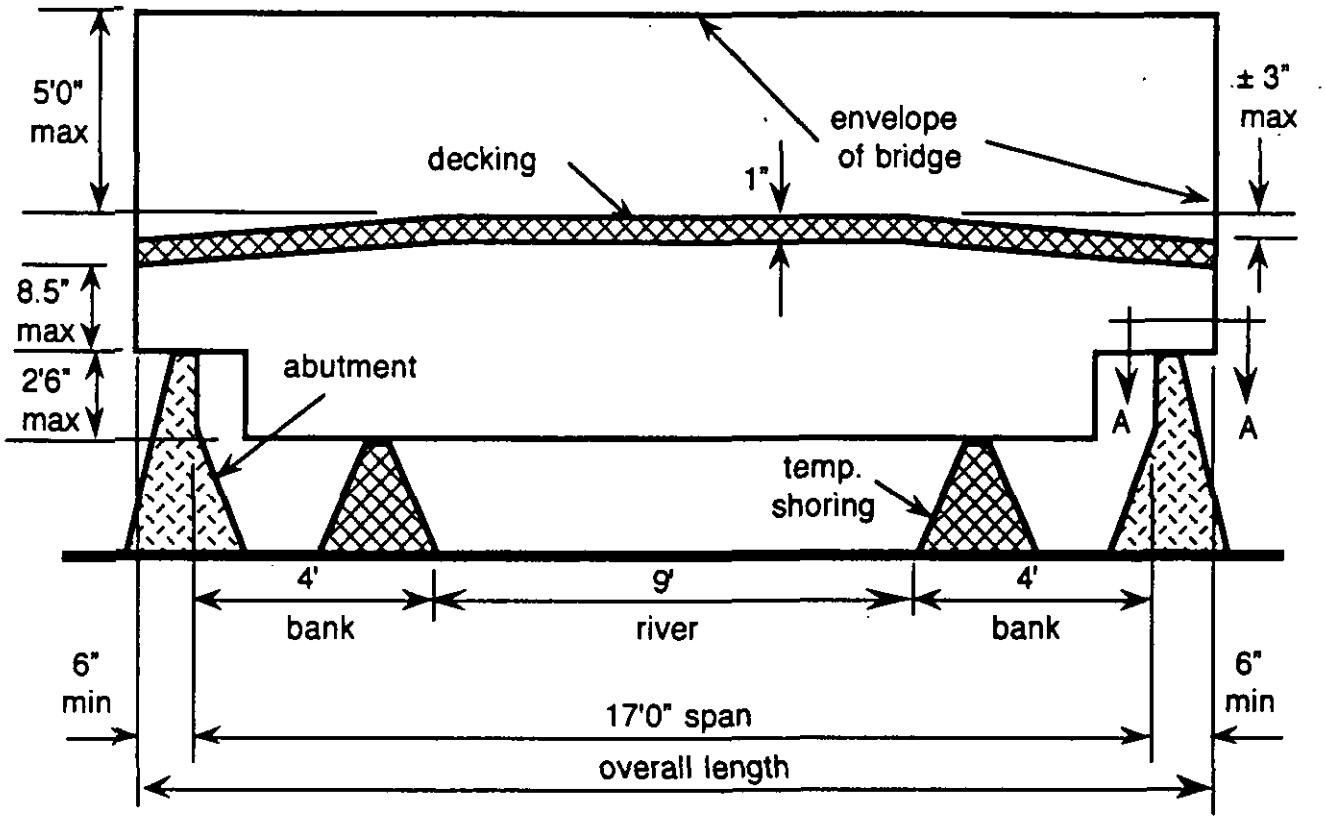
5. No part of the bridge may extend more than 5'0" feet above the top of the decking at any point on the span. Also see item 5 of the preceding section.

6. No part of the bridge may extend more than 2'6" below the top of the abutments at any point on the span. Also see item 6 of the preceding section.

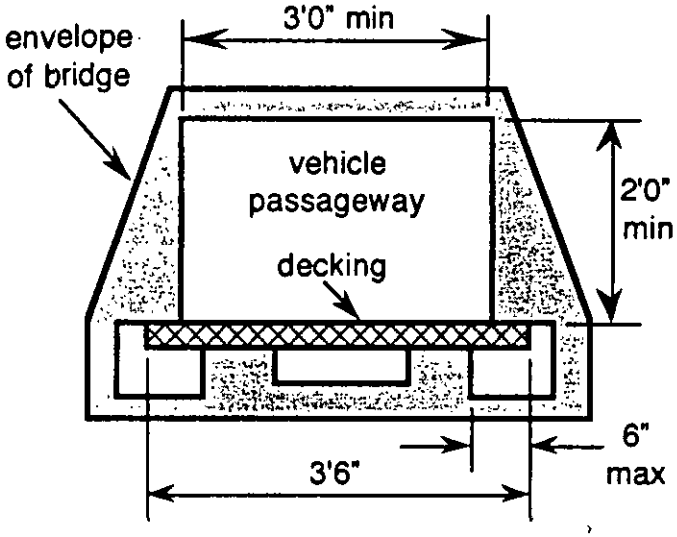
7. The surface of the decking support must be no more than 8.5" above the top of the abutments, measured at the abutments.

8. The absolute value of camber must not exceed 3 inches.

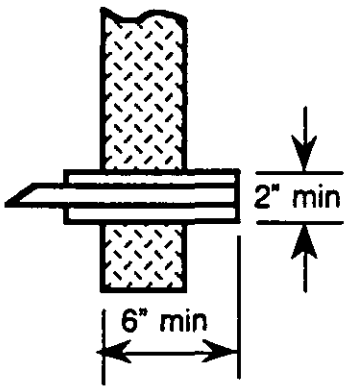
9. A 3'0" wide by 2'0" high rectangular vehicle passageway must be provided along the overall length of the bridge.



Side Elevation



Clearance and Deck Support



Section A-A
Typical 4 places

MATERIAL AND COMPONENTS

Safety

If the following regulation is violated, the bridge must be disqualified.

1. A member may not weigh more than 40 pounds. See the next section for definition of "member."

Durability and Constructibility

Violation of each of the following rules will result in a weight penalty being added to the weight of the bridge. The penalty for each violation is 10 pounds plus 5 times the weight of the non-conforming members, fasteners, assemblies and other parts.

1. A bridge may be constructed only of structural steel. For the purposes of this contest, structural steel is defined as an iron alloy that is strongly attracted to a magnet. Exceptions: Paint, banners, placards and other purely decorative items.

2. A bridge may be constructed only of components conforming to the following definitions of members, fasteners and assemblies.

a. A member is a rigid component that retains its shape, dimensions and rigidity during construction and in the completed bridge.

b. Fasteners are steel machine bolts and nuts. Bolts must be straight , threaded and have hexagonal, square or round heads that will accept a wrench or screwdriver. Eye bolts are not permitted. Nuts must be threaded internallly.

c. An assembly is no more than 3 members plus any number of fasteners that are joined together in the staging yards during timed construction.

3. A member may not have a cross-section that is both closed (hollow) and curvilinear. For example, a member may not be fabricated from pipe, conduit, circular tube or oval tube. The figure titled "Example Unacceptable Member Cross-Sections" shows examples of unacceptable cross-sections. Exception: washers, bushings and similar short sections pertaining to connections.

Hollow circular and oval tube and other curvilinear closed shapes

Fabricated sections including closed curvilinear components

Example Unacceptable Member Cross-Sections

4. A member may not exceed overall dimensions of 5'6" x 7.5" x 7.5." That is, it must fit in a prismatic box of those dimensions.

5. A member must be rigid. That is, hinged, jointed, articulated and telescoping members are prohibited, as are members with moving parts. This prohibition includes members with parts that are intended to slide, rotate, deflect or bend relative to the member during construction, such as cams, latches, sliding pins, springs, and snap-lock devices. Cables and strapping are prohibited, as are similar materials that would not be damaged by coiling and uncoiling.

6. A member may consist of several parts rigidly joined together before timed construction begins. Those parts must remain rigidly joined throughout the construction process and in the completed bridge. For example, if a member incorporates a turnbuckle, that turnbuckle may not be turned after the start of timed construction. However, a turnbuckle itself may be identified as a separate member, in which case builders must join it to other members during timed construction and may turn and adjust it during timed construction.

7. Fasteners must be threaded and may not exceed 3 inches in length. Bolts must have hexagonal, square or round heads that will accept a wrench or screwdriver. Eye bolts are not permitted.

8. Every bolt must be secured by screwing it into a nut or threaded hole.

9. Members and assemblies may be joined without the use of fasteners.

10. The members of an assembly must remain joined (not necessarily rigidly).

CONSTRUCTION

Safety

If any of the following safety regulations is violated during timed construction, the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools and bridge components will be returned to the positions they occupied before the violation. Then the builders will be asked to resume construction using safe procedures. A bridge that cannot be constructed safely must be disqualified.

1. Each unit of temporary shoring may not weigh more than 40 pounds. Temporary shoring is defined below.

2. Temporary shoring must not break or collapse during construction.

3. Only hand-held tools are permitted. Tools must be powered manually or by internal batteries. Field welding and tools requiring external power connections are prohibited. Ropes are permitted but gin poles, jacks, winches, come-alongs, counterweights and other hoisting devices are prohibited. Stools, ladders and similar objects for elevating builders are prohibited.

4. All builders must wear hardhats during timed construction.

5. A builder may not use the bridge, an abutment or temporary shoring to support the builder's body weight. For example, standing, sitting or kneeling on those objects is prohibited. However, a builder may lean on the bridge, abutment or shoring if both feet remain on the river bank.

6. A builder may not cross the river by jumping, by temporary scaffolding, by crossing the bridge, or by any other means.

7. A builder may lift or carry only one member or one unit of temporary shoring at a time. See "Material and Components" for definition of member.

8. An assembly may not be lifted or carried by one builder alone. See "Material and Components" for definition of assembly.

9. Two or more builders may lift or carry only one assembly at a time.

10. A constructed portion of the bridge (i.e. not conforming to the definitions of member or assembly) may not be lifted or carried.

11. A constructed portion of the bridge must be supported fully at all *times by some combination of temporary shoring and abutments. That is,* builders may not support either or both ends or sides of a constructed portion. Temporary shoring must be removed without lifting either or both ends or sides of a constructed portion of the bridge.

12. A constructed portion of the bridge may not be slid horizontally unless it is supported by both abutments, or by temporary shoring on both banks, or by one abutment and one unit of temporary shoring.

Team

The construction team, also referred to as builders, consists of everyone who handles the bridge or any of its components during timed construction. Participation is limited to students. Only builders are permitted in the construction site during timed construction.

Tools

Competitors provide their own tools. See item 3 of the preceding section. Hardhats are considered to be tools.

Construction Site

See the figure titled "Site Plan" for layout of river, banks, and other features that affect construction.

Temporary Shoring

Shoring is support on one or both river banks, and is provided by the competitors. Temporary shoring may be any material but must provide sufficient strength and stability to support the bridge. Temporary shoring must be removable without lifting the bridge.

Start

Before construction begins, all members, fasteners, units of temporary shoring, tools and builders are in the staging yards. Timing and construction begin when the builders signify that they are ready and the judge declares the start.

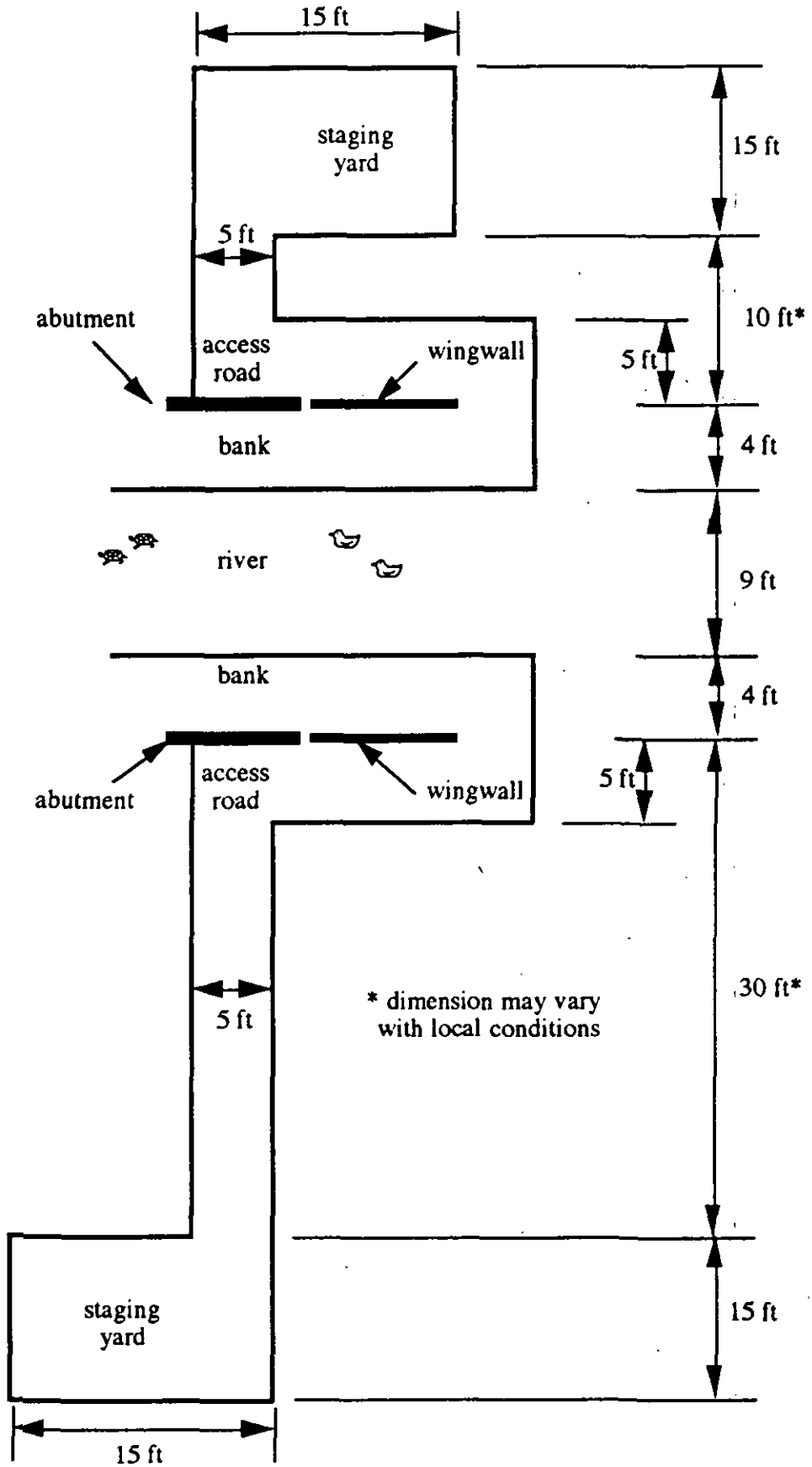
Time

Time is kept from the start to finish of construction. The clock will be stopped:

1. if a builder or judge sees a condition that could cause injury, or

2. when a safety regulation has been violated.

Construction ceases while the clock is stopped. The clock is restarted after the situation has been corrected.


15 ft
staging yard
15 ft
5 ft
abutment
access road
wingwall
10 ft*
5 ft
bank
4 ft
river
9 ft
bank
4 ft
abutment
access road
wingwall
5 ft
5 ft
* dimension may vary with local conditions
30 ft*
staging yard
15 ft
15 ft

Site Plan

Time Limit

The clock time for constructing a bridge is limited to 30 minutes. If construction exceeds that time limit, a penalty of $5000 per clock minute over the limit will be added to the score in the economy category.

Finish

Construction ends when the bridge is complete, and all tools, temporary shoring and builders are in the staging yards, and the builders signify that they are finished. Installation of decking is not included in timed construction.

Accidents

In general, the clock is not stopped when an "accident" occurs. Builders involved in accidents may continue to build, and components involved in accidents may be recovered and used. If an accident is continuous (for example, a builder stands in the river) it will be counted as multiple incidents. Types of accidents and the corresponding time penalties, which will be added to the construction time, are:

1. A builder touches the river. Penalty is 3 person-minutes per incident. Exception: Builders may step in the river without penalty to retrieve a dropped member, assembly, tool or fastener.

2. A builder throws something. Penalty is 3 person-minutes per incident.

3. A builder crosses a wingwall or an abutment. Penalty is 2 person-minutes per incident.

4. Temporary shoring touches the river or an access road, or extends over the river. Penalty is 2 person-minutes per incident.

5. A member, assembly, or the bridge touches the river, a bank, or an access road. Penalty is 2 person-minutes per incident.

6. A member or assembly is placed on or leaned against the bridge, a wingwall, an abutment or a unit of temporary shoring without being joined to the bridge or held by a builder. Penalty is 2 person-minutes per incident.

7. A fastener or tool is placed on or leaned against an abutment, a wingwall, or a unit of temporary shoring. Penalty is 1 person-minute per incident.

8. A tool or fastener touches the river, a bank, or an access road. Penalty is 1 person-minute per incident.

9. A builder steps beyond the limits of an access road, staging yard or river bank. Penalty is 1 person-minute per incident.

LOAD TESTS

Safety Precautions

A bridge could collapse or sway suddenly during load tests. Therefore, minimize the number of people near the bridge while it is being tested.

If abutments are adjustable, set them so that the bottom of the bridge is 3 to 6 inches above ground.

During testing, safety supports must be in place 3 to 6 inches below the bottom of the decking.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a cantilevered portion of the decking.

When any portion of the vertical load is on the bridge, no one is permitted to crawl, reach or step under the bridge. If such an action is necessary, the load must first be removed.

Repairs

A bridge will not be tested in a condition that compromises its strength or stability. Therefore, immediately prior to load testing, repairs may be made with the permission and supervision of a judge, according to the following provisions:

1. Damage occurring after construction will be repaired without penalty.

2. Minor construction errors will be repaired without penalty. For example, a nut may be adjusted to correct a slight misalignment of a primary component with no penalty.

3. Errors due to negligent construction will be repaired but a time penalty will be assessed in an amount, to be determined by the judge, that will exceed the incremental time required for careful initial construction. For example, a team that forgets to install bracing or makes no attempt to adjust nuts during timed construction will be penalized.

4. Deliberate exploitation of these repair provisions constitutes negligent construction and will be penalized heavily.

General Procedures and Definitions

Load tests are conducted without temporary shoring. Load test 1 is conducted without decking; load tests 2 and 3 are conducted with two decking units installed to accommodate the load.

Given weights of load are in addition to decking.

The figure titled "Location of Targets" illustrates some of the following procedures.

The judge designates, by a random process, the A and B sides of the bridge.

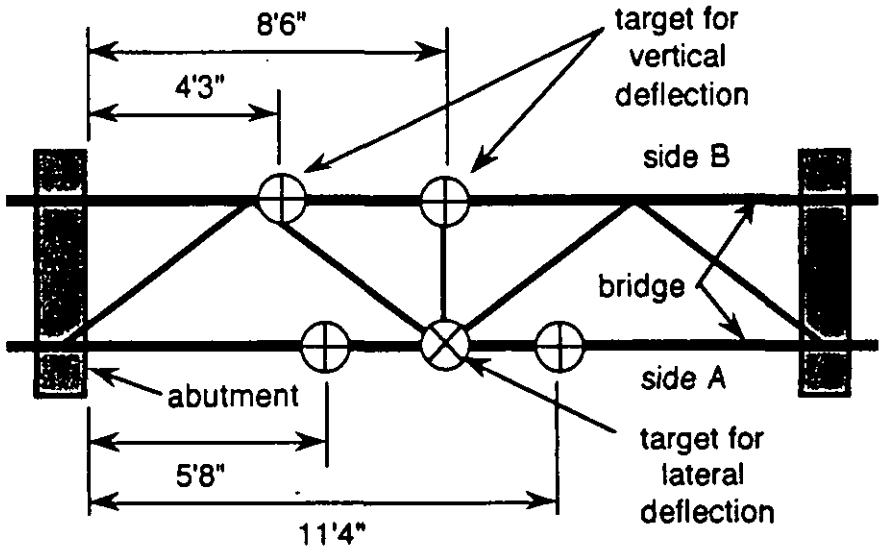
The judge marks a target at midspan on the A side, close to the level of the decking. All lateral deflection measurements are made to that target.

The judge marks targets on the A side at the third points of the span (i.e. 5 feet 8 inches and 11 feet 4 inches from the faces of the abutments). Then the judge also marks targets on the B side at the one quarter point and at midspan (i.e. 4 feet 3 inches and 8 feet 6 inches from the face of an abutment). The targets should be close to the level of the decking. Vertical deflection measurements are made to all four targets; vertical deflection is the largest absolute value of the four measurements.

Total lateral deflection is the absolute value of the horizontal distance of the target from its position at the beginning of load test 2. Incremental vertical deflection is the largest absolute value of the vertical distances of the targets from their positions at the beginning of load test 3.

Load tests are conducted in numerical order.

A BRIDGE THAT COLLAPSES DURING LOADING, DEFLECTION MEASUREMENTS OR UNLOADING MUST BE DISQUALIFIED.

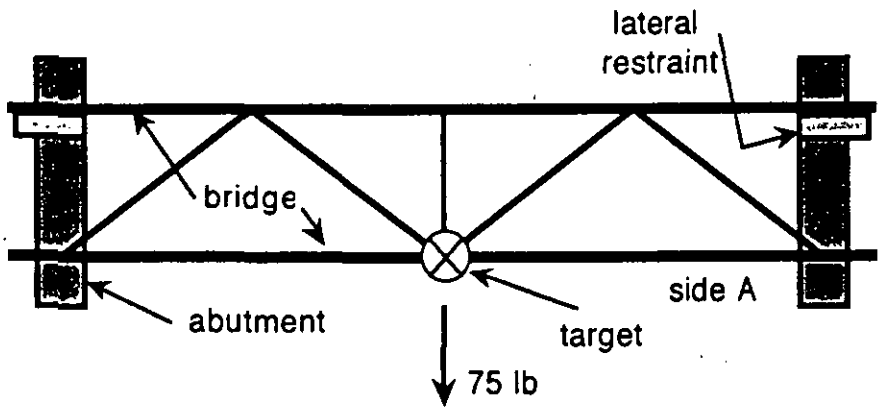


Location of Targets

Plan

Load Test 1 - Lateral

Load test 1 is conducted with lateral restraint installed on the abutments to prevent the ends of the bridge from sliding. On side A, as close as practical to midspan and to the level of the deck apply a 75 pound force in the lateral direction. To pass load test 1, the lateral deflection of the bridge must not exceed 1.0". If the bridge does not pass load test 1 it is disqualified; do not conduct any other load test. Remove the lateral load; it is not part of the remaining load tests.

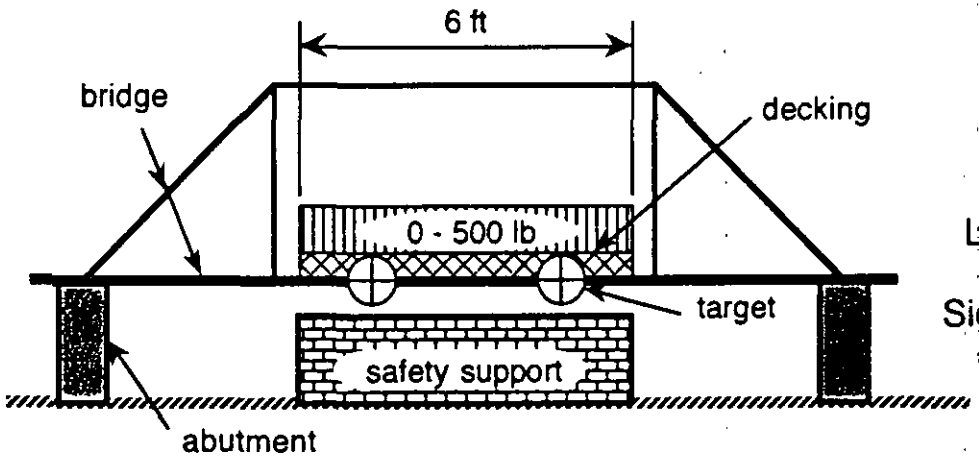


Load Test 1

Plan

Load Test 2 - Vertical, Preliminary

Uniformly distribute load over an area symmetric about the middle of the deck and extending 6 feet in the span direction, as shown in the figure. Terminate load test 2 when lateral deflection exceeds 1.0" or vertical deflection exceeds 2.0" or 500 pounds of load have been placed. A bridge passes load test 2 if 500 pounds of load was placed without a deflection limit being exceeded. If the bridge does not pass load test 2 it is disqualified; do not conduct any other load test.

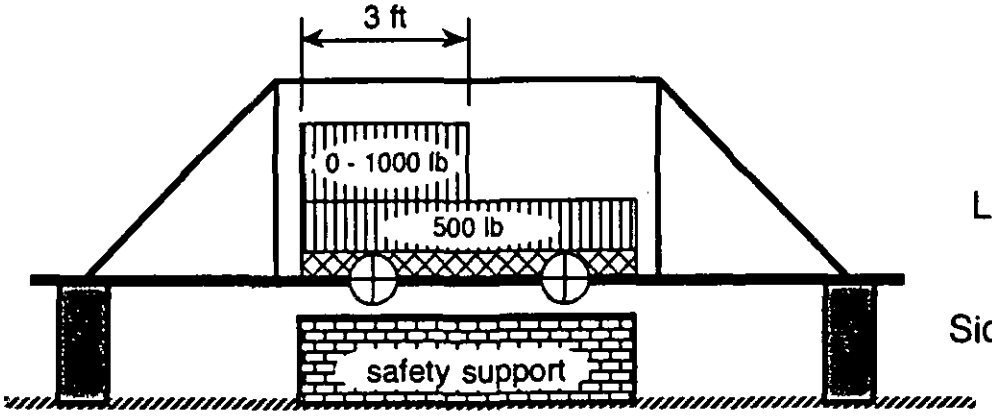


Load Test 2

Side Elevation

Load Test 3 - Vertical, for Deflection Measurement

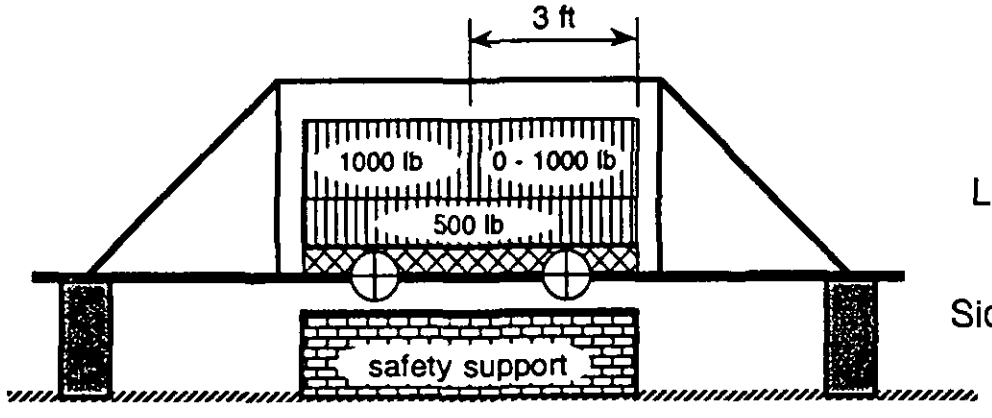
Step 1. With the 500 pound load from test 2 remaining in place, record the vertical deflections of all targets (because they will be needed to compute the incremental vertical deflection). Then, uniformly distribute additional load over an area symmetric to the midline of the deck and extending 3.0 feet from midspan toward an end randomly selected and designated by the judge. That is, the load is longitudinally eccentric, as shown in the figure. Terminate step 1 when total lateral deflection exceeds 2.0" or incremental vertical deflection exceeds 2.0" or total load is 1500 pounds. Terminate load test 3 and disqualify the bridge if either deflection limit is exceeded.



Load Test 3
Step 1

Side Elevation

Step 2. With previous loads remaining in place, uniformly distribute additional load over an area symmetric to the midline of the deck and extending 3.0 feet from midspan toward the end opposite to the one designated by the judge in step 1. That is, the load restores symmetry, as shown in the figure. Terminate step 2 when total lateral deflection exceeds 2.0" or incremental vertical deflection exceeds 2.0" or total load is 2500 pounds. Terminate load test 3 and disqualify the bridge if either deflection limit is exceeded. If the total load of 2500 pounds was placed without a deflection limit being exceeded, then the bridge passes load test 3. Record the incremental vertical deflection (that is, the largest absolute value of the vertical distances of the four targets from their positions at the start of test 3).



Load Test 3
Step 2

Side Elevation

EQUIPMENT PROVIDED BY HOST

The following equipment will be provided at the contest site by the host. Competitors should acquire similar equipment for use in practice and testing before the competition.

Lateral Load Device

Capable of applying 75 pound force in the horizontal direction.

Measuring Instruments and Scales

Load

2500 pounds total. The load should be supplied in uniform pieces of size and weight that may be handled safely. When in place, the load should not provide significant stiffness in the longitudinal direction of the bridge. Sections of steel angle of uniform size and length are recommended for load. 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.

Decking

The decking is steel bar grating identified as W-19-4 (1 x 1/8). The dimensions of a piece of grating are approximately 3'6" x 2'11-3/4" x 1". 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 of the grating that are perpendicular to the length.

Abutments

Construction. The top surface of each abutment should be at least 5 feet long, at least 3 inches wide, level, smooth, and approximately 3 feet above the ground.

Load Testing. A different set of abutments may be used during load testing. The top surface of each abutment should be at least 5 feet long, at least 3 inches wide, level and smooth. Height may be adjustable so that the bridge may be positioned close to the ground. Temporary lateral restraints are needed during load test 1.

Safety Support

The safety support must be used during load testing and is intended to limit the consequences of a bridge collapsing. The safety support should extend at least 6 feet along the length of the bridge. It should be adjustable in width and height, and should be centered under the bridge. The safety support must be placed before the beginning of load testing, with the top 3 to 6 inches below the bottom of the decking.

JUDGING

The host 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, rating and disqualification are the sole responsibility of the judges and will be final. The host will assure that the judges are fully informed of the rules and procedures, and fully equipped for their tasks. The host and judges will follow directions in the *Guide for Hosts and Judges* provided by AISC.

PROTESTS AND APPEALS

Before the Contest Each team will designate a student as team captain. The host will identify the head judge.

During the Contest A penalty, disqualification, measurement, score, or condition of competition may be protested only by a team captain and only to the head judge. The protest must be made as soon as possible after the situation becomes apparent. The head judge will not hear the protest if he or she is approached by students other than the team captain. As soon as possible after a protest is made, the head judge will interrupt the contest if necessary, gather the other judges and the captains of the teams involved, and hear the protest. The decision of the head judge is final.

Participants are reminded that civility and ethical behavior are expected during the contest and particularly concerning protests.

After the Regional Contest If a team wants to appeal the decision of the head judge regarding a protest it may do so in a letter mailed to Mr. Fromy Rosenberg (AISC, Suite 3100, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to ASCE Student Activities Coordinator (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The letter should include the name of the college or university making the appeal; the names, addresses and telephone numbers of the faculty adviser and one team member; brief description of the problem, the action taken at the contest to deal with it, and the action that the appealing team feels should have been taken; computation showing how the appealing team's rankings would have been improved if a different action had been taken.

Appeals must be made in writing. Only appeals received within one week of the regional contest will be considered.

The only redress that may be made is an invitation to participate in the national competition if the Rules Committee is convinced that the appeal is valid and that the appealing team should have placed first or second in its region. Decisions and rankings made by regional judges will not be overturned.

After the National Contest Appeals will not be accepted. However, AISC welcomes written suggestions for improving future competitions.

TIPS FOR COMPETITORS

1. Strive for challenging but realistic goals for design and construction. The following statistics from the 1998 National Student Steel Bridge Competition suggest the levels of performance that are possible. However, when reviewing these statistics keep in mind that the rules and scoring for 1999 differ from those for 1998.

	Winning bridge in category	Winning bridge, overall
Weight (lb)	57	75
Construction time (person-minutes)	9.23	14.89
Incremental vertical deflection (inches)	0.165	0.165

2. It is strongly recommended that bridges be load tested before competition, if it can be done safely, so that weaknesses and instability can be corrected.

3. Start work on the design early, leaving adequate time to procure materials, fabricate the bridge, load test it and practice construction.

4. Design a bridge that may be fabricated, erected and load tested safely, using available materials, tools and facilities.

5. Structural analysis may fail to disclose instability, such as buckling of slender compression members, sway, and torsion of under-deck trusses of triangular cross-section.

6. Allow tolerances for spacing and levelness of abutments.

7. Allow tolerances for all limiting dimensions, in order to accommodate imprecise fabrication, thermal expansion, elastic and inelastic deformation, wear, etc.

8. When fabricating your bridge, use safe tools, operate them carefully and with adequate supervision.

9. Make sure that abutments, temporary shoring and safety support are strong enough (with a generous factor of safety) and will not tip during use, even if the bridge collapses.

10. When practicing construction, wear hardhats for safety and to accustom yourself to contest conditions.

11. Follow all safety regulations and guidelines during construction practice.

12. When load testing your bridge keep it as low to the ground as possible and place safety support a few inches below the decking under at least 6 feet of the span. This will reduce risk of injury and limit damage to the bridge if it collapses. Keep hands and feet out from under the bridge.

13. Don't stand, sit or lie on your bridge.

14. To expedite the competition have a preset plan for unloading and staging components of your bridge. Before the competition adjust your temporary shoring to conform to the height of the host's abutments.

SCORE SHEET

Time Penalties

See "Construction: Accidents"

items 1,2: violations _____ x 3 = _____ person-min

items 3-6: violations _____ x 2 = + _____ person-min

items 7-9: violations _____ x 1 = + _____ person-min

TIME PENALTIES (add) _____ person-min

Weight Penalties

See "Dimensions and Support: Usability"

Number of violations _____ x 50 pounds = _____ pounds

See "Material and Components: Durability and Constructibility"

Number of violations _____ x 10 pounds = + _____ pounds

Wt. of parts in violation _____ pounds x 5 = + _____ pounds

WEIGHT PENALTIES (add) _____ pounds

Construction Time

_____ builders x _____ min

+ time penalties = _____ = _____ person-min

Total Weight

Bridge weight _____ pounds

+ weight penalties _____ = _____ pounds

Aesthetics

Name of college or university appears on bridge or on attached banner or placard in letters at least 2 inches high.

Other items that may be considered:

General appearance	Finish
Balance and proportion	Elegance
Construction organization	Teamwork

AESTHETICS SCORE _____

Deflection

(incremental vertical, test 3) _____ inches

Efficiency

Total weight (lb) _____ = _____

Incremental vert. deflect. (in) _____ x 300 = +_____

SNWD (add) _____

Cost

Const. Time _____ x $5000 = $_____

Total Weight _____ x $1000 = +$_____

Units of Temporary Shoring _____ x $30,000 = +$_____

TOTAL COST (add) $_____

Ranks

Disqualified bridges will not be ranked.

Lightness _____ Construction Speed _____

Aesthetics _____ Stiffness _____

Efficiency _____

Economy _____

Overall Performance

Sum of ranks, except lightness and aesthetics.

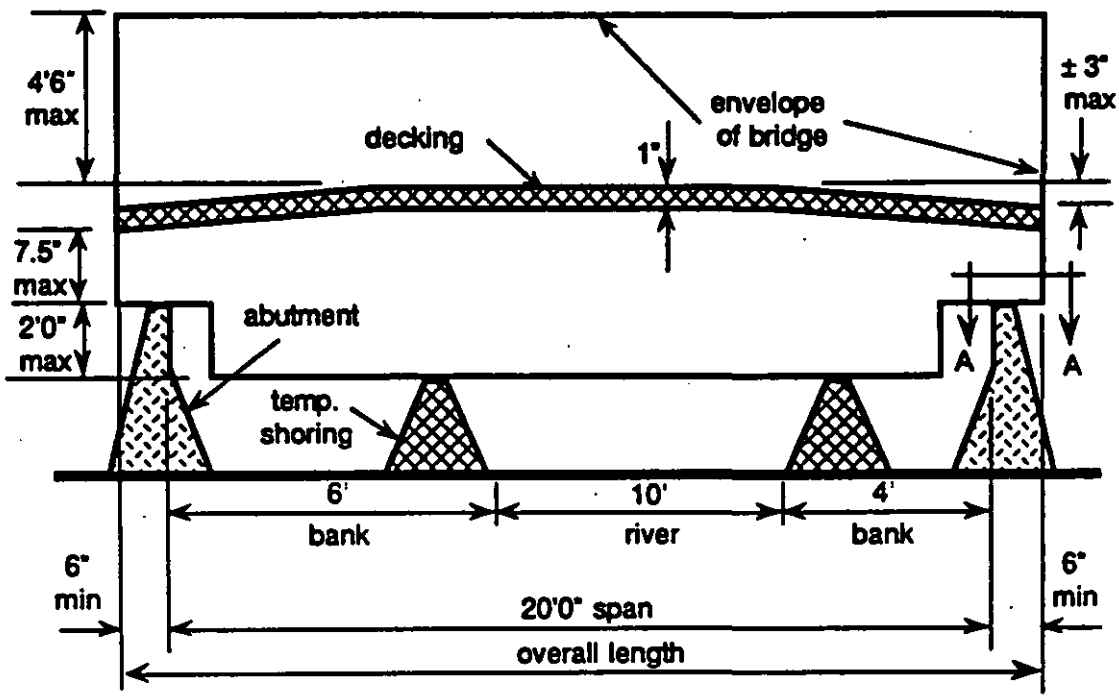
Construction speed + Stiffness + Efficiency + Economy = _____

Use aesthetics as tie breaker.

1998 STUDENT STEEL BRIDGE

COMPETITION

For Student Chapters Of
The American Society Of Civil Engineers



Side Elevation

Special thanks go to the following steel fabricator members of AISC for their financial support of the 1997 National Student Steel Bridge Competition:

Ace Iron & Steel Corp.
Builders Steel Company
Cadillac Iron, Inc.
E & H Steel Corp.
Enterprises Inc.
Fabarc Steel Supply, Inc.
Falcon Steel Co.
Ferguson Steel Co., Inc.
Fought & Company
Havens Steel Company
Indiana Steel & Engineering Corp.
International Bridge and Iron Co.
J.A. McMahon, Inc.
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Buffalo Structural Steel, Inc.
Cives Steel Company
Marks Brothers, Inc.
Martin Iron Works, Inc.
North Texas Steel Co. Inc.
Precise Fabricating Corp.
Snake Steel, Inc.
Southern Ohio Fabricators, Inc.
Steel, Inc.
Stein Steel
Stone Bridge Iron & Steel, Inc.
Structural Systems, Inc.
Stupp Bros. Bridge & Iron Co.
Unlimited Welding Inc.
Wilborn Steel Co.
Wylie Steel Fabricators, Inc.
Stud Welding, Inc.
Zalk Josephs Fabricators, Inc.
Zimkor Industries, Inc.

Special thanks to: Steel Erectors Association of America

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American Iron and Steel Institute

NATIONAL STEEL BRIDGE ALLIANCE

RULES

AISC STUDENT STEEL BRIDGE COMPETITION

1998

TABLE OF CONTENTS

INTRODUCTION

The Student Steel Bridge Competition is sponsored by the American Institute of Steel Construction and co-sponsored by the American Society of Civil Engineers, the American Iron and Steel Institute, the James F. Lincoln Arc Welding Foundation and the National Steel Bridge Alliance. This inter-collegiate challenge requires Civil Engineering students to design, fabricate and construct a steel bridge.

Safety is of primary importance. The AISC requests that competitors, hosts and judges take all necessary precautions to prevent injury.

The competition rules have been changed for 1998 in order to improve the contest and to assure that competitors design and build new bridges.

Ideally, students should fabricate the entire bridge themselves. However, appropriate shop facilities and supervision may not be available at every college and university. Therefore, the services of a commercial fabricator may be used provided that students observe the operations. Students are encouraged to maximize their personal involvement in fabricating their bridge.

There are two levels of competition: regional and national. Regional winners and runners-up are invited to compete at the national level. These *Rules* govern competition at both regional and national levels. A university may enter more than one bridge in regional competition but only the best one may qualify for national competition.

This booklet describes the contest and states the official rules for this year. It is distributed to universities throughout the country. A companion booklet, *Guide for Hosts and Judges*, is distributed to hosts and provides directions for conducting a competition.

The rules are intended to be prescriptive but may require some interpretation. The host should promptly inform all competitors and judges of questions and interpretations concerning the rules and other aspects of the competition. Interpretations should be in writing, and could be distributed by mail or e-mail (a mailing list processor would be convenient).

EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication and construction. Participating students gain practical experience in structural design, fabrication processes, construction planning, organization and teamwork.

The "Problem Statement" describes challenges encountered in a representative structural engineering project. The competition is a scaled simulation of that project.

Standards for durability, constructibility, usability, strength and serviceability reflect the volumes of regulations that govern the design and construction of full-scale bridges. Criteria for excellence are represented by the award categories of stiffness, lightness, construction speed, aesthetics, efficiency and economy. As with a full-scale construction project, safety is the primary concern.

The rules of the competition accommodate a large 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.

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

RULE CHANGES

The following list covers some of the major changes from the 1997 rules. Minor changes and reorganization are not covered. Contestants are advised to read this entire *Rules* booklet carefully.

1. The span is increased.

2. The width of the river is increased.

3. The height limit is decreased.

4. The width of the vehicle passageway is increased.

5. Lateral load is increased.

6. Additional requirements are imposed for bearing.

7. A penalty is imposed for placing members and assemblies on the bridge without joining them to it.

8. Some penalties have been changed.

9. Bridges may be modified after regional competition.

10. Bridges must accommodate dimensional variations in the decking.

11. Builders may not support ends or sides of constructed portions of the bridge.

PROBLEM STATEMENT

A century-old bridge that crosses a river valley in a mountainous region must be replaced. The bridge carries heavy truck traffic to and from mines which are the basis for the economy of this rural region, as well as providing access and emergency services to residences. A quick replacement is necessary because no other river crossing is available for miles.

The State Department of Transportation has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered, but the State has specified steel as the material because of its durability and fast erection. The bridge must be able to carry specified patterns of traffic and wind loads without exceeding deflection limits. In order to expedite environmental approvals, no piers may be erected in the river, nor may temporary scaffolding or causeways be used in the river. However, temporary shoring may be erected on the banks. Construction barges and marine cranes are not feasible due to fast currents and flash floods.

The stone abutments of the existing bridge are in good condition and will serve for the new bridge, provided that no lateral thrust or uplift is applied to the abutments. The State DOT will not permit modification of the existing abutments. The new bridge, when complete, must be supported only by the existing abutments; for example, stays and anchorages to the river banks are prohibited.

The new bridge must accommodate modular decking, which the State DOT salvaged from another bridge. Decking units may not be modified.

Access to the construction site is limited by narrow, winding roads. This imposes restrictions on the size of components, and on the movements of construction equipment. Soil conditions restrict the weight that may be lifted by cranes.

Your company's design/build proposal is among those that the State DOT has deemed responsive. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. The DOT will evaluate the models by multiple criteria including durability, constructibility, usability, stiffness, construction speed, efficiency, economy and aesthetics. The contract will be awarded to the company that submits the best model. This is an opportunity to become leaders in the bridge replacement market.

SAFETY

Safety has the highest priority. Judges are directed to disqualify bridges that cannot be safely constructed or load tested using the abutments and other equipment provided by the host, as described in this booklet. Collapse or deflection in excess of limits specified in this booklet is incontrovertible evidence of an unsafe bridge and will result in disqualification. A disqualified bridge is not eligible for awards in any category, and must be withdrawn from all subsequent participation in the contest.

SCORING

A university may enter several bridges in a regional competition. However, if both first and second places are won by the same university, then only the best one of that university's bridges will be invited to participate in the national contest, together with the highest ranked bridge entered by another university.

Categories of competition are lightness, construction speed, stiffness, efficiency, economy and aesthetics. In addition, overall performance is rated. Bridges that have been disqualified are not eligible for awards in any categories.

Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in "Material and Components" and "Dimensions and Support." Decking and temporary shoring are not included in total weight.

Construction Speed

The bridge with the lowest construction time will win in this category. Construction time is the product of the size of the construction team and the duration of construction plus time penalties prescribed in "Construction: Accidents." The construction team includes everyone who handles the bridge or any of its components during timed construction.

Stiffness

The bridge with the lowest incremental vertical deflection will win in the stiffness category. Incremental vertical deflection is determined from load test 3.

Efficiency

The bridge with the smallest sum of normalized total weight and deflection (SNWD) will win in the efficiency category. The sum of normalized weight and deflection is computed as

SNWD = Total weight (lb) + (100 x Incremental vertical deflection (in))

Economy

The bridge with the lowest cost (C) will win in the economy category. Cost is computed as

C = Total weight (lb) x 1000 ($/lb)
+ Construction time (person-min) x 5000 ($/person-minute)

Aesthetics

The full name of the college or university must appear on the bridge, or on a banner or placard attached to the bridge, in letters at least 2 inches high. If used, the banner or placard must be installed before the end of timed construction and is included in total weight.

In addition to the college or university name, other factors that may be considered include general appearance, balance and proportion of the design, elegance, finish, construction organization and teamwork. Quality of fabrication should not be considered because some bridges may be fabricated professionally while others are student work.

Overall Performance

The overall performance rating of a bridge is determined by adding the ranks of the bridge in the construction speed, stiffness, efficiency and economy categories. Note that the lightness rank is not included in the sum because lightness affects both efficiency and economy, which do appear in the sum. The bridge with the lowest score will win the overall competition. In the case of a tie, judges will use aesthetics as the tie breaker.

DIMENSIONS AND SUPPORT

Safety

If any of the following regulations is violated, the bridge must be disqualified. The figures titled "Side Elevation" and "Clearance and Deck Support" illustrate some of the requirements.

1. The bridge must provide rigid support for the decking along both of the edges that run in the longitudinal direction of the bridge. The support must be continuous for the central 9 feet of the bridge on which the load will be placed. Also see item 1 of the next section.

2. The bridge must span the abutments, which are fixed in place so that the clear distance between faces is 20 feet. Permanent shoring is not permitted.

3. The edges of the decking that run in the longitudinal direction of the bridge may be cantilevered over their supports no more than 6 inches.

4. Bearing areas at the four corners of the bridge must each extend behind the face of the abutment so that the bridge will remain supported by the abutments in the event that it is displaced either way in the direction of span. Also see item 4 of the next section.

5. No part of the bridge may extend so high that it cannot be constructed on the abutments in the building in which the contest is conducted. Also see item 5 of the next section.

6. No part of the bridge may be so low that it touches the river surface or bank with the bridge on the abutments. Also see item 6 of the next section.

7. The decking may not be attached nor anchored to the bridge.

8. The bridge may not be attached nor anchored to the abutments, and it may bear only on the top surface of the abutments.

9. The bridge may not be anchored, tied or braced to the ground.

Usability

Violation of the each of the following rules will result in a weight penalty of 50 pounds being added to the weight of the bridge. A penalty will be assessed for each violation. The figures titled "Side Elevation" and "Clearance and Deck Support" illustrate some of these rules. Dimensions will be checked without load on the bridge.

1. The bridge must provide support for the decking along both of the edges that run in the longitudinal direction of the bridge. The support must be continuous for the overall length of the bridge. This is easily verified by sliding a piece of decking along the full overall length of the bridge. Also see item 1 of the preceding section.

2. Although decking is nominally 42 inches wide and 1 inch thick, the bridge must accommodate widths ranging from 41.75 to 42.25 inches and thickness up to 1.25 inches.

3. Decking must be supported without gaps, overlaps or abrupt elevation differences between decking units. However, small elevation differences, such as those caused by decking resting on bolt heads, are acceptable.

4. Each of the four bearing areas at the corners of the bridge must extend at least 6 inches behind the face of the abutment and be at least 2 inches wide. Any portion of the bearing area that is flat stock (e.g. plate, bar, strip, sheet) must be at least 1/8 inch thick. The bottom surface must be flat and horizontal. Also see item 4 of the preceding section.

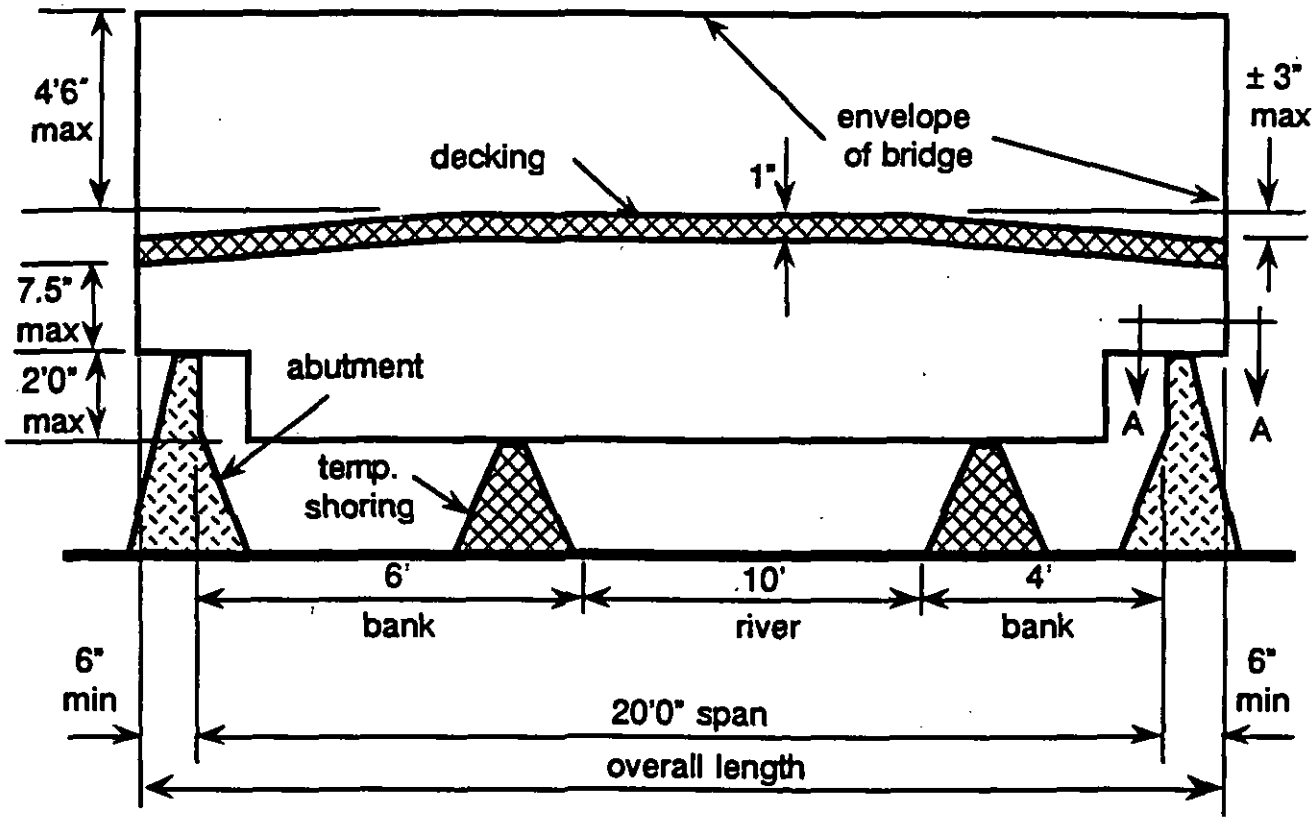
5 No part of the bridge may extend more than 4'6" feet above the top of the decking at any point on the span. Also see item 5 of the preceding section.

6. No part of the bridge may extend more than 2 feet below the top of the abutments at any point on the span. Also see item 6 of the preceding section.

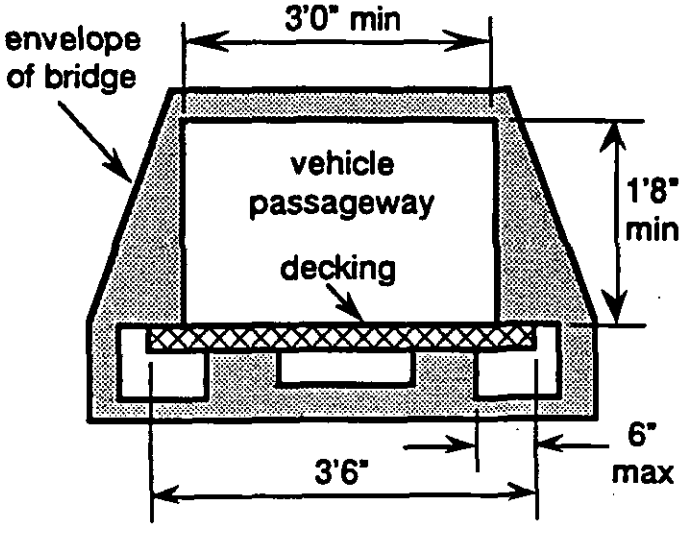
7. The surface of the decking support must be no more than 7.5" above the top of the abutments, measured at the abutments.

8. The absolute value of camber must not exceed 3 inches.

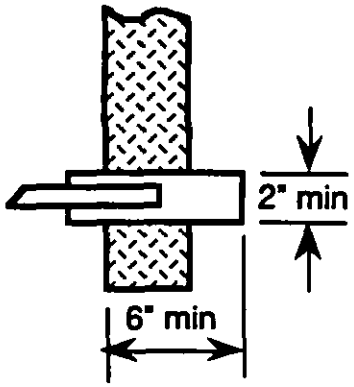
9. A 3'0" wide by 1'8" high rectangular vehicle passageway must be provided along the overall length of the bridge.



Side Elevation



Clearance and Deck Support



Section A-A Typical 4 places

MATERIAL AND COMPONENTS

Safety

If the following regulations is violated, the bridge must be disqualified.

1. A member may not weigh more than 40 pounds. See the next section for definition of "member."

Durability and Constructibility

Violation of each of the following rules will result in a weight penalty being added to the weight of the bridge. The penalty for each violation is 10 pounds plus 5 times the weight of the non-conforming members, fasteners, assemblies and other parts.

1. A bridge may be constructed only of structural steel. For the purposes of this contest, structural steel is defined as an iron alloy that is strongly attracted to a magnet. Exceptions: Paint, banners, placards and other purely decorative items.

2. A bridge may be constructed only of components conforming to the following definitions of members, fasteners and assemblies.

   a. A member is a rigid component that retains its shape, dimensions and rigidity during construction and in the completed bridge.

   b. Fasteners are steel machine bolts, with or without nuts. Fasteners must be threaded and have hexagonal, square or round heads that will accept a wrench or screwdriver. Eye bolts are not permitted. Nuts are permitted but not required.

   c. An assembly is no more than 3 members plus any number of fasteners that are joined together in the staging yards during timed construction.

3. A member may not exceed overall dimensions of 5'6" x 7.5" x 7.5." That is, it must fit in a prismatic box of those dimensions.

4. A member must be rigid. That is, hinged, jointed, articulated and telescoping members are prohibited, as are members with moving parts. This prohibition includes members with parts that are intended to slide, rotate, deflect or bend relative to the member during construction, such as cams, latches, sliding pins, springs, and snap-lock devices. Cables and strapping are prohibited, as are similar materials that would not be damaged by coiling and uncoiling.

5. A member may consist of several parts rigidly joined together before timed construction begins. Those parts must remain rigidly joined throughout the construction process and in the completed bridge. For example, if a member incorporates a turnbuckle, that turnbuckle may not be turned after the start of timed construction. However, a turnbuckle itself may be identified as a separate member, in which case builders must join it to other members during timed construction and may turn and adjust it during timed construction.

6. A fastener may not exceed 3 inches in length.

7. Fasteners must be threaded and have hexagonal, square or round heads that will accept a wrench or screwdriver. Eye bolts are not permitted. Nuts are permitted but not required.

8. Members and assemblies may be joined without the use of fasteners.

9. The members of an assembly must remain joined (not necessarily rigidly).

CONSTRUCTION

Safety

If any of the following safety regulations is violated during timed construction, the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools and bridge components will be returned to the positions they occupied before the violation. Then the builders will be asked to resume construction using safe procedures. A bridge that cannot be constructed safely must be disqualified.

1. Each unit of temporary shoring may not weigh more than 40 pounds. Temporary shoring is defined below.

2. Temporary shoring must not break or collapse during construction.

3. Only hand-held tools are permitted. Tools must be powered manually or by internal batteries. Field welding and tools requiring external power connections are prohibited. Ropes are permitted but gin poles, jacks, winches, come-alongs, counterweights and other hoisting devices are prohibited. Stools, ladders and similar objects for elevating builders are prohibited.

4. All builders must wear hardhats during timed construction.

5. A builder may not use the bridge, an abutment or temporary shoring to support the builder's body weight. For example, standing, sitting or kneeling on those objects is prohibited. However, a builder may lean on the bridge, abutment or shoring if both feet remain on the river bank.

6. A builder may not cross the river by jumping, by temporary scaffolding, by crossing the bridge, or by any other means.

7. A builder may lift or carry only one member or one unit of temporary shoring at a time. See "Material and Components" for definition of member.

8. An assembly may not be lifted or carried by one builder alone. See "Material and Components" for definition of assembly.

9. Two or more builders may lift or carry only one assembly at a time.

10. A constructed portion of the bridge (i.e. not conforming to the definitions of member or assembly) may not be lifted or carried.

11. A constructed portion of the bridge must be supported fully at all times by some combination of temporary shoring and abutments. That is, builders may not support either or both ends or sides of a constructed portion.

12. A constructed portion of the bridge may not be slid horizontally unless it is supported by both abutments, or by temporary shoring on both banks, or by one abutment and one unit of temporary shoring.

Team

The construction team, also referred to as builders, consists of everyone who handles the bridge or any of its components during timed construction. Participation is limited to students. Only builders are permitted in the construction site during timed construction.

Tools

Competitors provide their own tools. See item 3 of the preceding section. Hardhats are considered to be tools.

Construction Site

See the figure titled "Site Plan" for layout of river, banks, and other features that affect construction.

Temporary Shoring

Shoring is support on one or both river banks, and is provided by the competitors. Temporary shoring may be any material but must provide sufficient strength and stability to support the bridge.

Start

Before construction begins, all members, fasteners, units of temporary shoring, tools and builders are in the staging yards. Timing and construction begin when the builders signify that they are ready and the judge declares the start.

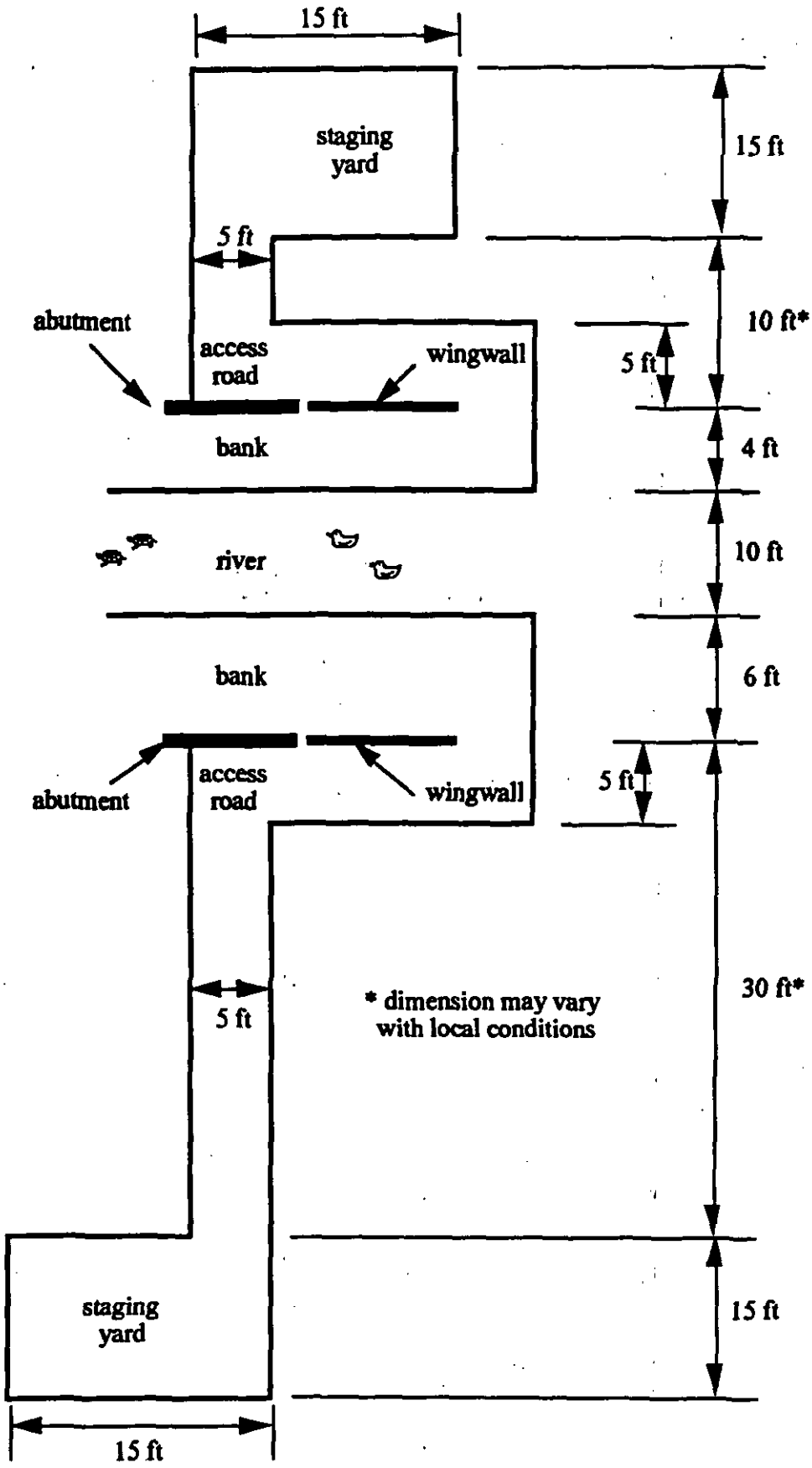
Time

Time is kept from the start to finish of construction. The clock will be stopped:

1. if a builder or judge sees a condition that could cause injury, or

2. when a safety regulation has been violated.

Construction ceases while the clock is stopped. The clock is restarted after the situation has been corrected.


15 ft
staging yard
15 ft
5 ft
10 ft*
abutment
access road
wingwall
5 ft
bank
4 ft
10 ft
river
bank
6 ft
abutment
access road
wingwall
5 ft
5 ft
* dimension may vary with local conditions
30 ft*
staging yard
15 ft
15 ft

Site Plan

Time Limit

The clock time for constructing a bridge is limited to 30 minutes. If construction exceeds that time limit, a penalty of $5000 per clock minute over the limit will be added to the score in the economy category.

Finish

Construction ends when the bridge is complete, and all tools, temporary shoring and builders are in the staging yards, and the builders signify that they are finished. Installation of decking is not included in timed construction.

Accidents

In general, the clock is not stopped when an "accident" occurs. Builders involved in accidents may continue to build, and components involved in accidents may be recovered and used. If an accident is continuous (for example, a builder stands in the river) it will be counted as multiple incidents. Types of accidents and the corresponding time penalties, which will be added to the construction time, are:

1. A builder touches the river. Penalty is 3 person-minutes per incident. Exception: Builders may step in the river without penalty to retrieve a dropped member, assembly, tool or fastener.

2. A builder throws something. Penalty is 3 person-minutes per incident.

3. A builder crosses a wingwall or an abutment. Penalty is 2 person-minutes per incident.

4. Temporary shoring touches the river. Penalty is 2 person-minutes per incident.

5. A member, assembly, or the bridge touches the river, a bank, or an access road. Penalty is 2 person-minutes per incident.

6. A member or assembly is placed on the bridge without being joined to it or held by a builder. Penalty is 2 person-minutes per incident.

7. A member, assembly, fastener or tool is leaned against an abutment, wingwall, temporary shoring or the bridge. Penalty is 2 person-minutes per incident.

8. A tool or fastener touches the river, a bank, or an access road. Penalty is 1 person-minute per incident.

9. A builder steps beyond the limits of an access road, staging yard or river bank. Penalty is 1 person-minute per incident.

LOAD TESTS

Safety Precautions

A bridge could collapse or sway suddenly during load tests. Therefore, minimize the number of people near the bridge while it is being tested.

If abutments are adjustable, set them so that the bottom of the bridge is 3 to 6 inches above ground.

During testing, safety supports must be in place 3 to 6 inches below the bottom of the decking.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a cantilevered portion of the decking.

When any portion of the vertical load is on the bridge, no one is permitted to crawl, reach or step under the bridge. If such an action is necessary, the load must first be removed.

Repairs

A bridge will not be tested in a condition that compromises its strength or stability. Therefore, immediately prior to load testing, repairs may be made with the permission and supervision of a judge, according to the following provisions:

1. Damage occurring after construction will be repaired without penalty.

2. Minor construction errors will be repaired without penalty. For example, a nut may be adjusted to correct a slight misalignment of a primary component with no penalty.

3. Errors due to negligent construction will be repaired but a time penalty will be assessed in an amount, to be determined by the judge, that will exceed the incremental time required for careful initial construction. For example, a team that forgets to install bracing or makes no attempt to adjust nuts during timed construction will be penalized.

4. Deliberate exploitation of these repair provisions constitutes negligent construction and will be penalized heavily.

General Procedures and Definitions

Load tests are conducted without temporary shoring. Load test 1 is conducted without decking; load tests 2 and 3 are conducted with three decking units installed to accommodate the load.

Given weights of load are in addition to decking.

The figure titled "Location of Targets" illustrates some of the following procedures.

The judge designates, by a random process, the A and B sides of the bridge.

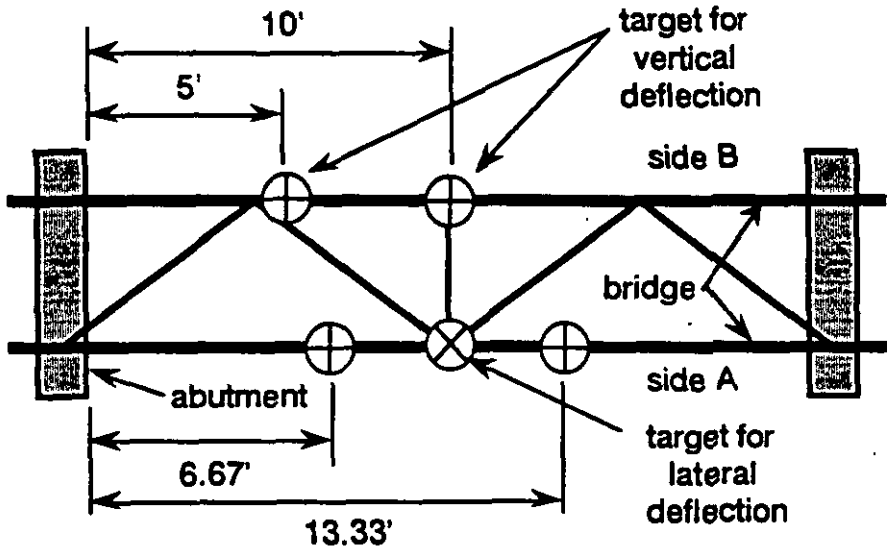
The judge marks a target at midspan on the A side, close to the level of the decking. All lateral deflection measurements are made to that target.

The judge marks targets on the A side at the third points of the span (i.e. 6 feet 8 inches and 13 feet 4 inches from the faces of the abutments). Then the judge also marks targets on the B side at the one quarter point and at midspan (i.e. 5 feet and 10 feet from the face of an abutment). The targets should be close to the level of the decking. Vertical deflection measurements are made to all four targets; vertical deflection is the largest absolute value of the four measurements.

Total lateral deflection is the absolute value of the horizontal distance of the target from its position at the beginning of load test 2. Incremental vertical deflection is the largest absolute value of the vertical distances of the targets from their positions at the beginning of load test 3.

Load tests are conducted in numerical order.

A BRIDGE THAT COLLAPSES DURING LOADING, DEFLECTION MEASUREMENTS OR UNLOADING MUST BE DISQUALIFIED.

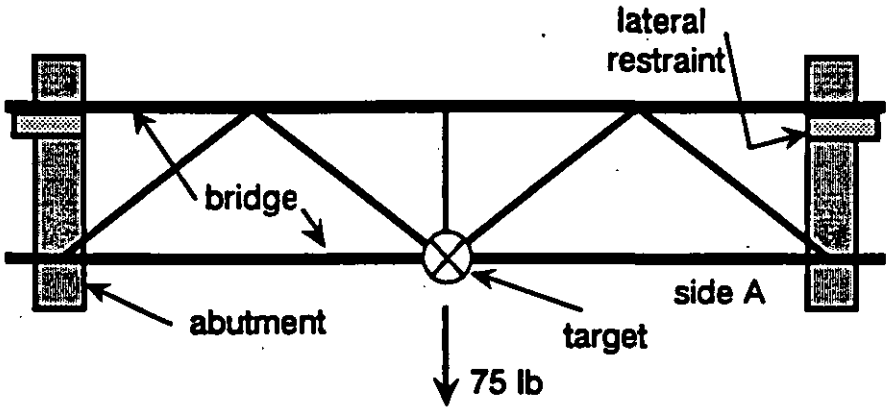


Location of Targets

Plan

Load Test 1 - Lateral

Load test 1 is conducted with lateral restraint installed on the abutments to prevent the ends of the bridge from sliding. On side A, as close as practical to midspan and to the level of the deck apply a 75 pound force in the lateral direction. To pass load test 1, the lateral deflection of the bridge must not exceed 1.0". If the bridge does not pass load test 1 it is disqualified; do not conduct any other load test. Remove the lateral load; it is not part of the remaining load tests.

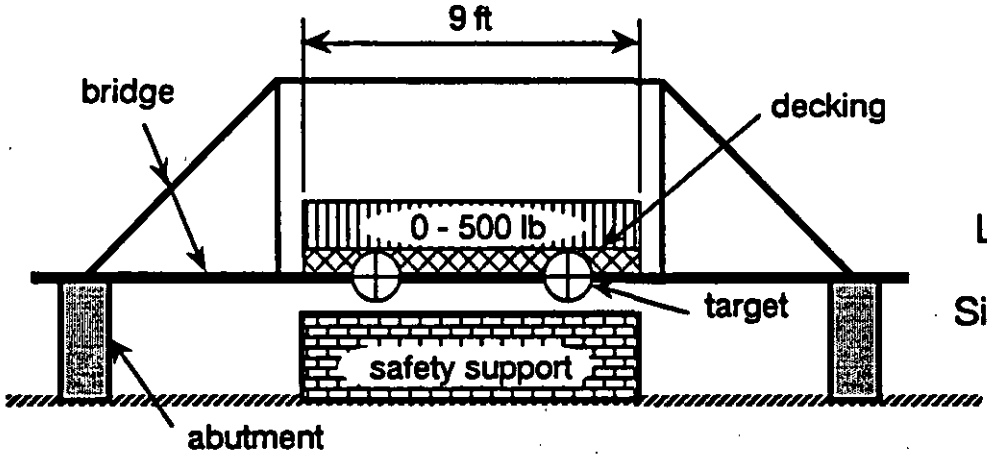


Load Test 1

Plan

Load Test 2 - Vertical, Preliminary

Uniformly distribute load over an area symmetric about the middle of the deck and extending 9 feet in the span direction, as shown in the figure. Terminate load test 2 when lateral deflection exceeds 1.0" or vertical deflection exceeds 2.0" or 500 pounds of load have been placed. A bridge passes load test 2 if 500 pounds of load was placed without a deflection limit being exceeded. If the bridge does not pass load test 2 it is disqualified; do not conduct any other load test.

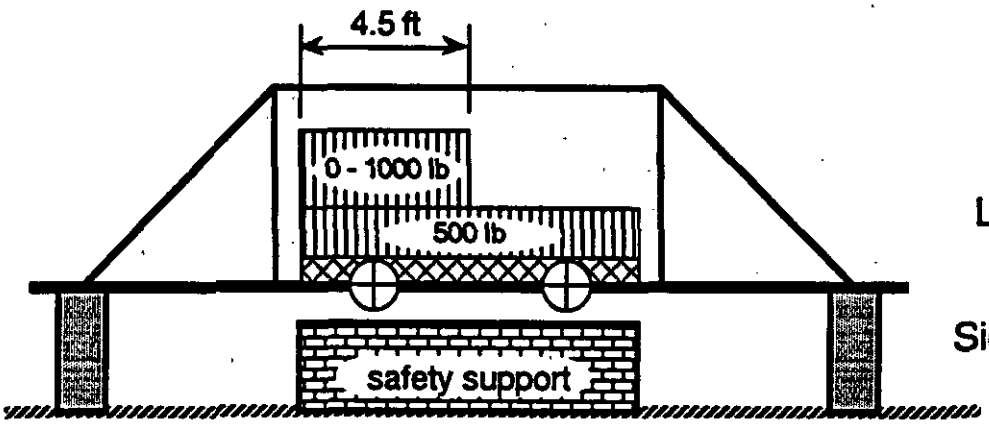


Load Test 2

Side Elevation

Load Test 3 - Vertical, for Deflection Measurement

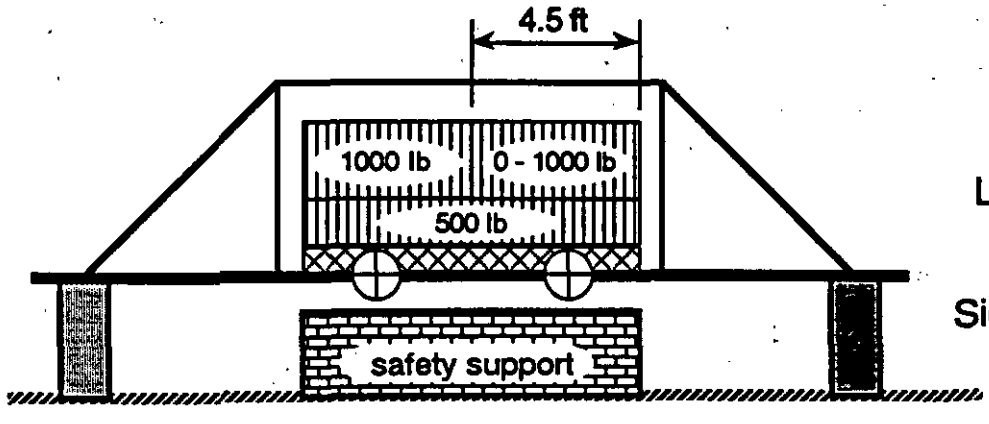
Step 1. With the 500 pound load from test 2 remaining in place, record the vertical deflections of all targets (because they will be needed to compute the incremental vertical deflection). Then, uniformly distribute additional load over an area symmetric to the midline of the deck and extending 4.5 feet from midspan toward an end randomly selected and designated by the judge. That is, the load is longitudinally eccentric, as shown in the figure. Terminate step 1 when total lateral deflection exceeds 2.0" or incremental vertical deflection exceeds 2.0" or total load is 1500 pounds. Terminate load test 3 and disqualify the bridge if either deflection limit is exceeded.



Load Test 3
Step 1

Side Elevation

Step 2. With previous loads remaining in place, uniformly distribute additional load over an area symmetric to the midline of the deck and extending 4.5 feet from midspan toward the end opposite to the one designated by the judge in step 1. That is, the load restores symmetry, as shown in the figure. Terminate step 2 when total lateral deflection exceeds 2.0" or incremental vertical deflection exceeds 2.0" or total load is 2500 pounds. Terminate load test 3 and disqualify the bridge if either deflection limit is exceeded. If the total load of 2500 pounds was placed without a deflection limit being exceeded, then the bridge passes load test 3. Record the incremental vertical deflection (that is, the largest absolute value of the vertical distances of the four targets from their positions at the start of test 3).



Load Test 3
Step 2

Side Elevation

EQUIPMENT PROVIDED BY HOST

The following equipment will be provided at the contest site by the host. Competitors should acquire similar equipment for use in practice and testing before the competition.

Lateral Load Device

Capable of applying 75 pound force in the horizontal direction.

Measuring Instruments and/or Scales

Load

2500 pounds total. The load should be supplied in uniform pieces of size and weight that may be handled safely. When in place, the load should not provide significant stiffness in the longitudinal direction of the bridge. Sections of steel angle of uniform size and length are recommended for load. 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.

Decking

The decking is steel bar grating identified as W-19-4 (1 x 1/8). The dimensions of a piece of grating are approximately 3'6" x 2'11-3/4" x 1". 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 of the grating that are perpendicular to the length.

Abutments

Construction. The top surface of each abutment should be at least 5 feet long, at least 3 inches wide, level, smooth, and approximately 3 feet above the ground.

Load Testing. A different set of abutments may be used during load testing. The top surface of each abutment should be at least 5 feet long, at least 3 inches wide, level and smooth. Height may be adjustable so that the bridge may be positioned close to the ground. Temporary lateral restraints are needed during load test 1.

Safety Support

The safety support must be used during load testing and is intended to limit the consequences of a bridge collapsing. The safety support should extend at least 6 feet along the length of the bridge. It should be adjustable in width and height, and should be centered under the bridge. The safety support must be placed before the beginning of load testing, with the top 3 to 6 inches below the bottom of the decking.

JUDGING

The host 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, rating and disqualification are the sole responsibility of the judges and will be final. The host will assure that the judges are fully informed of the rules and procedures, and fully equipped for their tasks. The host and judges will follow directions in the *Guide for Hosts and Judges* provided by AISC.

PROTESTS AND APPEALS

Before the Contest Each team will designate a student as team captain. The host will identify the head judge.

During the Contest A penalty, disqualification, measurement, score, or condition of competition may be protested only by a team captain and only to the head judge. The protest must be made as soon as possible after the situation becomes apparent. The head judge will not hear the protest if he or she is approached by students other than the team captain. As soon as possible after a protest is made, the head judge will interrupt the contest if necessary, gather the other judges and the captains of the teams involved, and hear the protest. The decision of the head judge is final.

Participants are reminded that civility and ethical behavior are expected during the contest and particularly concerning protests.

After the Regional Contest If a team wants to appeal the decision of the head judge regarding a protest it may do so in a letter mailed to Mr. Fromy Rosenberg (AISC, Suite 3100, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to Ms. Roshena M. Ham (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The letter should include the name of the college or university making the appeal; the names, addresses and telephone numbers of the faculty adviser and one team member; brief description of the problem, the action taken at the contest to deal with it, and the action that the appealing team feels should have been taken; computation showing how the appealing team's rankings would have been improved if a different action had been taken.

Appeals must be made in writing. Only appeals received within one week of the regional contest will be considered.

The only redress that may be made is an invitation to participate in the national competition if the Rules Committee is convinced that the appeal is valid and that the appealing team should have placed first or second in its region. Decisions and rankings made by regional judges will not be overturned.

After the National Contest Appeals will not be accepted. However, AISC welcomes written suggestions for improving future competitions.

TIPS FOR COMPETITORS

1. Strive for challenging but realistic goals for design and construction. The following statistics from the 1997 National Student Steel Bridge Competition suggest the levels of performance that are possible. However, when reviewing these statistics keep in mind that the rules and scoring for 1998 differ from those for 1997.

	Winning bridge in category	Winning bridge, overall
Weight (lb)	64	79
Construction time (person-minutes)	9.08	16.33
Incremental vertical deflection (inches)	0.182	0.182

2. It is strongly recommended that bridges be load tested before competition, if it can be done safely, so that weaknesses and instability can be corrected.

3. Start work on the design early, leaving adequate time to procure materials, fabricate the bridge, load test it and practice construction.

4. Design a bridge that may be fabricated, erected and load tested safely, using available materials, tools and facilities.

5. Structural analysis may fail to disclose instability, such as buckling of slender compression members, sway, and torsion of under-deck trusses of triangular cross-section.

6. Allow tolerances for spacing and levelness of abutments.

7. Allow tolerances for all limiting dimensions, in order to accommodate imprecise fabrication, thermal expansion, elastic and inelastic deformation, wear, etc.

8. When fabricating your bridge, use safe tools, operate them carefully and with adequate supervision.

9. Make sure that abutments, temporary shoring and safety support are strong enough (with a generous factor of safety) and will not tip during use, even if the bridge collapses.

10. When practicing construction, wear hardhats for safety and to accustom yourself to contest conditions.

11. Follow all safety regulations and guidelines during construction practice.

12. When load testing your bridge keep it as low to the ground as possible and place safety support a few inches below the decking under at least 6 feet of the span. This will reduce risk of injury and limit damage to the bridge if it collapses. Keep hands and feet out from under the bridge.

13. Don't stand, sit or lie on your bridge.

14 To expedite the competition have a preset plan for unloading and staging components of your bridge. Before the competition adjust your temporary shoring to conform to the height of the host's abutments.

SCORE SHEET

Time Penalties

See "Construction: Accidents"

items 1,2: violations _____ x 3 = _____ person-min

items 3-7: violations _____ x 2 = + _____ person-min

items 8,9: violations _____ x 1 = + _____ person-min

TIME PENALTIES (add) _____ person-min

Weight Penalties

See "Dimensions and Support: Usability"

Number of violations _____ x 50 pounds = _____ pounds

See "Material and Components: Durability and Constructibility"

Number of violations _____ x 10 pounds = + _____ pounds

Wt. of parts in violation _____ pounds x 5 = + _____ pounds

WEIGHT PENALTIES (add) _____ pounds

Construction Time

_____ builders x _____ min

+ time penalties = _____ = _____ person-min

Total Weight

Bridge weight _____ pounds

+ weight penalties _____ = _____ pounds

Aesthetics

Name of college or university appears on bridge or on attached banner or placard in letters at least 2 inches high.

Other items that may be considered:

General appearance	Finish
Balance and proportion	Elegance
Construction organization	Teamwork

AESTHETICS SCORE _____

0052

Deflection

(incremental vertical, test 3) ______________________________ inches

Efficiency

Total weight (lb) ____________________ = __________

Incremental vert. deflect. (in) ____________ x 100 = +__________

SNWD (add) ____________________

Cost

Const. Time __________ x $5000 = $__________

Total Weight __________ x $1000 = +$__________

TOTAL COST (add) $____________________

Ranks

Disqualified bridges will not be ranked.

Lightness __________ Construction Speed __________

Aesthetics __________ Stiffness __________

Efficiency __________

Economy __________

Overall Performance

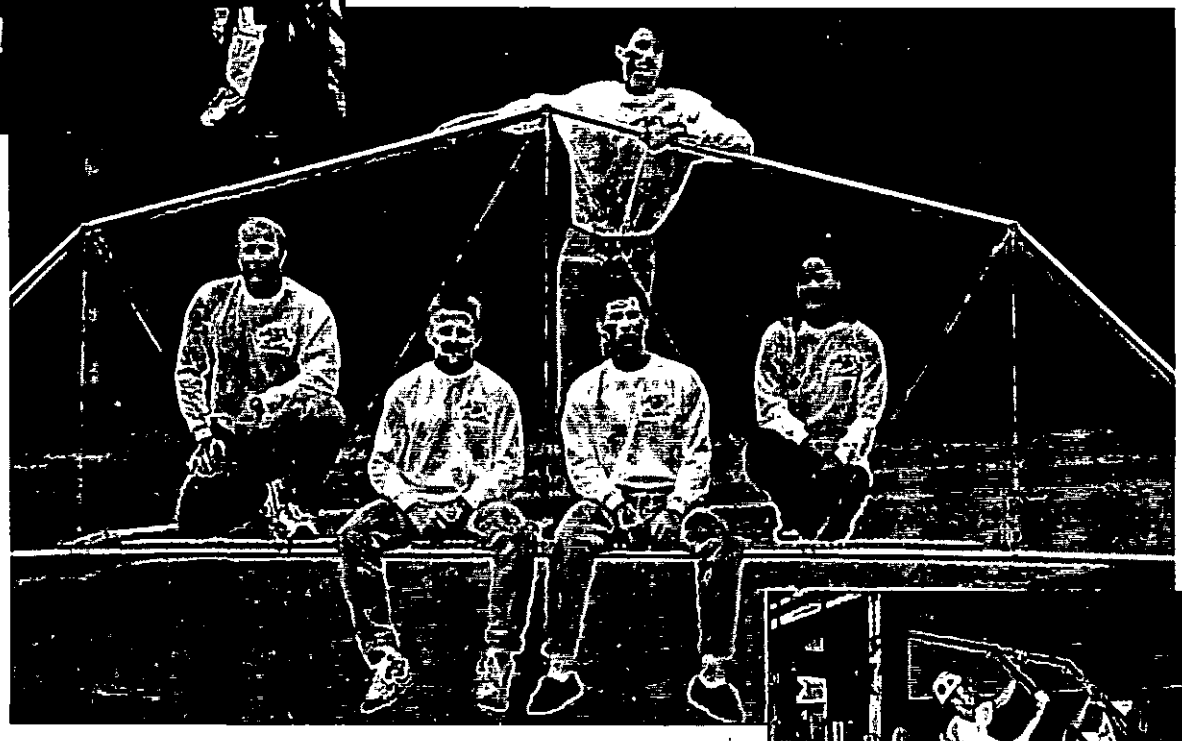
Sum of ranks, except lightness and aesthetics.

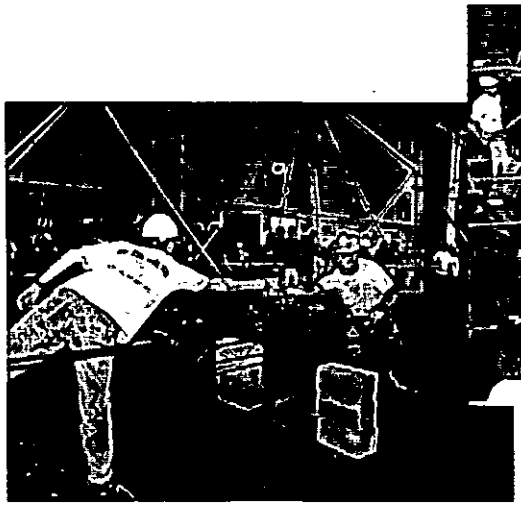
Construction speed + Stiffness + Efficiency + Economy = ____________________

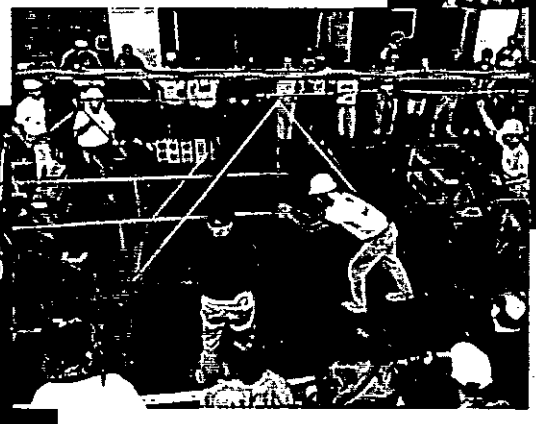
Use aesthetics as tie breaker.

1997 STEEL BRIDGE BUILDING
Competition

For Student Chapters Of
The American Society Of Civil Engineers







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RULES

AISC STEEL BRIDGE-BUILDING COMPETITION

1997

TABLE OF CONTENTS

INTRODUCTION

The Steel Bridge-Building Competition is sponsored by the American Institute of Steel Construction and co-sponsored by the American Society of Civil Engineers, the American Iron and Steel Institute, the James F. Lincoln Arc Welding Foundation and the National Steel Bridge Alliance. This inter-collegiate challenge requires Civil Engineering students to design, fabricate and construct a steel bridge.

Safety is of primary importance. The AISC requests that competitors, hosts and judges take all necessary precautions to prevent injury.

The competition rules have been changed for 1997 in order to improve the contest and to assure that competitors design and build new bridges.

Ideally, students should fabricate the entire bridge themselves. However, appropriate shop facilities and supervision may not be available at every college and university. Therefore, the services of a commercial fabricator may be used provided that students observe the operations. Students are encouraged to maximize their personal involvement in fabricating their bridge.

There are two levels of competition: regional and national. Regional winners and runners-up are invited to compete at the national level. It is intended that the teams competing nationally will use the same bridges that they entered in their regional competitions. A university may enter more than one bridge in regional competition but only the best one may qualify for national competition.

This booklet describes the contest and states the official rules for this year. It is distributed to universities throughout the country. A companion booklet, *Guide for Hosts and Judges*, is distributed to hosts and provides directions for conducting a competition.

The rules are intended to be prescriptive but may require some interpretation. Questions regarding interpretation should be directed to the host.

EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication and construction. Participating students gain practical experience in structural design, fabrication processes, construction planning, organization and teamwork.

The "Problem Statement" describes challenges encountered in a representative structural engineering project. The competition is a scaled simulation of that project.

Standards for durability, constructibility, usability, strength and serviceability reflect the volumes of regulations that govern the design and construction of full-scale bridges. Criteria for excellence are represented by the award categories of stiffness, lightness, construction speed, aesthetics, efficiency and economy. As with a full-scale construction project, safety is the primary concern.

The rules of the competition accommodate a large 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.

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

RULE CHANGES

The following list covers some of the major changes from the 1996 rules. Minor changes and reorganization are not covered. Contestants are advised to read this entire *Rules* booklet carefully.

1. Violation of certain rules will result in penalties rather than disqualification. Grounds for disqualification are clarified.

2. Bridges that collapse or deflect beyond limits are disqualified from all categories of competition.

3. Penalties are changed. Most penalties will be added weight and construction time.

4. The span of the bridge is increased.

5. The height limit is decreased.

6. The river is wider and one bank is narrower.

7. Structural steel is defined by magnetic attraction.

8. Cables are not permitted.

9. Type of fastener is limited.

10. The name of the college or university must appear on its bridge.

11. The cost penalty for using temporary shoring is eliminated, but shoring must be installed and removed during timed construction, and is subject to weight and handling limitations.

12. Cordless electric hand-held tools are permitted.

13. Safety support is eliminated during construction. Safety support remains mandatory during load testing.

14. Lateral load is reduced.

15. Placement of targets for vertical deflection measurements is changed.

16. The loading pattern is changed.

17. Computation of overall performance score is changed.

18. Teams should use the same bridges in national competition that they used in their regional contests.

PROBLEM STATEMENT

A century-old bridge that crosses a river valley in a mountainous region must be replaced. The bridge carries heavy truck traffic to and from mines which are the basis for the economy of this rural region, as well as providing access and emergency services to residences. A quick replacement is necessary because no other river crossing of adequate capacity is available for miles.

The State Department of Transportation has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered, but the State has specified steel as the material because of its durability and fast erection. The bridge must accommodate two lanes of traffic and be able to carry specified patterns of traffic and wind loads without exceeding deflection limits. In order to expedite environmental approvals, no piers may be erected in the river, nor may temporary scaffolding or causeways be used in the river. However, temporary shoring may be erected on the banks. Construction barges and marine cranes are not feasible due to fast currents and flash floods.

The stone abutments of the existing bridge are in good condition and will serve for the new bridge, provided that no lateral thrust or uplift is applied to the abutments. The State DOT will not permit modification of the existing abutments. The new bridge, when complete, must be supported only by the existing abutments; for example, stays and anchorages to the river banks are prohibited.

The new bridge must accommodate modular decking, which the State DOT salvaged from another bridge. Decking units may not be modified.

Access to the construction site is limited by narrow, winding roads. This imposes restrictions on the size of components, and on the movements of construction equipment. Soil conditions restrict the weight that may be lifted by cranes.

Your company's design/build proposal is among those that the State DOT has deemed responsive. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. The DOT will evaluate the models by multiple criteria including durability, constructibility, usability, stiffness, construction speed, efficiency, economy and aesthetics. The contract will be awarded to the company that submits the best model. This is an opportunity to become leaders in the bridge replacement market.

SAFETY REGULATIONS
(Grounds for Disqualification)

Safety has the highest priority. Judges are directed to disqualify bridges that cannot be safely constructed or load tested using the abutments and other equipment provided by the host, as described in this booklet. Collapse or deflection in excess of limits specified in this booklet is incontrovertible evidence of an unsafe bridge and will result in disqualification. A disqualified bridge is not eligible for awards in any category, and must be withdrawn from all subsequent participation in the contest.

Safe Construction

If any of the following safety regulations is violated during timed construction, the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools and bridge components will be returned to the positions they occupied before the violation. Then the builders will be asked to resume construction using safe procedures.

1. A member may not weigh more than 40 pounds. See "Material and Components" for definition of member.

2. Each unit of temporary shoring may not weigh more than 40 pounds. See "Construction" for definition of temporary shoring.

3. Temporary shoring must not break or collapse during construction.

4. Only hand-held tools are permitted. Tools must be powered manually or by internal batteries. Field welding and tools requiring external power connections are prohibited. Ropes are permitted but gin poles, jacks, winches, come-alongs, counterweights and other hoisting devices are prohibited. Stools, ladders and similar objects for elevating builders are prohibited.

5. All builders must wear hardhats during timed construction.

6. A builder may not use the bridge, an abutment or temporary shoring to support the builder's body weight. For example, standing, sitting or kneeling on those objects is prohibited. However, a builder may lean on the bridge, abutment or shoring if both feet remain on the river bank.

7. A builder may not cross the river by jumping, by temporary scaffolding, by crossing the bridge, or by any other means.

8. A builder may lift or carry only one member or one unit of temporary shoring at a time.

9. An assembly may not be lifted nor carried by one builder alone. See "Material and Components" for definition of assembly.

10. Two or more builders may lift or carry only one assembly at a time.

11. A constructed portion of the bridge (i.e. not conforming to the definitions of member or assembly) may not be slid horizontally unless it is supported by both abutments, or by temporary shoring on both banks, or by one abutment and one unit of temporary shoring.

12. One side or end of a constructed portion of the bridge may not be moved in any direction unless the other side or end of the constructed portion remains supported by an abutment, shoring or another portion of the bridge.

13. A constructed portion of the bridge may not be lifted nor carried.

Strength and Serviceability

If any of the following strength and dimensional regulations is violated, the bridge must be disqualified. The figures on page 10 titled "Side Elevation" and "Clearance and Deck Support" illustrate some of the requirements.

1. The bridge must span the abutments, which are fixed in place so that the clear distance between faces is 19 feet. Permanent shoring is not permitted.

2. The bridge must provide bearing area extending at least 6 inches behind the face of each abutment so that the bridge will remain supported by the abutments in the event that it is displaced 6 inches in the direction of span.

3. No part of the bridge may be so low that it touches the river surface or bank with the bridge on the abutments.

4. No part of the bridge may extend so high that it cannot be constructed on the abutments in the building in which the contest is conducted.

5. The bridge must provide support for the decking along both of the edges that run in the longitudinal direction of the bridge. The support must be continuous for the central 9 feet of the bridge on which the load will be placed. For further guidance on decking support see item 6 on page 9.

6. The edges of the decking that run in the longitudinal direction of the bridge may be cantilevered over their supports no more than 6 inches.

7. The decking may not be attached nor anchored to the bridge.

8. The bridge may not be attached nor anchored to the abutments, and it may bear only on the top surface of the abutments.

9. The bridge may not be anchored, tied nor braced to the ground.

SCORING

A university or college may enter several bridges in a regional competition. However, only the best one of those bridges may be invited to participate in the national contest.

Categories of competition are lightness, construction speed, stiffness, efficiency, economy and aesthetics. In addition, overall performance is rated. Bridges that have been disqualified are not eligible for awards in any categories.

Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in "Material and Components" and "Dimensions and Support." Decking and temporary shoring are not included in total weight.

Construction Speed

The bridge with the lowest construction time will win in this category. Construction time is the product of the size of the construction team and the duration of construction plus time penalties prescribed in "Construction: Accidents." The construction team includes everyone who handles the bridge or any of its components during timed construction.

Stiffness

The bridge with the lowest incremental vertical deflection will win in the stiffness category. Incremental vertical deflection is determined from load test 3.

Efficiency

The bridge with the smallest sum of normalized total weight and deflection (SNWD) will win in the efficiency category. The sum of normalized weight and deflection is computed as

SNWD = Total weight (lb) + (100 x Incremental vertical deflection (in))

Economy

The bridge with the lowest cost (C) will win in the economy category. Cost is computed as

C = Total weight (lb) x 1000 ($/lb)
+ Construction time (person-min) x 5000 ($/person-minute)

Aesthetics

The full name of the college or university must appear on the bridge, or on a banner or placard attached to the bridge, in letters at least 2 inches high. If used, the banner or placard must be installed before the end of timed construction and is included in total weight.

In addition to the college or university name, other factors that may be considered include general appearance, balance and proportion of the design, elegance of connections, finish, construction organization and teamwork. *Quality of fabrication should not be considered because some bridges may be* fabricated professionally while others are student work.

Overall Performance

The overall performance rating of a bridge is determined by adding the ranks of the bridge in the construction speed, stiffness, efficiency and economy categories. Note that the lightness rank is not included in the sum because lightness affects both efficiency and economy, which do appear in the sum. The bridge with the lowest score will win the overall competition. In the case of a tie, judges will use aesthetics as the tie breaker.

DIMENSIONS AND SUPPORT

Violation of the each of the following rules will result in a weight penalty of 30 pounds being added to the weight of the bridge. A penalty will be assessed for each violation. The figures titled "Side Elevation" and "Clearance and Deck Support" illustrate some of these rules.

1. A 2'0" wide by 1'8" high rectangular vehicle passageway must be provided along the overall length of the bridge.

2. No part of the bridge may extend more than 2 feet below the top of the abutments at any point on the span. Also see item 3 of "Safety Regulations: Strength and Serviceability" on page 6.

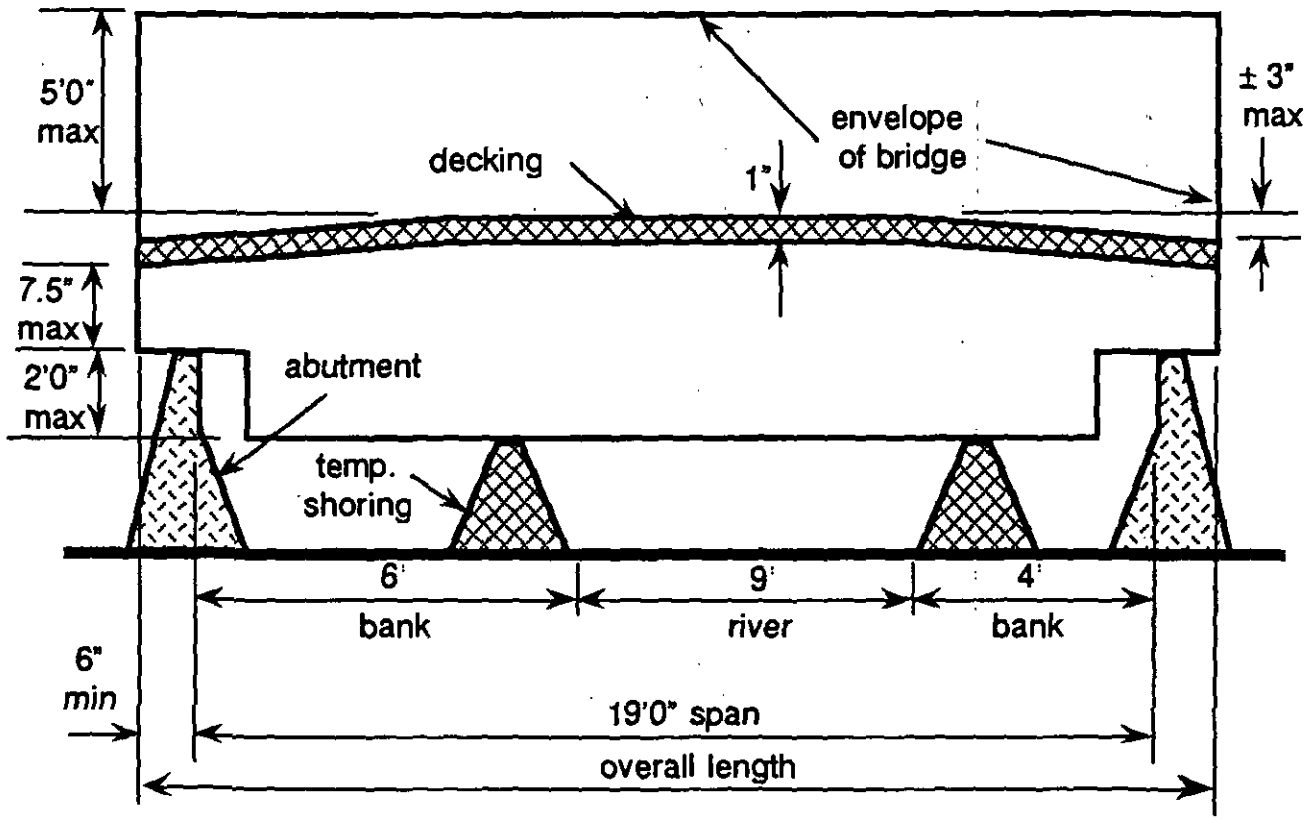
3. No part of the bridge may extend more than 5 feet above the top of the decking at any point on the span. Also see item 4 of "Safety Regulations: Strength and Serviceability" on page 6.

4. The surface of the decking support must be no more than 7.5" above the top of the abutments, measured at the abutments.

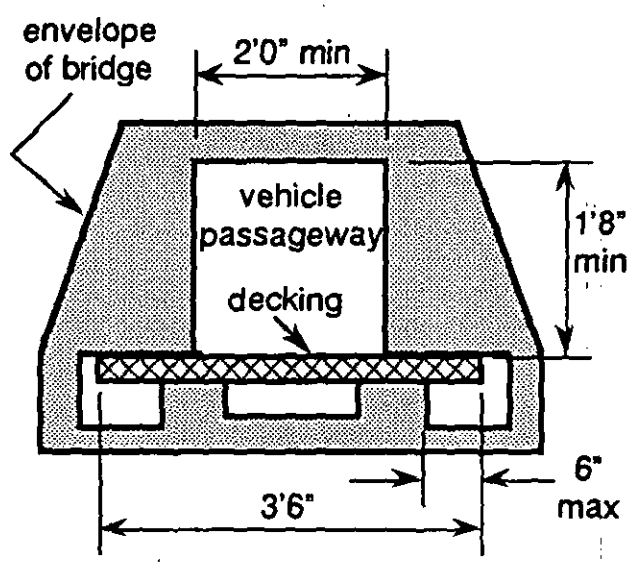
5. The absolute value of camber must not exceed 3 inches.

6. The bridge must provide support for the decking along both of the edges that run in the longitudinal direction of the bridge. The support must be continuous for the overall length of the bridge. This is easily verified by sliding a piece of decking along the full overall length of the bridge. Also see item 5 of "Safety Regulations: Strength and Serviceability" on page 6.

7. Decking must be supported without gaps, overlaps or abrupt elevation differences between decking units. However, small elevation differences, such as those caused by decking resting on bolt heads, are acceptable.



Side Elevation



Clearance and Deck Support

MATERIAL AND COMPONENTS

Violation of each of the following rules will result in a weight penalty being added to the weight of the bridge. The penalty for each violation is 10 pounds plus 5 times the weight of the non-conforming members, fasteners, assemblies and other parts.

1. A bridge may be constructed only of structural steel. For the purposes of this contest, structural steel is defined as an iron alloy that is strongly attracted to a magnet. Exception: Paint, banners, placards and other purely decorative items.

2. A bridge may be constructed only of components conforming to the following definitions of members, fasteners and assemblies.

   a. A member is a rigid component that retains its shape, dimensions and rigidity during construction and in the completed bridge.

   b. Fasteners are steel machine bolts with or without nuts.

   c. An assembly is no more than 3 members plus any number of fasteners that are connected together in the staging yards during timed construction.

3. A member may not exceed overall dimensions of 5'6" x 7.5" x 7.5." That is, it must fit in a prismatic box of those dimensions.

4. A member must be rigid. That is, hinged, jointed, articulated and telescoping members are prohibited, as are members with moving parts. This prohibition includes members with parts that are intended to slide, rotate, deflect or bend relative to the member during construction, such as cams, latches, sliding pins, springs, and snap-lock devices.

5. A member may consist of several parts rigidly fastened together before timed construction begins. Those parts must remain rigidly connected throughout the construction process and in the completed bridge.

6. The members of an assembly must remain connected.

CONSTRUCTION

Tools

Competitors provide their own tools. See item 4 of "Safety Regulations: Safe Construction" on page 5. Hardhats are considered to be tools.

Construction Site

See the figure on page 13 titled "Site Plan" for layout of river, banks, and other features that affect construction.

Temporary Shoring

Shoring is support on one or both river banks, and is provided by the competitors. Temporary shoring may be any material but must provide sufficient strength and stability to support the bridge.

Start

Before construction begins, all members, fasteners, units of temporary shoring, tools and builders are in the staging yards. Timing and construction begin when the builders signify that they are ready and the judge declares the start.

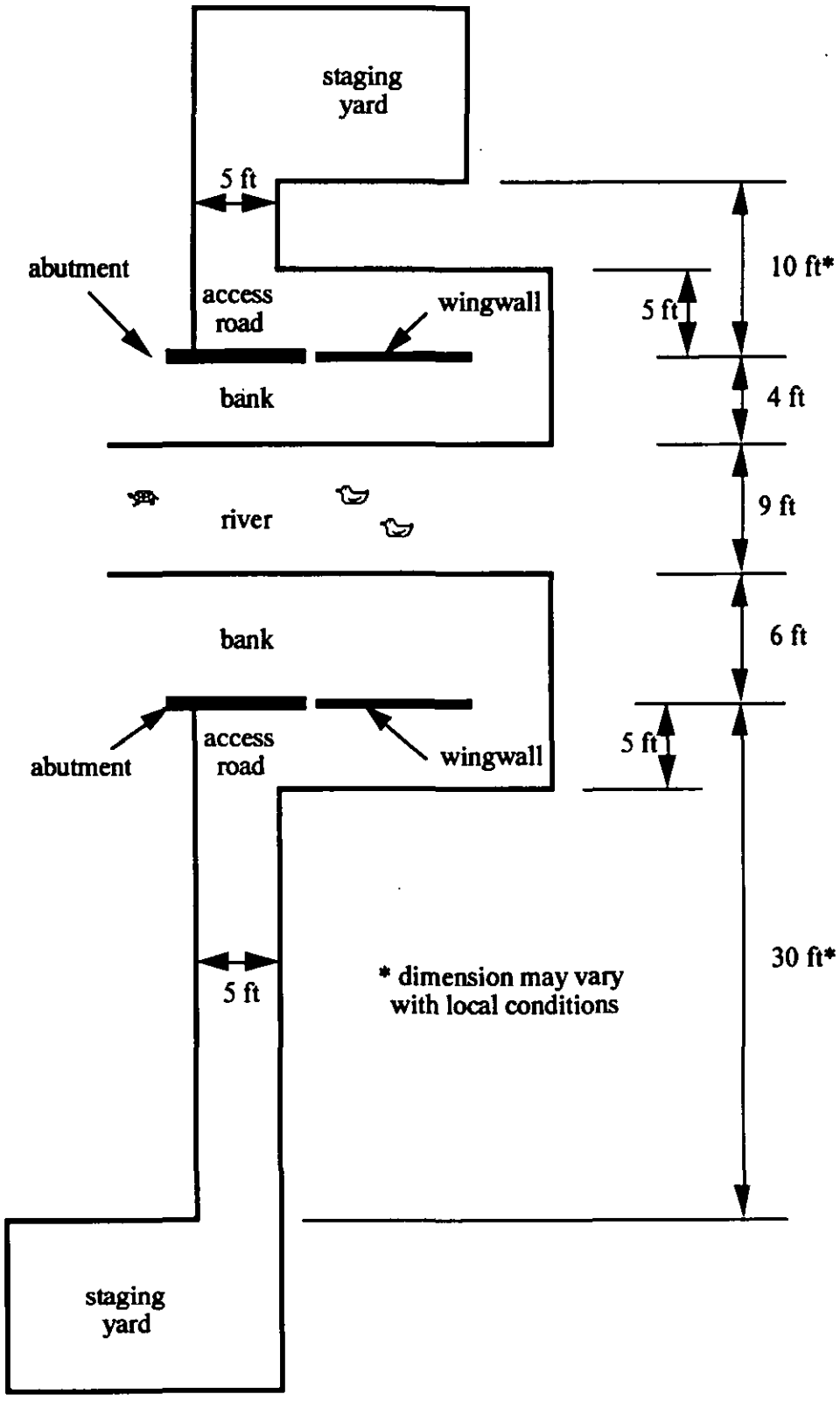
Time

Time is kept from the start to finish of construction. The clock will be stopped:

1. if a builder or judge sees a condition that could cause injury, or

2. when a safety regulation has been violated.

Construction ceases while the clock is stopped. The clock is restarted after the situation has been corrected.



Site Plan

Time Limit

In order to expedite the competition the host may limit the clock time for constructing a bridge to 30 minutes. If construction exceeds that time limit, a penalty of $5000 per clock minute over the limit will be added to the score in the economy category. If the host opts to impose a time limit, all competitors must be notified at least a month before the competition.

Finish

Construction ends when the bridge is complete, and all tools, temporary shoring and builders are in the staging yards, and the builders signify that they are finished. Installation of decking is not included in timed construction.

Accidents

In general, the clock is not stopped when an "accident" occurs. Builders involved in accidents may continue to build, and components involved in accidents may be recovered and used. If an accident is continuous (for example, a builder stands in the river) it will be counted as multiple incidents. Types of accidents and the corresponding time penalties, which will be added to the construction time, are:

1. A builder touches the river. Penalty is 3 person-minutes per incident. Exception: Builders may step in the river without penalty to retrieve a dropped member, assembly, tool or fastener.

2. A builder throws something. Penalty is 3 person-minutes per incident.

3. A builder crosses a wingwall or an abutment. Penalty is 2 person-minutes per incident.

3. Temporary shoring touches the river. Penalty is 2 person-minutes per incident.

4. A member, assembly, or the bridge touches the river, a bank, or an access road. Penalty is 2 person-minutes per incident.

5. A member, assembly, fastener or tool is leaned against an abutment, temporary shoring or the bridge. Penalty is 2 person-minutes per incident.

6. A tool or fastener touches the river, a bank, or an access road. Penalty is 1 person-minute per incident.

7. A builder steps beyond the limits of an access road, staging yard or river bank. Penalty is 1 person-minute per incident.

LOAD TESTS

Safety Precautions

A bridge could collapse or sway suddenly during load tests. Therefore, minimize the number of people near the bridge while it is being tested.

If abutments are adjustable, set them so that the bottom of the bridge is 3 to 6 inches above ground.

During testing, safety supports must be in place 3 to 6 inches below the bottom of the decking.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a cantilevered portion of the decking.

When any portion of the vertical load is on the bridge, no one is permitted to crawl, reach or step under the bridge. If such an action is necessary, the load must first be removed.

Repairs

A bridge will not be tested in a condition that compromises its strength or stability. Therefore, immediately prior to load testing, repairs may be made with the permission and supervision of a judge, according to the following provisions:

1. Damage occurring after construction will be repaired without penalty.

2. Minor construction errors will be repaired without penalty. For example, a nut may be adjusted to correct a slight misalignment of a primary component with no penalty.

3. Errors due to negligent construction will be repaired but a time penalty will be assessed in an amount, to be determined by the judge, that will exceed the incremental time required for careful initial construction. For example, a team that forgets to install bracing or makes no attempt to adjust nuts during timed construction will be penalized.

4. Deliberate exploitation of these repair provisions constitutes negligent construction and will be penalized heavily.

General Procedures and Definitions

Load tests are conducted without temporary shoring. Load test 1 is conducted without decking; load tests 2 and 3 are conducted with three decking units installed to accommodate the load.

Given weights of load are in addition to decking.

The figure titled "Location of Targets" illustrates some of the following procedures.

The judge designates, by a random process, the A and B sides of the bridge.

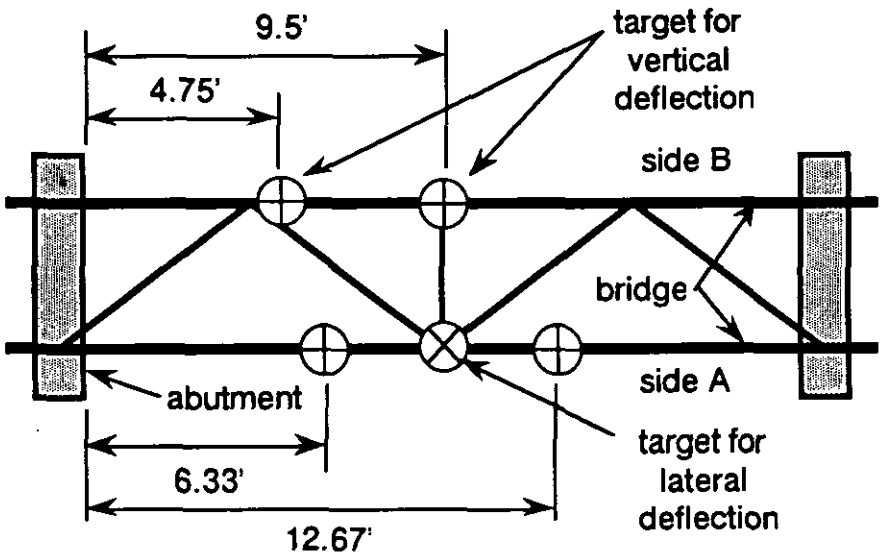
The judge marks a target at midspan on the A side, close to the level of the decking. All lateral deflection measurements are made to that target.

The judge marks targets on the A side at the third points of the span (i.e. 6 feet 4 inches and 12 feet 8 inches from the faces of the abutments). Then the judge also marks targets on the B side at the one quarter point and at midspan (i.e. 4 feet 9 inches and 9 feet 6 inches from the face of an abutment). The targets should be close to the level of the decking. Vertical deflection measurements are made to all four targets; vertical deflection is the largest absolute value of the four measurements.

Total lateral deflection is the absolute value of the horizontal distance of the target from its position at the beginning of load test 2. Incremental vertical deflection is the largest absolute value of the vertical distances of the targets from their positions at the beginning of load test 3.

Load tests are conducted in numerical order.

A BRIDGE THAT COLLAPSES DURING LOADING, DEFLECTION MEASUREMENTS OR UNLOADING MUST BE DISQUALIFIED.



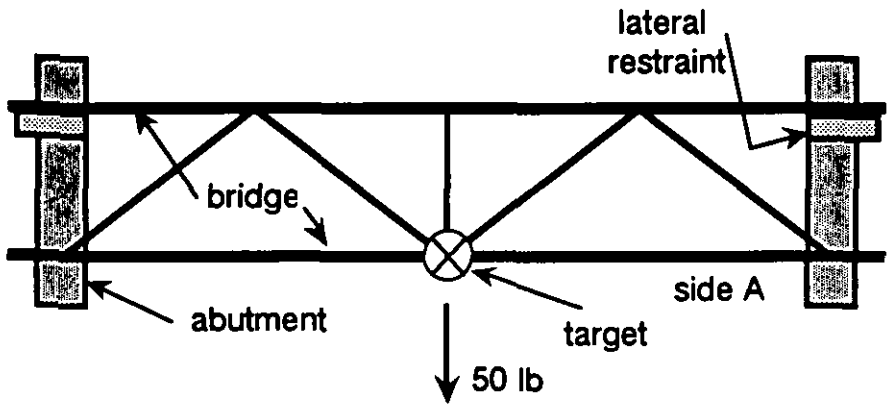
Location of Targets

Plan

5000

Load Test 1 - Lateral

Load test 1 is conducted with lateral restraint installed on the abutments to prevent the ends of the bridge from sliding. On side A, as close as practical to midspan and to the level of the deck apply a 50 pound force in the lateral direction. To pass load test 1, the lateral deflection of the bridge must not exceed 1.0". If the bridge does not pass load test 1 it is disqualified; do not conduct any other load test. Remove the lateral load; it is not part of the remaining load tests.

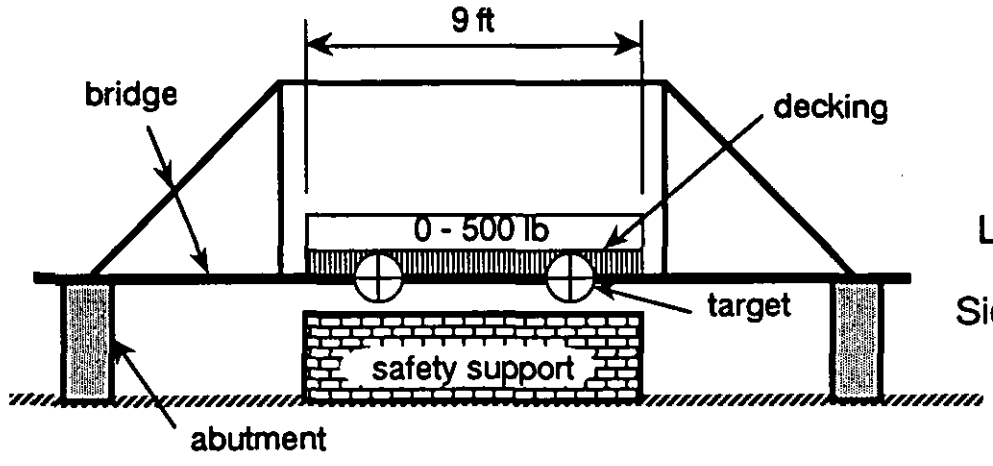


Load Test 1

Plan

Load Test 2 - Vertical, Preliminary

Uniformly distribute load over an area symmetric about the middle of the deck and extending 9 feet in the span direction, as shown in the figure. Terminate load test 2 when lateral deflection exceeds 1.0" or vertical deflection exceeds 2.0" or 500 pounds of load have been placed. A bridge passes load test 2 if 500 pounds of load was placed without a deflection limit being exceeded. Record the vertical deflection. If the bridge does not pass load test 2 it is disqualified; do not conduct any other load test.

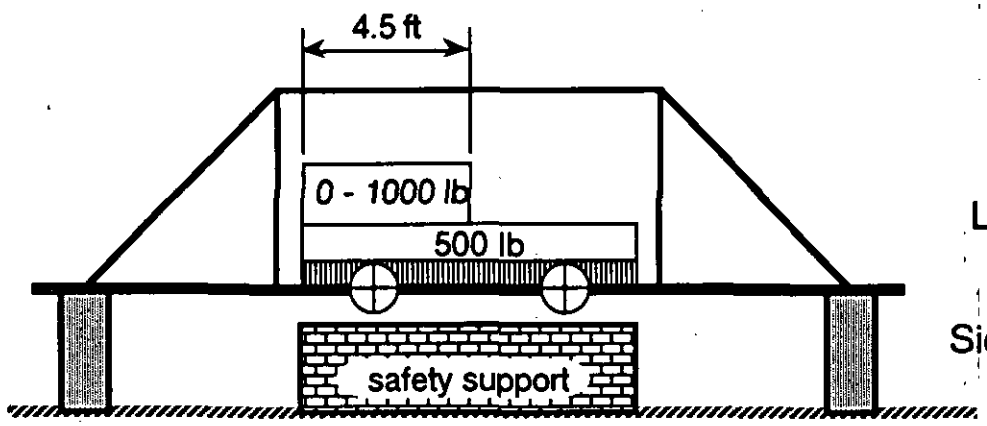


Load Test 2

Side Elevation

Load Test 3 - Vertical, for Deflection Measurement

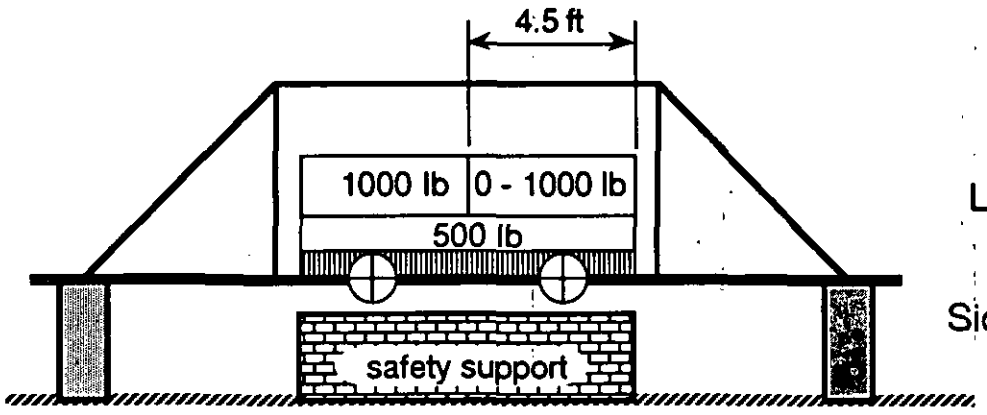
Step 1. With the 500 pound load from test 2 remaining in place, uniformly distribute additional load over an area symmetric to the midline of the deck and extending 4.5 feet from midspan toward an end randomly selected and designated by the judge. That is, the load is longitudinally eccentric, as shown in the figure. Terminate step 1 when total lateral deflection exceeds 2.0" or incremental vertical deflection exceeds 2.0" or total load is 1500 pounds. Terminate load test 3 and disqualify the bridge if either deflection limit is exceeded.



Load Test 3
Step 1

Side Elevation

Step 2. With previous loads remaining in place, uniformly distribute additional load over an area symmetric to the midline of the deck and extending 4.5 feet from midspan toward the end opposite to the one designated by the judge in step 1. That is, the load restores symmetry, as shown in the figure. Terminate step 2 when total lateral deflection exceeds 2.0" or incremental vertical deflection exceeds 2.0" or total load is 2500 pounds. Terminate load test 3 and disqualify the bridge if either deflection limit is exceeded. If the total load of 2500 pounds was placed without a deflection limit being exceeded, then the bridge passes load test 3. Record the incremental vertical deflection (that is, the largest absolute value of the vertical distances of the four targets from their positions at the start of test 3).



Load Test 3
Step 2

Side Elevation

EQUIPMENT PROVIDED BY HOST

The following equipment will be provided at the contest site by the host. Competitors should acquire similar equipment for use in practice and testing before the competition.

Lateral Load Device

Capable of applying 50 pound force in the horizontal direction.

Measuring Instruments and/or Scales

Load

2500 pounds total. The load should be supplied in uniform pieces of size and weight that may be handled safely. When in place, the load should not provide significant stiffness in the longitudinal direction of the bridge. Sections of steel angle of uniform size and length are recommended for load. 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.

Decking

The decking is steel bar grating identified as W-19-4 (1 x 1/8). The dimensions of a piece of grating are 3'6" x 2'11-3/4" x 1". 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 of the grating that are perpendicular to the length.

Abutments

Construction. The top surface of each abutment should be at least 5 feet long, 3 inches wide, level, smooth, and approximately 3 feet above the ground.

Load Testing. A different set of abutments may be used during load testing. The top surface of each abutment should be at least 5 feet long, 3 inches wide, level and smooth. Height may be adjustable so that the bridge may be positioned close to the ground. Temporary lateral restraints are needed during load test 1.

Safety Support

The safety support must be used during load testing and is intended to limit the consequences of a bridge collapsing. The safety support should extend at least 6 feet along the length of the bridge. It should be adjustable in width and height, and should be centered under the bridge. The safety support must be placed before the beginning of load testing, with the top 3 to 6 inches below the bottom of the decking.

JUDGING

The host 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, rating and disqualification are the sole responsibility of the judges and will be final. The host will assure that the judges are fully informed of the rules and procedures, and fully equipped for their tasks. The host and judges will follow directions in the *Guide for Hosts and Judges* provided by AISC.

PROTESTS AND APPEALS

Before the Contest Each team will designate two students as team captains. The host will identify the head judge.

During the Contest A penalty, disqualification, measurement, score, or condition of competition may be protested only by the team captains and only to the head judge. The protest must be made as soon as possible after the situation becomes apparent. The head judge will not hear the protest if he or she is approached by students other than team captains. As soon as possible after a protest is made, the head judge will interrupt the contest if necessary, gather the other judges and the captains of the teams involved, and hear the protest. The decision of the head judge is final.

Participants are reminded that civility and ethical behavior are expected during the contest and particularly concerning protests.

After the Regional Contest If a team wants to appeal the decision of the head judge regarding a protest it may do so in a letter mailed to Mr. Fromy Rosenberg (AISC, Suite 3100, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to the Student Services Manager of ASCE. The letter should include the name of the college or university making the appeal; the names, addresses and telephone numbers of the faculty adviser and one team member; brief description of the problem, the action taken at the contest to deal with it, and the action that the appealing team feels should have been taken; computation showing how the appealing team's rankings would have been improved if a different action had been taken.

Appeals must be made in writing. Only appeals received within one week of the regional contest will be considered.

The only redress that may be made is an invitation to participate in the national competition if the Rules Committee is convinced that the appeal is valid and that the appealing team should have placed first or second in its region. Decisions and rankings made by regional judges will not be overturned.

After the National Contest Appeals will not be accepted. However, AISC welcomes written suggestions for improving future competitions.

TIPS FOR COMPETITORS

1. Strive for challenging but realistic goals for design and construction. The following statistics from the 1996 National Steel Bridge-Building Competition suggest the levels of performance that are possible. However, when reviewing these statistics keep in mind that the rules and scoring for 1997 differ from those for 1996.

	Winning bridge in category	*Winning bridge, overall*
Weight (lb)	52	52
Construction time (person-minutes)	6.9	12.96
Incremental vertical deflection (inches)	0.102	0.242

2. Start work on the design early, leaving adequate time to procure materials, fabricate the bridge, load test it and practice construction.

3. Design a bridge that may be fabricated, erected and load tested safely, using available materials, tools and facilities.

4. Structural analysis may fail to disclose instability, such as buckling of slender compression members, sway, and torsion of under-deck trusses of triangular cross-section.

5. Allow tolerances for the decking to be slightly larger or smaller than specified.

6. Allow tolerances for spacing and levelness of abutments.

7. When fabricating your bridge, use safe tools, operate them carefully and with adequate supervision.

8. Make sure that abutments, temporary shoring and safety support are strong enough (with a generous factor of safety) and will not tip during use, even if the bridge collapses.

9. When practicing construction, wear hardhats for safety and to accustom yourself to contest conditions.

10. Follow all safety regulations and guidelines during construction practice.

11. When load testing your bridge before the competition keep it as low to the ground as possible and place safety support a few inches below the decking under at least 6 feet of the span. This will reduce risk of injury and limit damage to the bridge if it collapses. Keep hands and feet out from under the bridge.

12. Don't stand, sit or lie on your bridge.

13. To expedite the competition have a preset plan for unloading and staging components of your bridge. Before the competition adjust your temporary shoring to conform to the height of the host's abutments.

SCORE SHEET

Time Penalties

See "Construction: Accidents"

item 1: violations _____ x 3 = _____ person-min

items 2, 3: violations _____ x 2 = + _____ person-min

items 4, 5: violations _____ x 1 = + _____ person-min

TIME PENALTIES (add) _____ person-min

Weight Penalties

See "Dimensions and Support"

Number of violations _____ x 30 pounds = _____ pounds

See "Material and Components"

Number of violations _____ x 10 pounds = + _____ pounds

Wt. of parts in violation _____ pounds x 5 = + _____ pounds

WEIGHT PENALTIES (add) _____ pounds

Construction Time

_____ builders x _____ min

+ time penalties = _____ = _____ person-min

Total Weight

Bridge weight _____ pounds

+ weight penalties _____ = _____ pounds

Aesthetics

Name of college or university appears on bridge or on attached banner or placard in letters at least 2 inches high.

Other items that may be considered:

General appearance	Balance and proportion
Finish	Elegance of connections
Construction organization	Teamwork

AESTHETICS SCORE _____

Deflection

(incremental vertical, test 3) _____ inches

Efficiency

Total weight (lb) _____ = _____

Incremental vert. deflect. (in) _____ x 100 = +_____

SNWD (add) _____

Cost

Const. Time _____ x $5000 = $_____

Weight _____ x $1000 = +$_____

TOTAL COST (add) $_____

Ranks

Disqualified bridges will not be ranked.

Lightness _____ Construction Speed _____

Aesthetics _____ Stiffness _____

Efficiency _____

Economy _____

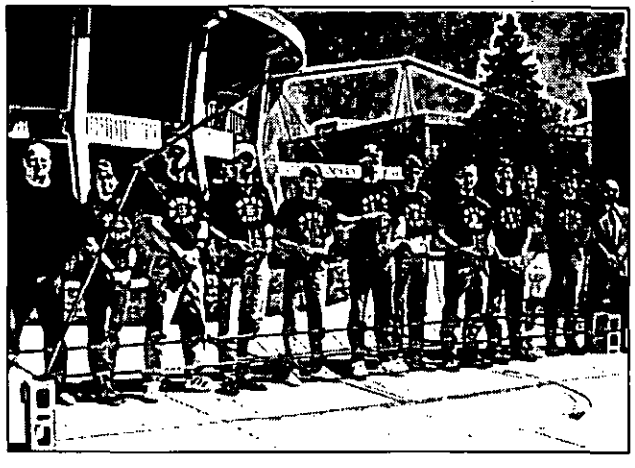
Overall Performance

Sum of ranks, except lightness and aesthetics.

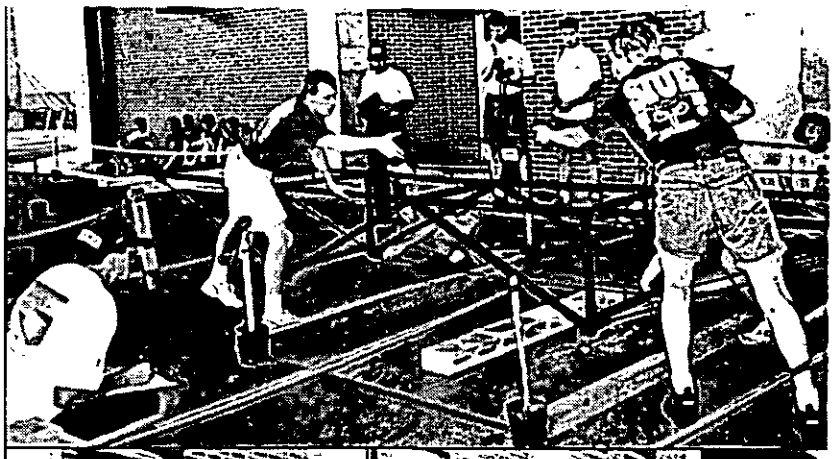
Construction speed + Stiffness + Efficiency + Economy = _____

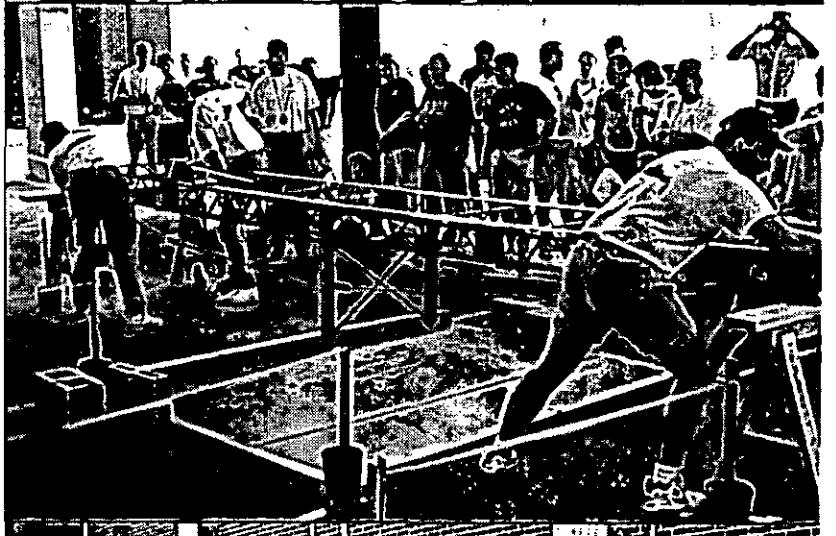
Use aesthetics as tie breaker.

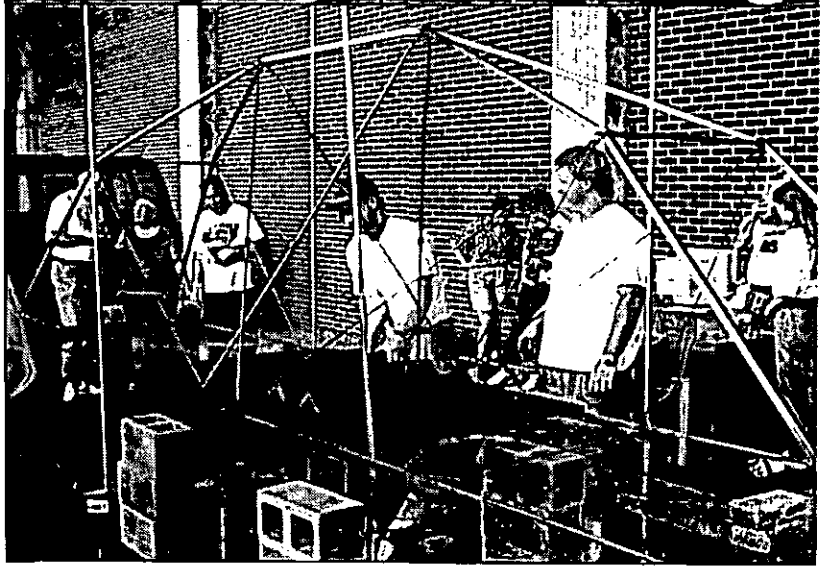
1996 STEEL BRIDGE BUILDING COMPETITION



For student chapters of the American Society of Civil Engineers







COSPONSORS

AMERICAN SOCIETY OF CIVIL ENGINEERS

American Iron and Steel Institute

THE JAMES F. LINCOLN ARC WELDING FOUNDATION

RULES

AISC STEEL BRIDGE-BUILDING COMPETITION

1996

TABLE OF CONTENTS

INTRODUCTION

The Steel Bridge-Building Competition is sponsored by the American Institute of Steel Construction and co-sponsored by the American Society of Civil Engineers, the American Iron and Steel Institute and the James F. Lincoln Arc Welding Foundation. This inter-collegiate challenge requires Civil Engineering students to design, fabricate and construct a steel bridge.

Safety is of primary importance. The AISC requests that competitors, hosts and judges take all necessary precautions to prevent injury.

The competition rules have been changed for 1996 in order to improve the contest and to assure that competitors design and build new bridges.

Ideally, students should fabricate the entire bridge themselves. However, appropriate shop facilities and supervision may not be available at every college and university. Therefore, the services of a commercial fabricator may be used provided that students observe the operations. Students are encouraged to maximize their personal involvement in fabricating their bridge.

This booklet describes the contest and states the official rules for this year. It is distributed to universities throughout the country. A companion booklet, *Guide for Hosts and Judges*, is distributed to hosts and provides directions for conducting a competition.

The rules are intended to be prescriptive but may require some interpretation. Questions regarding interpretation should be directed to the host.

EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication and construction. Participating students gain practical experience in structural design, fabrication processes, construction planning, organization and teamwork.

The Problem Statement describes challenges encountered in a representative structural engineering project. The competition is a scaled simulation of that project.

Standards for durability, constructibility, usability, strength and serviceability reflect the volumes of regulations that govern the design and construction of full-scale bridges. Criteria for excellence are represented by the award categories of stiffness, lightness, construction speed, aesthetics, efficiency and economy. As with a real construction project, safety is the primary concern.

The rules of the competition accommodate a large 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.

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

PROBLEM STATEMENT

A century-old bridge that crosses a river valley in a mountainous region must be replaced. The bridge carries heavy truck traffic to and from mines which are the basis for the economy of this rural region, as well as providing access and emergency services to residences. A quick replacement is necessary because no other river crossing of adequate capacity is available for miles.

The State Department of Transportation has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered, but the State has specified steel as the material because of its durability and fast erection. The bridge must accommodate two lanes of traffic and be able to carry specified patterns of traffic and wind loads without exceeding deflection limits. In order to expedite environmental approvals, no piers may be erected in the river, nor may temporary scaffolding or causeways be used in the river. However, temporary shoring may be erected on the banks. Construction barges and marine cranes are not feasible due to fast currents and flash floods.

The stone abutments of the existing bridge are in good condition and will serve for the new bridge, provided that no lateral thrust nor uplift is applied to the abutments. The State DOT will not permit modification of the existing abutments. The new bridge, when complete, must be supported only by the existing abutments; for example, stays and anchorages to the river banks are prohibited.

The new bridge must accommodate modular decking, which the State DOT salvaged from another bridge. Decking units may not be modified.

Access to the construction site is limited by narrow, winding roads. This imposes restrictions on the size of components, and on the movements of construction equipment. Soil conditions restrict the weight that may be lifted by cranes.

Your company's design/build proposal is among those that the State DOT has deemed responsive. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. The DOT will evaluate the models by multiple criteria including durability, constructibility, usability, stiffness, construction speed, efficiency, economy and aesthetics. The contract will be awarded to the company that submits the best model. This is an opportunity to become leaders in the bridge replacement market.

QUALIFICATION

In order to compete for awards, a bridge must qualify by satisfying the following minimum standards for durability, constructibility, usability, strength and serviceability.

Durability

The bridge must be constructed entirely of steel.

Constructibility

The bridge may be constructed only of components conforming to the restrictions on size and weight specified in "Components." The bridge must be constructible according to regulations given in "Construction" and without violating requirements listed in "Safety Regulations."

Usability

The bridge must conform to the specifications described in "Dimensions and Support."

Strength and Serviceability

The bridge must pass load tests 1 and 2 described in "Load Tests."

AWARD COMPETITION

Only qualified bridges are eligible to compete for awards. Categories of competition are stiffness, lightness, construction speed, efficiency, economy and aesthetics. In addition, overall performance is rated.

Stiffness

The bridge with the lowest incremental vertical deflection will win in the stiffness category. Incremental vertical deflection is determined from load test 3. A bridge that fails load test 3 will be eliminated from the stiffness and efficiency categories of competition.

Lightness

The bridge with the least total weight will win in the lightness category. Decking and temporary shoring are not included in total weight.

Construction Speed

The bridge with the lowest construction time will win in this category. Construction time is the product of the size of the construction team and the duration of construction. The construction team includes everyone who handles the bridge or any of its components during timed construction. A bridge that accumulates $150,000 or more in penalties will be eliminated from competition in the construction speed and economy categories (see "Accidents.")

Efficiency

The bridge with the smallest sum of normalized weight and deflection (SNWD) will win in the efficiency category. The sum of normalized weight and deflection is computed as

SNWD = Total weight (lb) + (100 x Incremental vertical deflection (in))

Economy

The bridge with the lowest cost (C) will win in the economy category. Cost is computed as

C = Total weight (lb) x 1000 ($/lb)

+ Construction time (person-min) x 5000 ($/person-minute)

+ $2000 if temporary shoring is used on one bank

+ $2000 if temporary shoring also is used on the other bank

+ Penalty for accidents (listed in "Accidents")

+ Penalty for negligent construction
(explained in "Load Tests, Repairs")

Aesthetics

Factors that may be considered include general appearance, balance and proportion of the design, elegance of connections, finish, construction organization and teamwork. Quality of fabrication should not be considered because some bridges may be fabricated professionally while others are student work.

Overall Performance

The overall performance rating of a bridge is determined by adding the rank of the bridge in the efficiency category to its rank in the economy category. The bridge with the lowest sum will win the overall competition. A bridge that was eliminated from the efficiency or economy categories is not eligible for the overall performance competition. In the case of a tie, judges will use aesthetics as the tie breaker.

COMPONENTS

A bridge may be constructed only of components made entirely of steel and conforming to the following descriptions of members, cables with fittings, assemblies, and fasteners.

A member is a rigid component that retains its shape, dimensions and rigidity during construction and in the completed bridge. A member must comply with the following limitations:

1. A member may not weigh more than 40 pounds.

2. A member may not exceed overall dimensions of 5'6" x 7.5" x 7.5."

3. A member must be rigid. That is, hinged, jointed, articulated and telescoping members are prohibited, as are members with moving parts. This prohibition includes members with parts that are intended to slide, rotate, deflect or bend relative to the member during construction, such as cams, latches, sliding pins, springs, and snap-lock devices.

4. A member may consist of several parts rigidly fastened together before timed construction begins. Those parts must remain rigidly connected throughout the construction process and in the completed bridge.

A cable with fittings is a flexible component that retains its length and flexibility during construction and in the completed bridge. A cable with fittings must comply with the following limitations:

1. A cable with fittings must be capable of being coiled to a diameter not exceeding two feet. Rigid parts must conform to the following description of fittings. Flexible parts must be coilable to the specified diameter.

2. Fittings (eyes, hooks, plates, clamps, clevises, turnbuckles and similar parts connected to cables) may not exceed 7.5" in any dimension.

3. A cable with fittings may have any number of ends.

4. A cable with fittings may not weigh more than 40 pounds.

5. A cable with fittings may consist of several parts fastened together before timed construction begins. Those parts must remain connected throughout the construction process and in the completed bridge.

An assembly is no more than 3 members and/or cables with fittings that are connected together in the staging yards during timed construction.

Fasteners are bolts and nuts, pins, plates, shims and similar parts used for connecting members, cables with fittings, and assemblies, and not exceeding 7.5" in any dimension.

CONSTRUCTION

Tools

Competitors provide their own tools. Only hand tools are permitted. Field welding and power tools are prohibited. Ropes are permitted but gin poles, jacks, winches, come-alongs, counterweights and other hoisting devices are prohibited. Stools, ladders and similar objects for elevating builders are prohibited. Hardhats are considered to be tools.

Construction Site

See the figure titled "Site Plan" for layout of river, banks, and other features that affect construction.

Temporary Shoring

Shoring is temporary support on one or both river banks, and is provided by the competitors. There are no restrictions on the materials and design for temporary shoring other than that it must provide sufficient strength and stability to support the bridge. Temporary shoring facilitates construction but there is a cost assigned to its use.

Safety Support

During construction the top of the safety support must be in place at the midspan of the bridge with its top surface no more than 8 inches below primary beams on both sides of the bridge.

Start

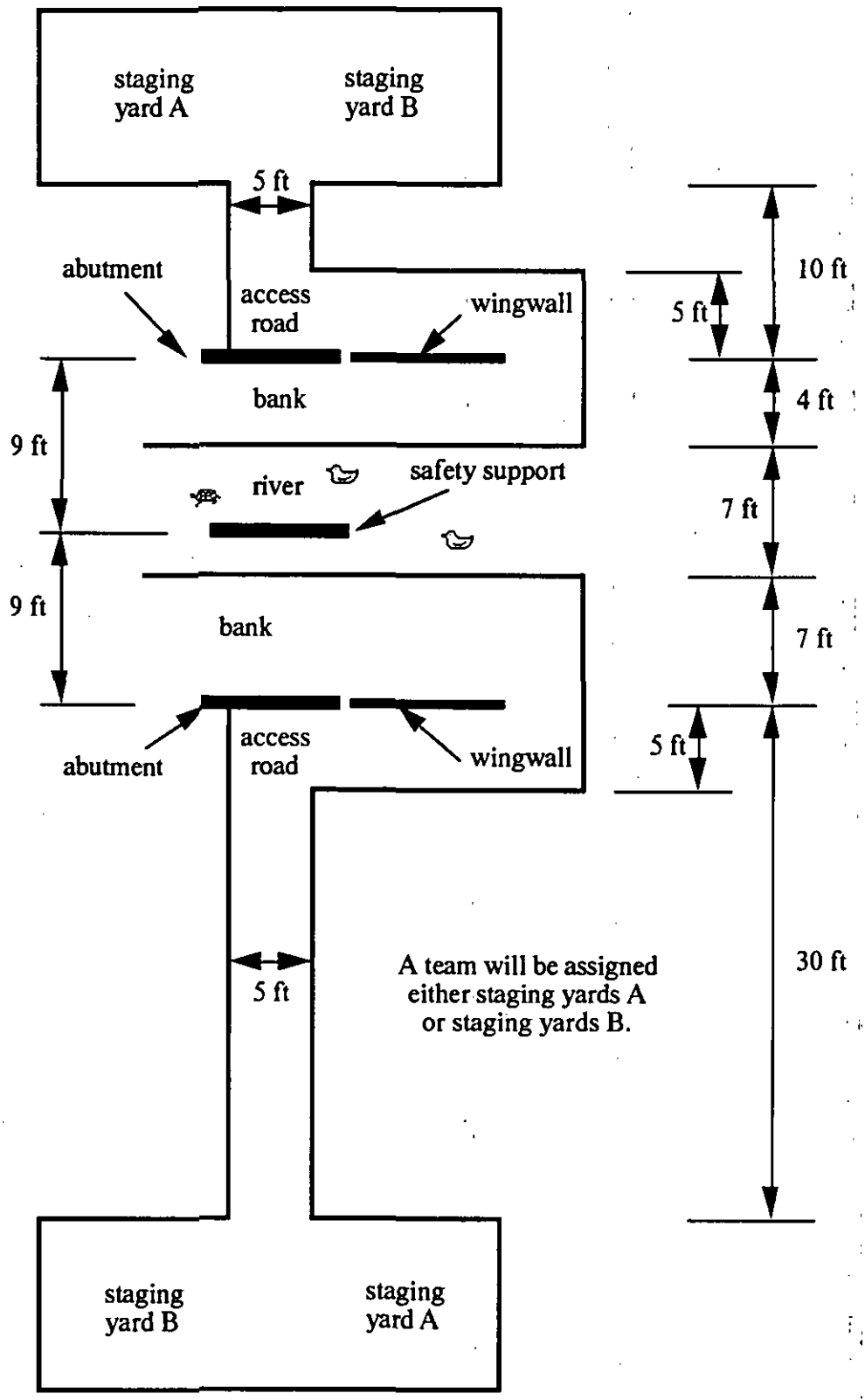
Before construction begins, all members, cables with fittings, fasteners, tools and builders are in the staging yards. Cables with fittings are coiled to a diameter not exceeding two feet. Temporary shoring, if used, is in place on one or both river banks. The safety support is in place. Timing and construction begin when the builders signify that they are ready and the judge declares the start.

Time

Time is kept from the start to finish of construction. The clock will be stopped:

1. if a builder or judge sees a condition that could cause injury,
2. when a safety regulation has been violated, or
3. if the safety support must be adjusted.

Construction ceases while the clock is stopped. The clock is restarted after the situation has been corrected.


staging
yard A
staging
yard B
5 ft
abutment
access
road
wingwall
bank
9 ft
river
safety support
9 ft
bank
abutment
access
road
wingwall
5 ft
A team will be assigned
either staging yards A
or staging yards B.
staging
yard B
staging
yard A
10 ft
5 ft
4 ft
7 ft
7 ft
5 ft
30 ft

Site Plan

Time Limit

In order to expedite the competition the host may limit the clock time for constructing a bridge to 30 minutes. A higher limit may be imposed. A bridge that exceeds the limit will be eliminated from all categories of competition. If the host opts to impose a time limit, all competitors must be notified at least a month before the competition.

Finish

Construction ends when the bridge is complete, and all tools and builders are in the staging yards, and the builders signify that they are finished. Temporary shoring may remain on the banks. Installation of decking is not included in timed construction.

SAFETY REGULATIONS

If any of the following safety regulations is violated the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools and bridge components will be returned to the positions they occupied before the violation. Construction that necessitates violation of safety regulations is not permitted.

1. All builders must wear hardhats during timed construction.

2. Temporary shoring may not be placed in the river.

3. A builder may not use the bridge, an abutment or temporary shoring to support the builder's body weight. For example, standing, sitting or kneeling on those objects is prohibited. However, a builder may lean on the bridge, abutment or shoring if both feet remain on the river bank.

4. A builder may not stand, sit or kneel in the river or on the safety support, nor use the river or safety support for support in any way.

5. A builder must stay within the limits of the access roads and river banks.

6. A builder may not cross a wingwall or an abutment.

7. A builder may not cross the river by jumping, by temporary scaffolding, by crossing the bridge, or by any other means.

8. Nothing may be thrown.

9. A builder may lift or carry only one member or one cable with fittings at a time.

10. An assembly may not be lifted nor carried by one builder alone.

11. Two or more builders may lift or carry only one assembly at a time.

12. A constructed portion of the bridge (i.e. not conforming to the definitions of member, cable with fittings, or assembly) may not be lifted nor carried.

13. A constructed portion of the bridge may be slid horizontally, provided that it is supported by both abutments, or by temporary shoring on both banks, or by one abutment and one unit of temporary shoring.

14. One side or end of a constructed portion of the bridge may be moved a few inches in any direction in order to align a connection. However, the other side or end of the constructed portion must remain supported by an abutment, temporary shoring or another portion of the bridge.

15. A member, cable with fittings, assembly, fastener or tool may not be laid down except in the staging yards, on an abutment, or on the bridge.

16. A member, cable with fittings, assembly, fastener or tool may not be leaned against an abutment, temporary shoring, safety support or the bridge.

ACCIDENTS

In general, the clock is not stopped when an "accident" occurs. Builders involved in accidents may continue to build, and components involved in accidents may be recovered and used. Types of accidents and the corresponding cost penalties are:

1. A builder touches the river or the safety support. $50,000 for each occurrence.

2. A member, cable with fittings, assembly, or the bridge touches the river, a bank, an access road or the safety support. $20,000 for each occurrence.

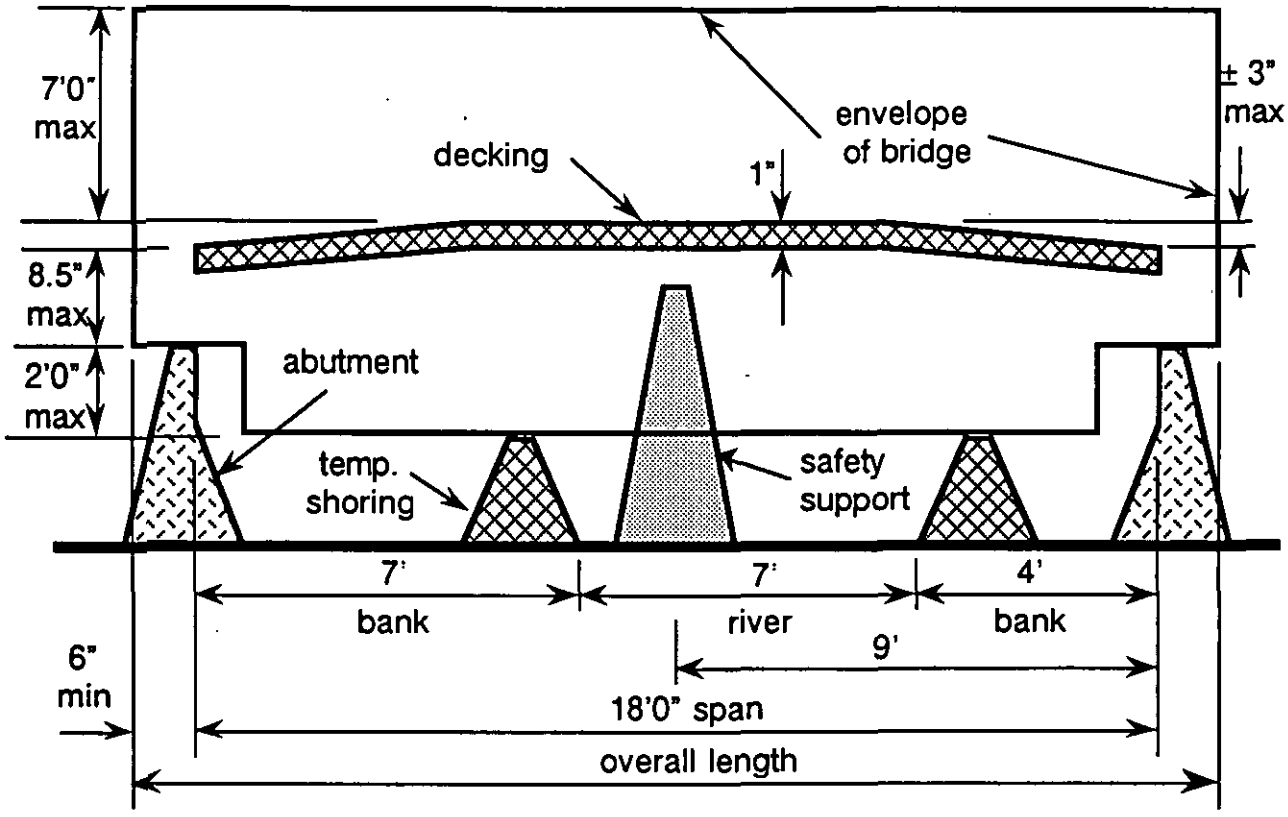
3. A tool or fastener touches the river, a bank, an access road or the safety support. $1000 for each occurrence.

DIMENSIONS AND SUPPORT

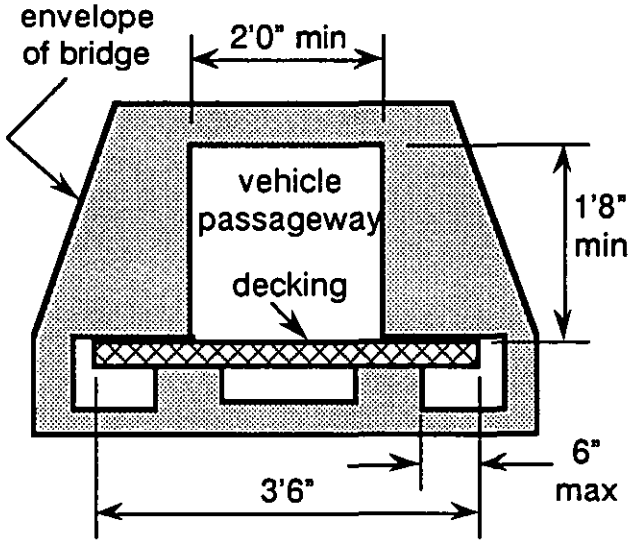
The figures titled "Side Elevation" and "Clearance and Deck Support" illustrate some of the following specifications.

1. The bridge must span the abutments, which are fixed in place so that the distance between faces is 18 feet.

2. The bridge must provide bearing area extending at least 6 inches behind the face of each abutment so that the bridge will remain supported by the abutments in the event that it is displaced 6 inches in the direction of span.



Side Elevation



Clearance and Deck Support

3. A 2'0" wide by 1'8" high rectangular vehicle passageway must be provided along the overall length of the bridge.

4. No part of the bridge may extend more than 2 feet below the top of the abutments at any point on the span.

5. No part of the bridge may extend more than 7 feet above the top of the decking at any point on the span.

6. The surface of the decking must be no more than 8.5" above the top of the abutments, measured at the abutments.

7. The absolute value of camber must not exceed 3 inches.

8. The bridge must provide support for the decking on both of the edges that run in the longitudinal direction of the bridge. The support must be continuous for the overall length of the bridge. This is easily verified by sliding a piece of decking along the full overall length of the bridge.

9. Decking must be supported without gaps, overlaps or abrupt elevation differences between decking units. However, small elevation differences, such as those caused by decking resting on bolt heads, are acceptable.

10. The edges of the decking that run in the longitudinal direction of the bridge may be cantilevered over their supports no more than 6 inches.

11. The decking may not be attached nor anchored to the bridge.

12. The bridge may not be attached nor anchored to the abutments, and it may bear only on the top surface of the abutments.

13. The bridge may not be anchored, tied nor braced to the ground.

LOAD TESTS

Safety Precautions

A bridge could collapse or sway suddenly during load tests. Therefore:

Minimize the number of people near the bridge while it is being tested.

If abutments are adjustable, set them so that the bottom of the bridge is 5 to 8 inches above ground.

During testing, safety support must be in place 5 to 8 inches below the bottom of the decking.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a cantilevered portion of the decking.

When any portion of the vertical load is on the bridge, no one is permitted to crawl, reach or step under the bridge. If such an action is necessary, the load must first be removed.

Repairs

A bridge will not be tested in a condition that compromises its strength or stability. Therefore, immediately prior to load testing, repairs may be made with the permission and supervision of a judge, according to the following provisions:

1. Damage occurring after construction will be repaired without penalty.

2. Minor construction errors will be repaired without penalty. For example, a turnbuckle may be re-adjusted to correct a slight misalignment of a primary component with no penalty.

3. Errors due to negligent construction will be repaired but a cost penalty will be assessed in an amount, to be determined by the judge, that will exceed the incremental cost of careful initial construction. For example, a team that forgets to install bracing or makes no attempt to adjust turnbuckles during timed construction will be penalized.

4. Deliberate exploitation of these repair provisions constitutes negligent construction and will be penalized heavily.

General Procedures and Definitions

Load tests are conducted without temporary shoring. Load test 1 is conducted without decking; load tests 2 and 3 are conducted with three decking units installed to accommodate the load.

The judge selects a side of the bridge and marks a target at midspan on that side, close to the level of the decking. All lateral deflection measurements are made to that target.

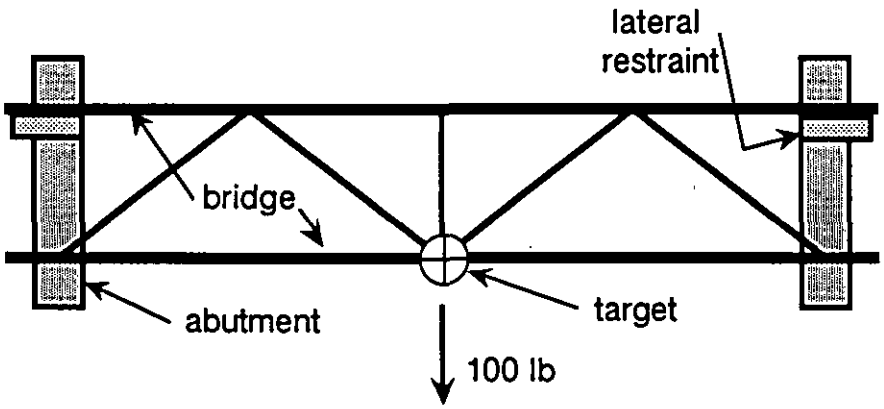
The judge selects a side of the bridge and marks targets at the third points of the span (i.e. 6 and 12 feet from the faces of the abutments). The targets should be close to the level of the decking. Vertical deflection measurements are made to both targets; vertical deflection is the larger absolute value of the two measurements.

Total lateral deflection is the absolute value of the horizontal distance of the target from its position at the beginning of load test 2. Incremental vertical deflection is the larger absolute value of the vertical distances of the targets from their positions at the beginning of load test 3.

Load tests are conducted in numerical order.

Load Test 1 - Qualifying, Lateral

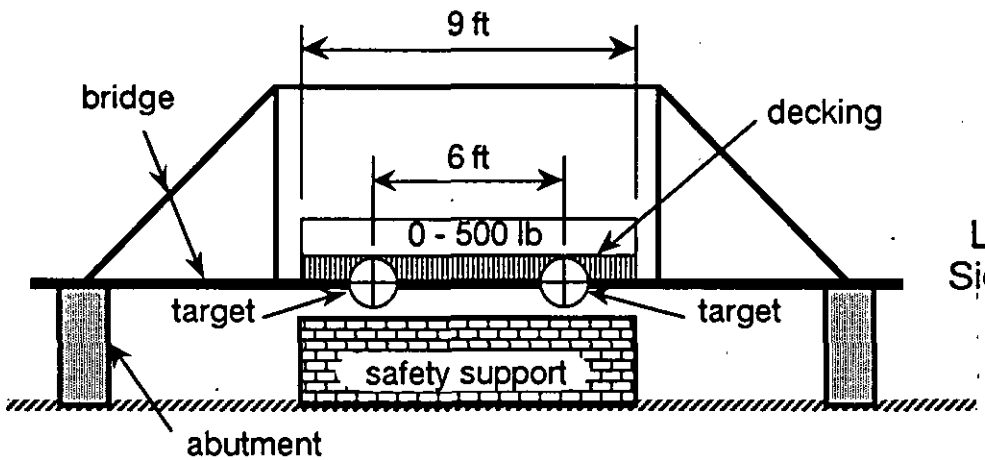
Load test 1 is conducted with lateral restraint installed on the abutments to prevent the ends of the bridge from sliding. As close as practical to midspan and to the level of the deck apply a 100 pound force in the lateral direction. To pass load test 1, the lateral deflection of the bridge must not exceed 1.0". If the bridge does not pass load test 1, do not conduct any other load test. Remove the lateral load; it is not part of the remaining load tests.



Load Test 1
Plan

Load Test 2 - Qualifying, Vertical

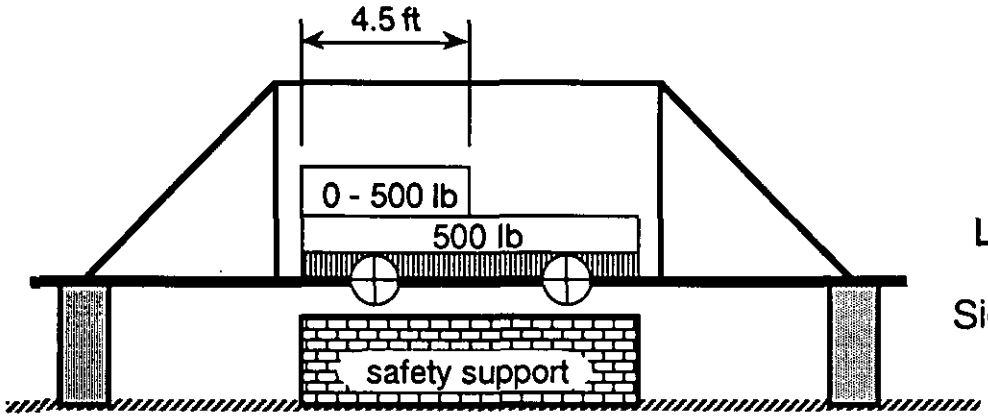
Uniformly distribute load over an area symmetric about the middle of the deck and extending 9 feet in the span direction, as shown in the figure. Terminate load test 2 when lateral deflection exceeds 1.0" or vertical deflection exceeds 2.0" or 500 pounds of load have been placed. A bridge passes load test 2 if 500 pounds of load was placed without a deflection limit being exceeded. Record the vertical deflection. If the bridge does not pass load test 2, do not conduct any other load test.



Load Test 2
Side Elevation

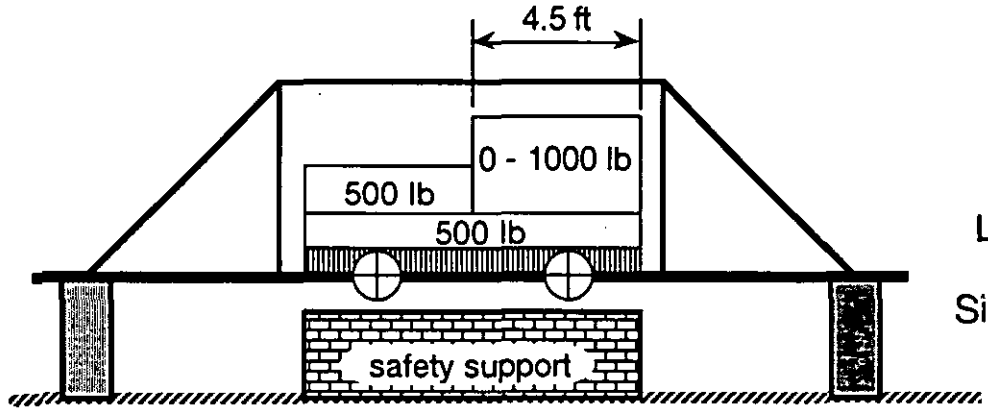
Load Test 3 - Competition, Vertical

Step 1. With the 500 pound load from test 2 remaining in place, uniformly distribute additional load over an area symmetric to the midline of the deck and extending 4.5 feet from midspan toward an end designated by the judge. That is, the load is longitudinally eccentric, as shown in the figure. Terminate step 1 when total lateral deflection exceeds 2.0" or incremental vertical deflection exceeds 2.0" or total load is 1000 pounds. Terminate load test 3 if either deflection limit is exceeded.



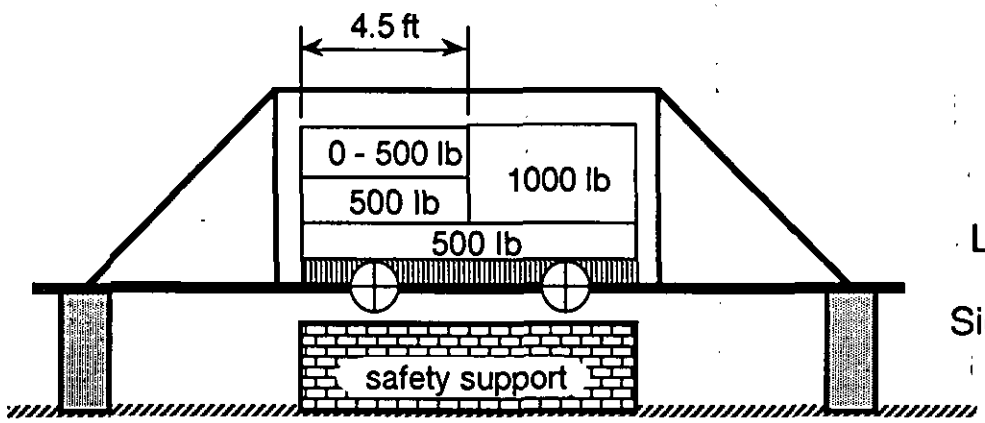
Load Test 3
Step 1
Side Elevation

Step 2. With previous loads remaining in place, uniformly distribute additional load over an area symmetric to the midline of the deck and extending 4.5 feet from midspan toward the end opposite to the one designated by the judge in step 1. That is, the eccentricity is reversed, as shown in the figure. Terminate step 2 when total lateral deflection exceeds 2.0" or incremental vertical deflection exceeds 2.0" or total load is 2000 pounds. Terminate load test 3 if either deflection limit is exceeded.



Load Test 3
Step 2
Side Elevation

Step 3. With previous loads remaining in place, uniformly distribute additional load over an area symmetric to the midline of the deck and extending 4.5 feet from midspan toward the end designated by the judge in step 1. That is, the load restores symmetry, as shown in the figure. Terminate testing when total lateral deflection exceeds 2.0" or incremental vertical deflection exceeds 2.0" or total load is 2500 pounds. If the total load of 2500 pounds was placed without a deflection limit being exceeded, then the bridge passes load test 3. Record the incremental vertical deflection (that is, the larger absolute value of the vertical distances of the targets from their positions at the start of test 3).



Load Test 3
Step 3
Side Elevation

EQUIPMENT PROVIDED BY HOST

The following equipment will be provided at the contest site by the host. Competitors should acquire similar equipment for use in practice and testing before the competition.

Lateral Load Device

Capable of applying 100 pound force in the horizontal direction.

Measuring Scales and/or Instruments

Load

2500 pounds total. The load should be supplied in uniform pieces of size and weight that may be handled safely. When in place, the load should not provide significant stiffness in the longitudinal direction of the bridge. Sections of steel angle of uniform size and length are recommended for load. Sacks of material, containers of liquid, concrete blocks or jacking systems could be used.

Decking

The decking is steel bar grating identified as W-19-4 (1 x 1/8). The dimensions of a piece of grating are 3'6" x 2'11-3/4" x 1". 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 of the grating that are perpendicular to the length.

Abutments

Construction. The top surface of each abutment should be at least 5 feet long, 3 inches wide, level, smooth, and approximately 3 feet above the ground.

Load Testing. A different set of abutments may be used during load testing. The top surface of each abutment should be at least 5 feet long, 3 inches wide, level and smooth. Height may be adjustable so that the bridge may be positioned close to the ground. Temporary lateral restraints are needed during load test 1.

Safety Support

Construction. The safety support is intended to limit the consequences of a bridge collapsing or sliding off the abutments during construction. The safety support should be placed at the middle of the span and adjusted to the proper height before the start of timed construction. At all times during construction the top of the safety support should be no more than 8 inches below primary beams on both sides of the bridge. If the safety support must be adjusted when the bridge is partially constructed, the clock will be stopped while the safety support is re-positioned.

Load Testing. A different safety support should be used during load testing. This safety support is intended to limit the consequences of a bridge collapsing during load tests. The safety support should be at least 6 feet long and adjustable in width, and should be centered under the bridge. The safety support must be placed before the beginning of load testing, with the top 5 to 8 inches below the bottom of the decking.

JUDGING

The host 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 ambiguities in the rules. Decisions, scoring, rating and disqualification are the sole responsibility of the judges and will be final. The host will assure that the judges are fully informed of the rules and procedures, and fully equipped for their tasks. The host and judges will follow directions in the *Guide for Hosts and Judges* provided by AISC.

TIPS FOR COMPETITORS

1. Strive for challenging but realistic goals for design and construction. The following statistics from the 1995 National Steel Bridge-Building Competition suggest the levels of performance that are possible. However, when reviewing these statistics keep in mind that the rules and scoring for 1996 differ from those for 1995.

	Winning bridge in category	Winning bridge, overall
Weight (lb)	70	84
Construction time (person-minutes)	6.52	8.8
Incremental vertical deflection (inches)	0.111	0.14

2. Start work on the design early, leaving adequate time to procure materials, fabricate the bridge, load test it and practice construction.

3. Design a bridge that may be fabricated, erected and load tested safely.

4. Design a bridge that may be fabricated with available materials, tools and facilities.

5. Structural analysis may fail to disclose instability, such as buckling of slender compression members, sway, and torsion of under-deck trusses of triangular cross-section.

6. Allow tolerances for the decking to be slightly larger or smaller than specified. Provide adequate clearances so that the decking may be installed anywhere on the overall length.

7. Allow tolerances for spacing and levelness of abutments.

8. When fabricating your bridge, use safe tools, operate them carefully and with adequate supervision.

9. Make sure that abutments, safety supports and temporary shoring are strong enough (with a generous factor of safety) and will not tip during construction practice or if the bridge collapses during load testing.

10. When practicing construction, use a safety support and wear hardhats for safety and to accustom yourself to contest conditions.

11. Follow all safety regulations and guidelines during construction practice.

12. When load testing your bridge before the competition keep it as low to the ground as possible and place safety support a few inches below the decking under at least 6 feet of the span. This will reduce risk of injury and limit damage to the bridge if it collapses. Keep hands and feet out from under the bridge.

13. Don't stand, sit or lie on your bridge.

14. To expedite the competition have a preset plan for unloading and staging components of your bridge. Before the competition adjust your temporary shoring to conform to the height of the host's abutments. Know in advance the required elevation of the safety support.

SCORE SHEET

Penalties

Builder touches river or safety support ($50,000 each) $_____

Part touches river, bank, road or safety support ($20,000 each) $_____

Tool or fastener touches river, bank, road or safety support ($1000 each) $_____

Negligent construction (see "Load Tests, Repairs") $_____

TOTAL PENALTIES $_____

Construction Time

_____ builders x _____ min = _____ person-min

Total Weight

_____ pounds

Aesthetics

Items that may be considered:

General appearance	Balance and proportion
Finish	Elegance of connections
Construction organization	Teamwork

AESTHETICS SCORE _____

Deflection (incremental vertical, test 3) _____ inches

Efficiency

Total weight (lb) _____ = _____

Incremental vert. deflect. (in) _____ x 100 = +_____

SNWD (add) _____

Cost

Temporary Shoring ($2000 if used on one bank
or $4000 if used on both banks) $_____

Const. Time _____ x $5000 = +$_____

Weight _____ x $1000 = +$_____

Total Penalties +$_____

TOTAL COST (add) $_____

Rank

Construction Speed _____ Efficiency _____

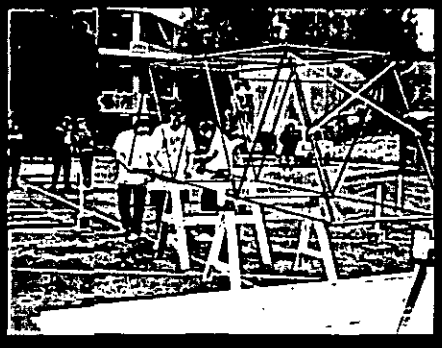
Lightness _____ Economy _____

Stiffness _____ Aesthetics _____

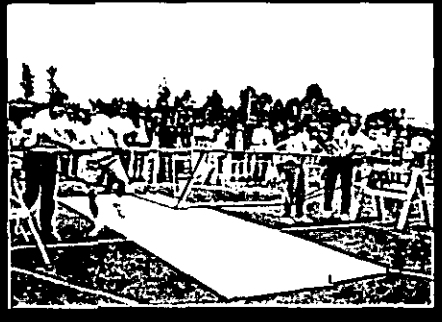
Overall Performance (Efficiency + Economy) = _____

Use aesthetics as tie breaker

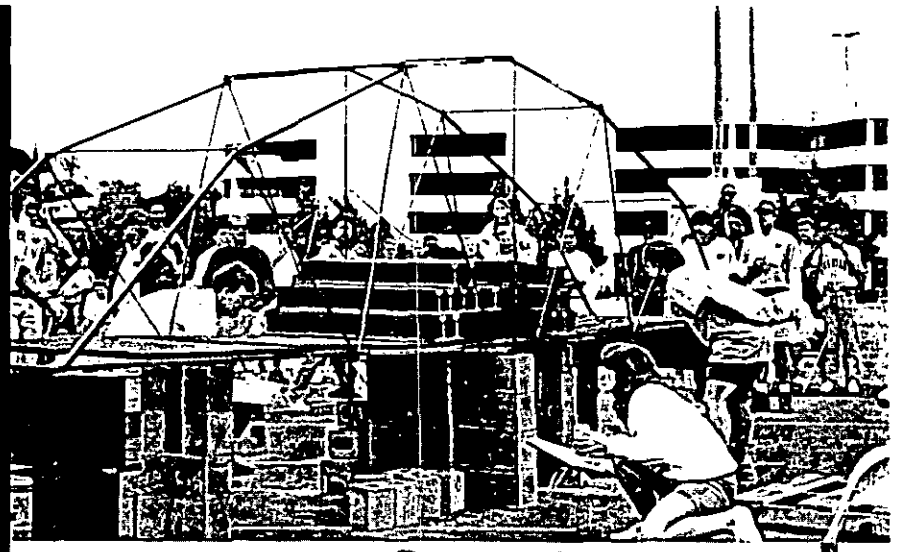
1995 STEEL BRIDGE BUILDING COMPETITION

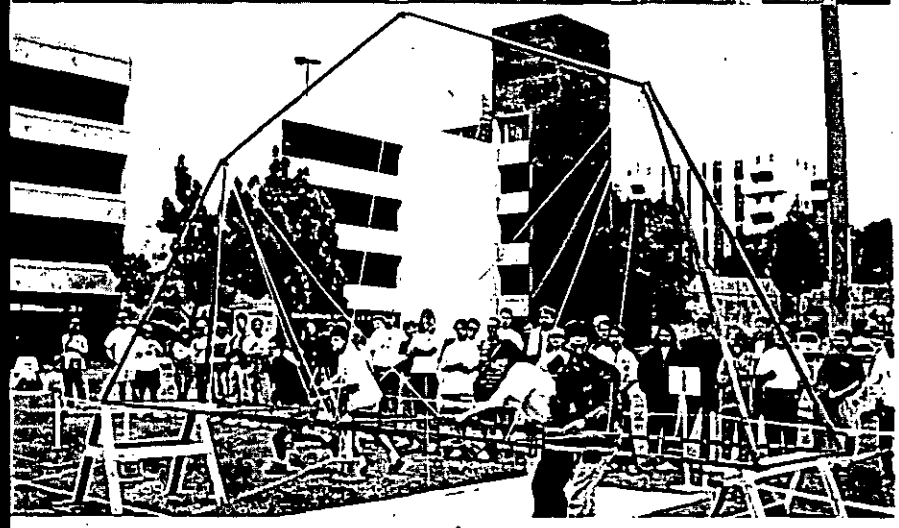


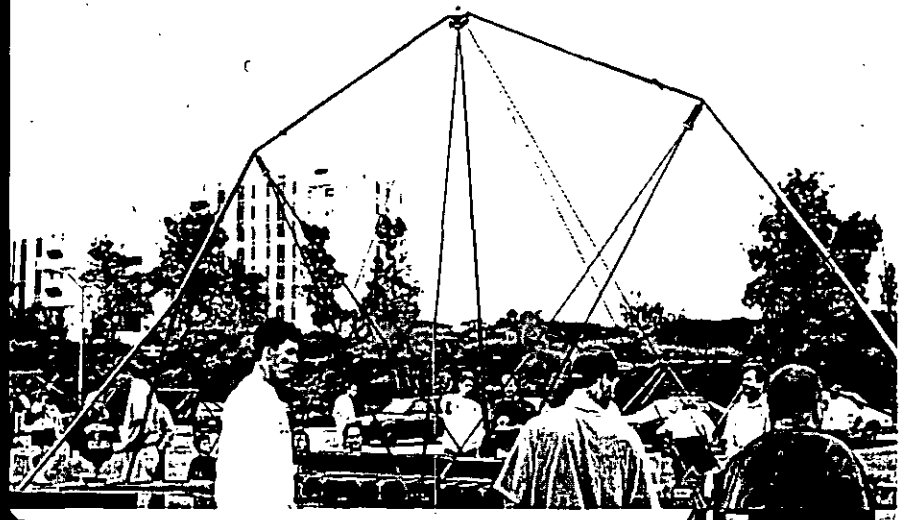
For student chapters of the American Society of Civil Engineers

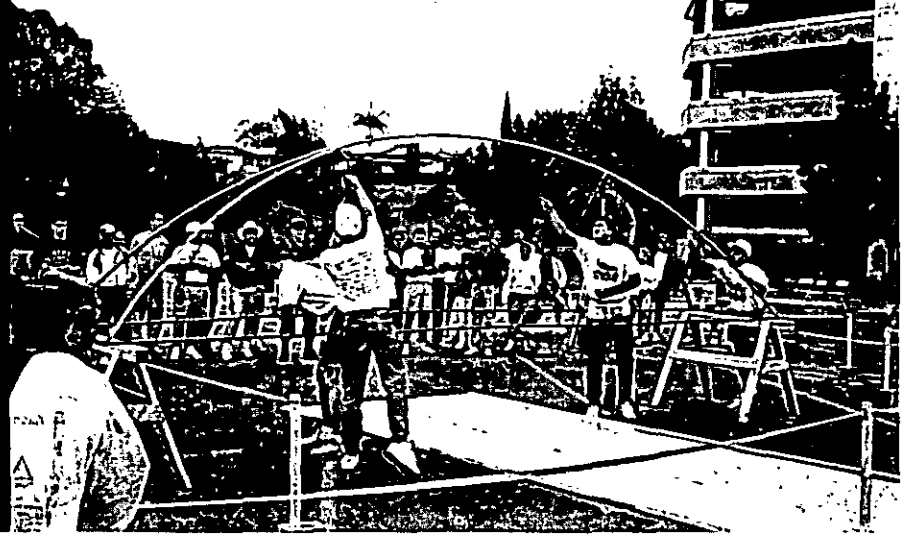


In Cooperation With ASCE
American Society Of Civil Engineers









RULES

AISC STEEL BRIDGE-BUILDING COMPETITION

1995

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INTRODUCTION

The Steel Bridge-Building Competition is sponsored by the American Institute of Steel Construction. This inter-collegiate challenge requires Civil Engineering students to design, fabricate and construct a steel bridge.

Safety is of primary importance. The AISC requests that competitors, hosts and judges take all necessary precautions to prevent injury.

The competition rules have been changed for 1995 in order to improve the contest and to assure that competitors design and build new bridges.

Ideally, students should fabricate the entire bridge themselves. However, appropriate shop facilities and supervision may not be available at every college and university. Therefore, the services of a commercial fabricator may be used provided that students observe the operations.

This booklet describes the contest and states the official rules for this year. It is distributed to universities throughout the country. A companion booklet is distributed to hosts and provides directions for conducting a competition.

EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication and construction. Participating students gain practical experience in structural design, fabrication processes, construction planning, organization and teamwork.

The Problem Statement describes challenges encountered in a representative structural engineering project. The competition is a scaled simulation of that project.

Standards for durability, constructability, usability, strength and serviceability reflect the volumes of regulations that govern the design and construction of full-scale bridges. Criteria for excellence are represented by the award categories of stiffness, lightness, construction speed, aesthetics, efficiency and economy. As with a real construction project, safety is the primary concern.

The rules of the competition accommodate a large variety of designs and allow innovation. Designers must carefully consider the comparative advantages of various alternatives. For example, a truss bridge may be stiffer than a girder bridge but slower to construct.

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

PROBLEM STATEMENT

A century-old bridge that crosses a river valley in a mountainous region must be replaced. The bridge carries heavy truck traffic to and from mines which are the basis for the economy of this rural region, as well as providing access and emergency services to residences. A quick replacement is necessary because no other river crossing of adequate capacity is available for miles.

The State Department of Transportation has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered, but the State has specified steel as the material because of its durability and fast erection. The bridge must accommodate two lanes of traffic and be able to carry specified patterns of traffic and wind loads without exceeding deflection limits. In order to expedite environmental approvals, no piers may be erected in the river, nor may temporary scaffolding or causeways be used in the river. However, temporary shoring may be erected on the banks. Construction barges and marine cranes are not feasible due to fast currents and flash floods.

The stone abutments of the existing bridge are in good condition and will serve for the new bridge, provided that no lateral thrust nor uplift is applied to the abutments. The State DOT will not permit modification of the existing abutments. The new bridge, when complete, must be supported only by the existing abutments; for example, stays and anchorages to the river banks are prohibited.

The new bridge must accommodate modular decking, which the State DOT salvaged from another bridge. Decking units may not be modified.

Access to the construction site is limited by narrow, winding roads. This imposes restrictions on the size of components, and on the movements of construction equipment. Soil conditions restrict the weight that may be lifted by cranes.

Your company's design/build proposal is among those that the State DOT has deemed responsive. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. The DOT will evaluate the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy and aesthetics. The contract will be awarded to the company that submits the best model. This is an opportunity to become leaders in the bridge replacement market.

QUALIFICATION

In order to compete for awards, a bridge must qualify by satisfying the following minimum standards for durability, constructability, usability, strength and serviceability.

Durability

The bridge must be constructed entirely of steel.

Constructability

The bridge may be constructed only of components conforming to the restrictions on size and weight specified in "Components." The bridge must be constructable according to regulations given in "Construction" and without violating requirements listed in "Safety Regulations."

Usability

The bridge must conform to the specifications described in "Dimensions and Support."

Strength and Serviceability

The bridge must pass load tests 1 and 2 described in "Load Tests."

AWARD COMPETITION

Only qualified bridges are eligible to compete for awards. Categories of competition are stiffness, lightness, construction speed, efficiency, economy and aesthetics. In addition, overall performance is rated.

Stiffness

The bridge with the lowest incremental vertical deflection will win in the stiffness category. Incremental vertical deflection is determined from load test 3. A bridge that fails load test 3 will be eliminated from the stiffness and efficiency categories of competition.

Lightness

The bridge with the least total weight will win in the lightness category. Decking and temporary shoring are not included in total weight.

Construction Speed

The bridge with the lowest construction time will win in this category. Construction time is the product of the size of the construction team and the duration of construction. The construction team includes everyone who handles the bridge or any of its components during timed construction. A bridge that accumulates $150,000 or more in penalties will be eliminated from competition in the construction speed and economy categories (see "Accidents.")

Efficiency

The bridge with the smallest sum of normalized weight and deflection ratios (SNWD) will win in the efficiency category. The sum of normalized weight and deflection ratios is computed as

$$\text{SNWD} = \frac{\text{Incremental vertical deflection (in)}}{0.20\ \text{(in)}} + \frac{\text{Total weight (lb)}}{100\ \text{(lb)}}$$

Economy

The bridge with the lowest cost (C) will win in the economy category. Cost is computed as

C = Total weight (lb) x 1000 ($/lb)

+ Construction time (person-min) x 5000 ($/person-minute)

+ $10,000 if temporary shoring is used

+ Penalty costs (listed in "Accidents")

Aesthetics

Factors that may be considered include general appearance, balance and proportion of the design, elegance of connections, finish, construction organization and teamwork. Quality of fabrication should not be considered because some bridges may be fabricated professionally while other are student work.

Overall Performance

The overall performance rating of a bridge is determined by adding the rank of the bridge in the efficiency category to its rank in the economy category. The bridge with the lowest sum will win the overall competition. A bridge that was eliminated from the efficiency and/or economy categories is not eligible for the overall performance competition. In the case of a tie, judges will use aesthetics as the tie breaker.

COMPONENTS

A bridge may be constructed only of components made entirely of steel and conforming to the following descriptions of members, cables with fittings, assemblies, and fasteners.

A member may not weigh more than 40 pounds nor exceed overall dimensions of 5'6" x 7.5" x 7.5." A member may consist of parts connected together before timed construction begins but those parts must remain connected throughout the construction process. A member may be hinged, jointed, articulated or telescoping.

A cable together with its fittings may weigh no more than 40 pounds and must be capable of being coiled to a diameter not exceeding two feet. Fittings are eyes, hooks, plates, clamps, clevises, turnbuckles and similar parts connected to cables, and not exceeding 7.5" in any dimension. A cable with fittings may consist of parts connected together before timed construction begins but those parts must remain connected throughout the construction process. A cable with fittings may have any number of ends.

An assembly is no more than 3 members and/or cables with fittings that are connected together in the staging yards during timed construction.

Fasteners are bolts and nuts, pins, plates, shims and similar parts used for connecting members, cables and assemblies, and not exceeding 7.5" in any dimension.

CONSTRUCTION

Tools

Competitors provide their own tools. Only hand tools are permitted. Field welding and power tools are prohibited. Ropes are permitted but gin poles, jacks, winches, come-alongs, counterweights and other hoisting devices are prohibited. Stools, ladders and similar objects for elevating builders are prohibited.

Construction Site

See the figure titled "Site Plan" for layout of river, banks, and other features that affect construction.

Temporary Shoring

Shoring is temporary support on the river banks, and is provided by the competitors. There are no restrictions on the materials and design for temporary shoring other than it must provide sufficient strength and stability to

support the bridge and builders. There is a cost assigned to temporary shoring; its advantage is that builders may be supported by the bridge only if temporary shoring is in place. If temporary shoring is used, it must be used on both banks.

Safety Support

During construction the top of the safety support must be in place at the midspan of the bridge with its top surface no more than 8 inches from the bottom of the bridge.

Start

Before construction begins, all members, cables with fittings, fasteners, tools and builders are in the staging yards. Temporary shoring, if used, has been constructed and is in place on both river banks. The safety support is in place. Timing and construction begin when the builders signify that they are ready and the judge declares the start.

Time

Time is kept from the start to finish of construction. The clock will be stopped:

1. if a builder or judge sees a condition that could cause personal injury;

2. when a safety regulation has been violated, and

3. if the safety support must be adjusted.

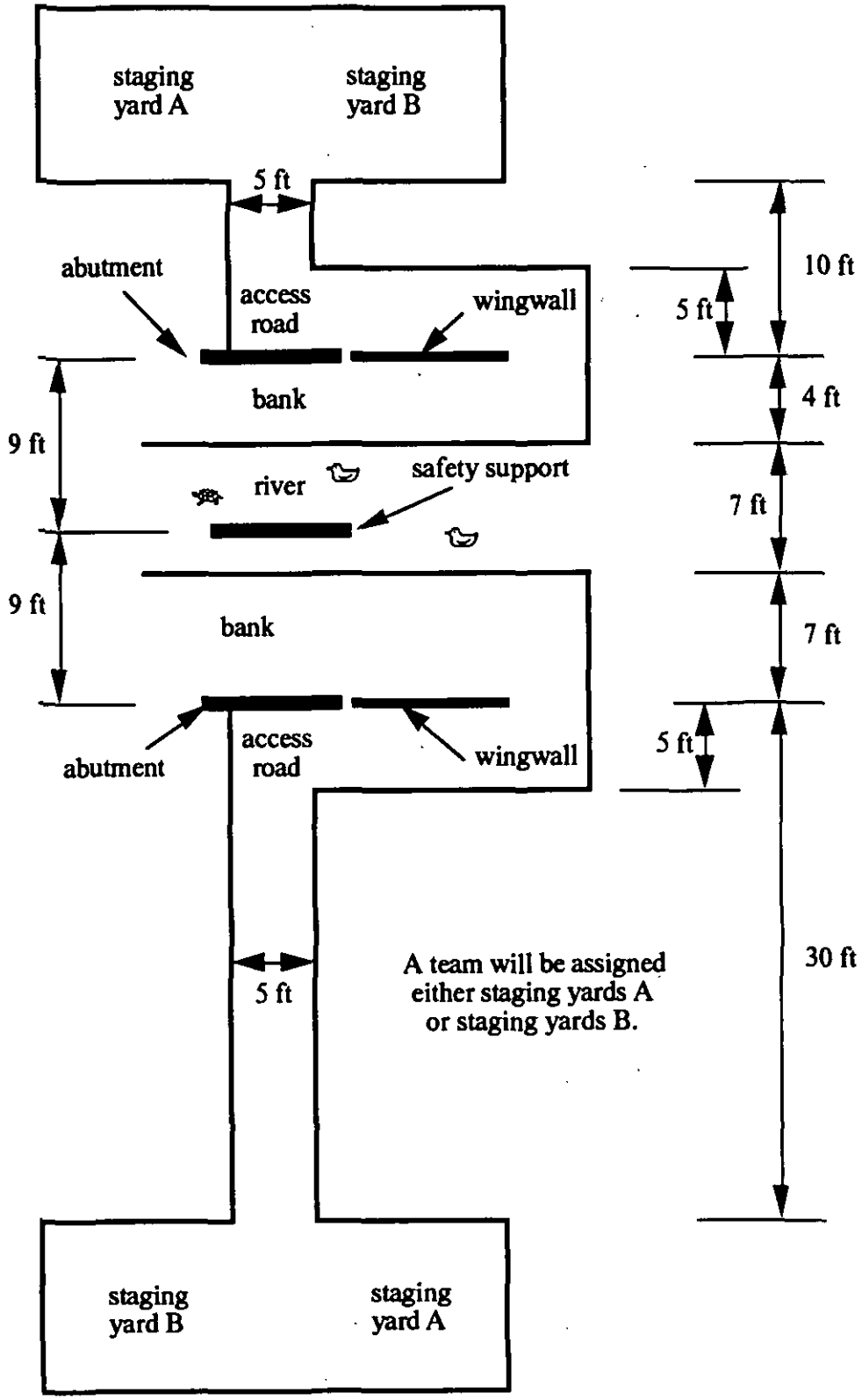
Construction ceases while the clock is stopped. The clock is restarted after the situation has been corrected.

Time Limit

In order to expedite the competition the host may limit the clock time for constructing a bridge to 30 minutes. A higher limit may be imposed. A bridge that exceeds the limit will be eliminated from all categories of competition. If the host opts to impose a time limit, all competitors must be notified at least a month before the competition.

Finish

Construction ends when the bridge is complete, and all tools and builders are in the staging yards, and the builders signify that they are finished. Temporary shoring may remain on the banks. Installation of decking is not included in timed construction.



Site Plan

SAFETY REGULATIONS

If any of the following safety regulations are violated the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools and bridge components will be returned to the positions they occupied before the violation. Construction that necessitates violation of safety regulations is not permitted.

1. If temporary shoring is not used, a builder may not stand on the bridge nor occupy it in any other way such that the bridge supports the builder's body weight. However, a builder may lean on the bridge if both feet remain on the river bank.

2. Temporary shoring may not be placed in the river.

3. A builder may lift or carry only one member or one cable with fittings at a time.

4. An assembly may not be lifted nor carried by one builder alone.

5. Two or more builders may lift or carry only one assembly at a time.

6. Nothing may be thrown.

7. A builder may not stand, sit or kneel in the river, nor use the river for support in any way.

8. A builder must stay within the limits of the access roads and river banks.

9. A builder may not cross the wingwalls.

10. The safety support as well as temporary shoring on both banks must be in place and properly adjusted before a builder climbs onto the bridge.

11. A builder may not cross the abutments except to climb onto the bridge with temporary shoring and safety support in place.

12. No member, cable with fittings nor assembly may be carried while climbing onto the bridge.

13. A builder may not cross the river by jumping, by temporary scaffolding, by crossing the bridge, nor by any other means.

14. A member, cable with fittings, assembly, fastener or tool may not be laid down except in the staging yards, on the abutments, on the temporary shoring and on the bridge. A member, cable with fittings, assembly, fastener or tool may not be leaned against an abutment, temporary shoring or safety support.

15. A constructed portion of the bridge may be slid horizontally, provided that it is supported by both abutments, or by temporary shoring on both banks, or by one abutment and one unit of temporary shoring.

16. One side or end of a constructed portion of the bridge may be moved a few inches in any direction in order to align a connection.

ACCIDENTS

In general, the clock is not stopped when an "accident" occurs. Builders involved in accidents may continue to build, and components involved in accidents may be recovered and used. Types of accidents and the corresponding cost penalties are:

1. A builder touches the river or the safety support. $50,000 for each occurrence.

2. A member, cable with fittings, assembly, or the bridge touches the river, a bank, an access road or the safety support. $20,000 for each occurrence.

3. A tool or fastener touches the river, a bank or an access road. $1000 for each occurrence.

DIMENSIONS AND SUPPORT

The figures titled "Side Elevation" and "Clearance and Deck Support" illustrate some of the following specifications.

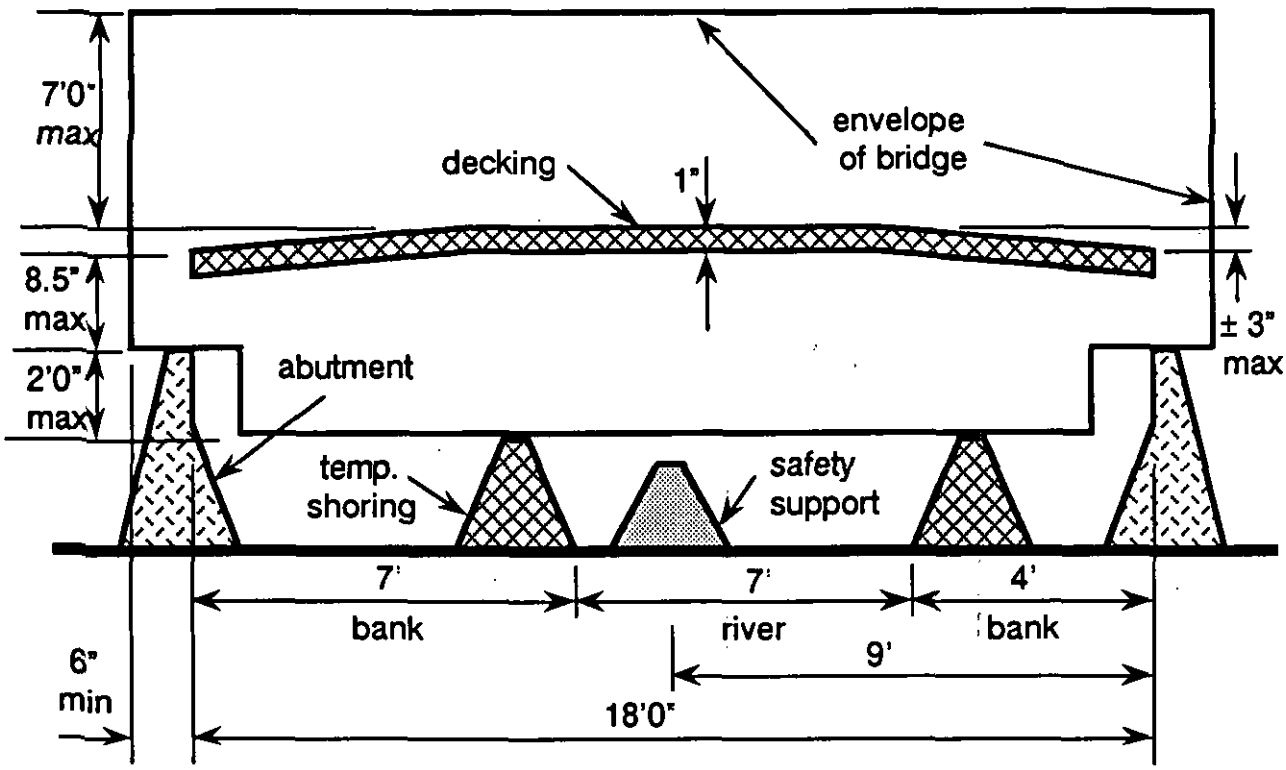
1. The bridge must span the abutments, which are fixed in place so that the distance between faces is 18 feet.

2. The bridge must provide bearing area extending at least 6 inches behind the face of each abutment so that the bridge will remain supported by the abutments in the event that it is displaced 6 inches in the direction of span.

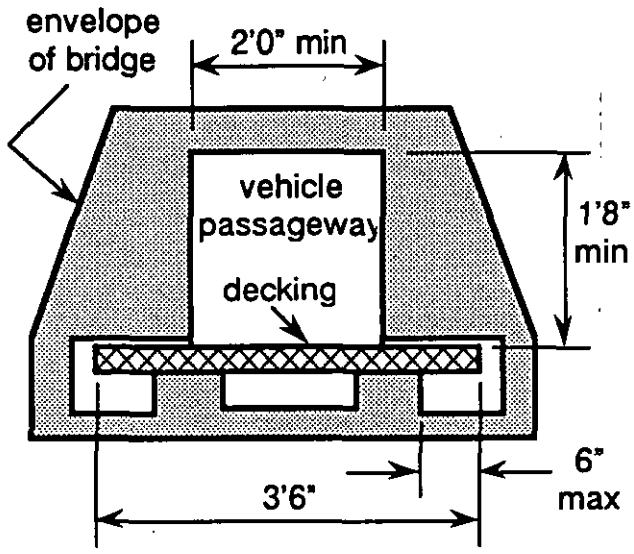
3. A 2'0" wide by 1'8" high rectangular vehicle passageway must be provided along the full length of the bridge.

4. No part of the bridge may extend more than 2 feet below the top of the abutments at any point on the span.

5. No part of the bridge may extend more than 7 feet above the top of the deck at any point on the span.



Side Elevation



Clearance and Deck Support

6. The surface of the deck must be no more than 8.5" above the top of the abutments, measured at the abutments.

7. The absolute value of camber must not exceed 3 inches.

8. The bridge must provide support for the decking on both of the edges that run in the longitudinal direction of the bridge. The support must be continuous for the full span of the bridge.

9. The edges of the decking that run in the longitudinal direction of the bridge may be cantilevered over their supports no more than 6 inches.

10. The continuous supports for the deck must be capable of accommodating decking anywhere on the span, without gaps, overlaps or abrupt elevation differences between decking units. However, small elevation differences, such as those caused by decking resting on bolt heads, are acceptable.

11. The decking may not be attached nor anchored to the bridge.

12. The bridge may not be attached nor anchored to the abutments, and it may bear only on the top surface of the abutments.

13. The bridge may not be anchored, tied nor braced to the ground.

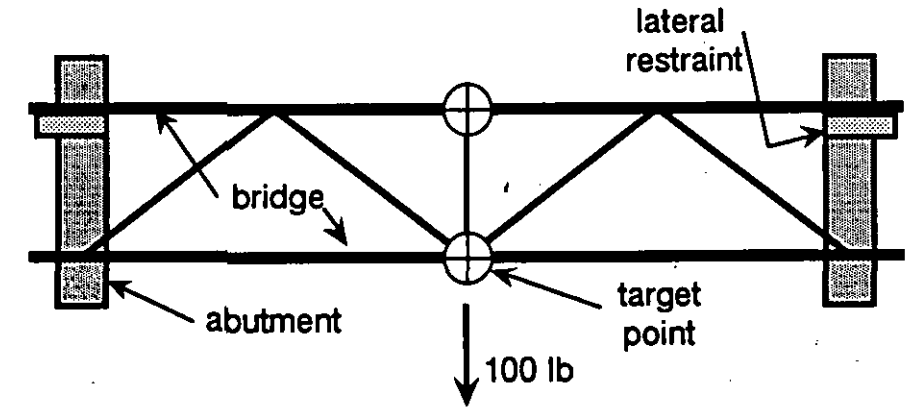
LOAD TESTS

CAUTION: A bridge could collapse or sway suddenly during load tests. Therefore, minimize the number of people near the bridge while it is being tested. During testing the bridge must be supported so that its lowest point is no more than 8 inches above ground or above the top of the safety support.

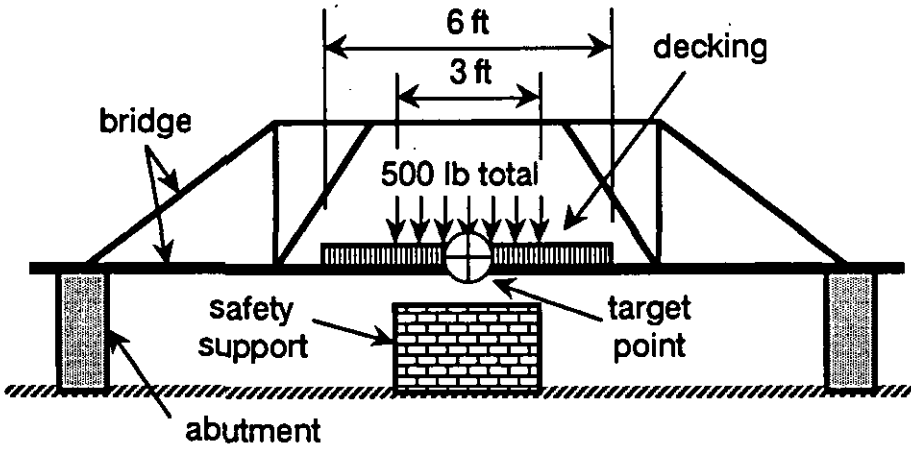
The figure titled "Load Tests" illustrates some of the following procedures.

Load tests are conducted without temporary shoring. Load test 1 is conducted without decking; load tests 2 and 3 are conducted with two decking units installed to accommodate the load.

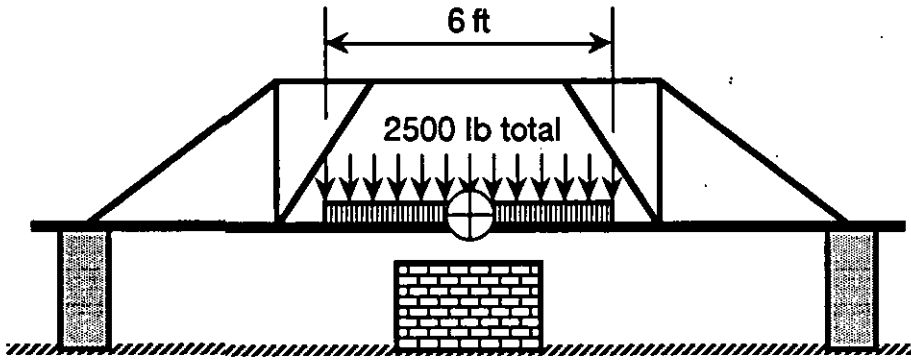
The judge designates two target points on the bridge, both located at midspan, one on each side. The target points should be close to the level of the deck, and may be on the decking itself. Lateral deflection measurements are made to the target point on one side of the bridge, designated by the judge. Vertical deflection measurements are made to both target points; vertical deflection is the maximum absolute value of the two measurements.



Load Test 1
Plan



Load Test 2
Side Elevation



Load Test 3
Side Elevation

Load Tests

Total lateral deflection is the absolute value of the horizontal distance of the target point from its position at the beginning of load test 2. Incremental vertical deflection is the maximum absolute value of the vertical distances of the target points from their positions at the beginning of load test 3.

Load tests are conducted in numerical order.

Load Test 1 - Qualifying, Lateral

Load test 1 is conducted with lateral restraint installed on the abutments to prevent the ends of the bridge from sliding. As close as practical to midspan apply a 100 pound force in the lateral direction. To pass load test 1, the lateral deflection of the bridge must not exceed 1.0". If the bridge does not pass load test 1, do not conduct any other load test. Remove the lateral load; it is not part of the remaining load tests.

Load Test 2 - Qualifying, Vertical

Uniformly distribute load over an area symmetric about the middle of the deck and extending 3 feet in the span direction. Terminate load test 2 when lateral deflection reaches 1.0" or vertical deflection reaches 2.0" or 500 pounds of load has been placed. A bridge passes load test 2 if 500 pounds of load was placed without a deflection limit being exceeded. If the bridge does not pass load test 2, do not conduct any other load test.

Load Test 3 - Competition, Vertical

With the load from test 2 remaining in place, uniformly distribute additional load over an area symmetric about the middle of the deck and extending 6 feet in the span direction. Terminate load test 3 when total lateral deflection reaches 2.0" or incremental vertical deflection reaches 2.0" or 2000 pounds of additional load has been placed. A bridge passes load test 3 if 2000 pounds of additional load was placed without a deflection limit being exceeded. If the bridge passes load test 3, record the incremental vertical deflection.

EQUIPMENT PROVIDED BY HOST CHAPTER

The following equipment will be provided at the contest site by the host. Competitors may wish to acquire similar equipment for use in practice and testing before the competition.

Lateral Load Device

Capable of applying 100 lb force in the horizontal direction.

Measuring Scales and/or Instruments

Load

2500 pounds total. The load should be supplied in uniform increments of size and weight that may be handled safely. When in place, the load should not provide significant stiffness in the longitudinal direction of the bridge. Sections of steel angle of uniform size and length are recommended for load. Sacks of material, containers of liquid, concrete blocks or jacking systems could be used.

Decking

The decking is steel bar grating identified as W-19-4 (1 x 1/8). The dimensions of a piece of grating are 3'6" x 2'11-3/4" x 1". Grating has 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 must be provided along the edges that are parallel to the length of the bridge. No support is needed for the edges of the grating that are perpendicular to the length of the bridge.

When loading, do not exceed 400 psf uniform load nor 500 pounds concentrated load. Do not load on a cantilevered portion of the grating.

Abutments

The top surface of each abutment should be at least 5 feet long, 3 inches wide, level, smooth, and approximately 3 feet above the ground. Temporary lateral restraints are needed during load test 1.

Safety Support

The safety support is intended to limit the consequences of a bridge collapsing during construction or load tests, but should not come in contact with the bridge unless there is a collapse or excessive deflection. The safety support is placed at the middle of the span and adjusted so that the top of the support is no more than 8 inches from the bottom of the bridge.

The safety support should be placed and adjusted to the proper height before the start of timed construction. At all times during construction the top of the safety support should be within 8 inches of the bottom of the bridge. If the safety support must be adjusted when the bridge is partially constructed, the clock will be stopped while the safety support is positioned. Builders are prohibited from being on the bridge unless the safety support is in place, as well as temporary shoring on both banks.

The safety support must be at least 6 feet wide in the lateral direction of the bridge.

JUDGING

The host will recruit judges. Judges have full authority over conduct of the competition and interpretation of ambiguities in the rules. Judges are empowered to halt any activity that they deem to be hazardous. Decisions, scoring and rating are the sole responsibility of the judges and will be final.

TIPS FOR COMPETITORS

1. Strive for challenging but realistic goals for design and construction. The following statistics from the 1994 National Steel Bridge-Building Competition suggest the levels of performance that are possible. However, when reviewing these statistics keep in mind that the rules and scoring for 1995 differ from those for 1994.

	Winning bridge in category	Winning bridge, overall
Weight (lb)	84.5	117
Construction time (person-minutes)	10.28	28.60
Incremental vertical deflection (inches)	0.195	0.227

2. Start work on the design early, leaving adequate time to procure materials, fabricate the bridge, load test it and practice construction.

3. Design a bridge that may be fabricated, erected and load tested safely.

4. Design a bridge that may be fabricated with available materials, tools and facilities.

5. Allow tolerances for the decking to be slightly larger or smaller than specified. Provide adequate clearances so that the decking may be installed anywhere on the span.

6. When fabricating your bridge, use safe tools, operate them carefully and with adequate supervision.

7. When load testing your bridge before the competition keep it as low to the ground as possible and place safety supports a few inches below the bridge at intervals along the span. This will prevent injury and limit damage to the bridge if it collapses. Keep hands and feet out from under the bridge.

8. Make sure that abutments, safety supports and temporary shoring are strong enough (with a generous factor of safety) and will not tip during construction practice or if the bridge collapses during load testing.

9. Follow all safety regulations and guidelines during construction practice.

10. Don't stand, sit or lie on your bridge unless a safety support and temporary shoring are in place.

11. To expedite the competition have a preset plan for unloading and staging components of your bridge. Before the competition adjust your temporary shoring to conform to the height of the host's abutments. Know in advance the required elevation of the safety support.

SCORE SHEET

Penalties for Accidents

Builder touches river or safety support ($50,000 each) $_____

Part touches river, bank, road or safety support ($20,000 each) $_____

Tool or fastener dropped in river, on bank or road ($1000 each) $_____

TOTAL PENALTIES $_____

Construction Time

_____ builders x _____ min = _____ person-min

Total Weight

_____ pounds

Aesthetics

Items that may be considered:

General appearance	Balance and proportion
Finish	Elegance of connections
Construction organization	Teamwork

AESTHETICS SCORE _____

Deflection (incremental vertical, test 3) _____ inches

Efficiency

Total weight (lb) _____ / 100 = _____

Incremental vert. deflect. (in) _____ / 0.20 = +_____

SNWD (add) _____

Cost

Temporary Shoring: $10,000 if used $_____

Const. Time _____ x $5000 = +$_____

Weight _____ x $1000 = +$_____

Total Penalties +$_____

TOTAL COST (add) $_____

Rank

Construction Speed _____ Efficiency _____

Lightness _____ Economy _____

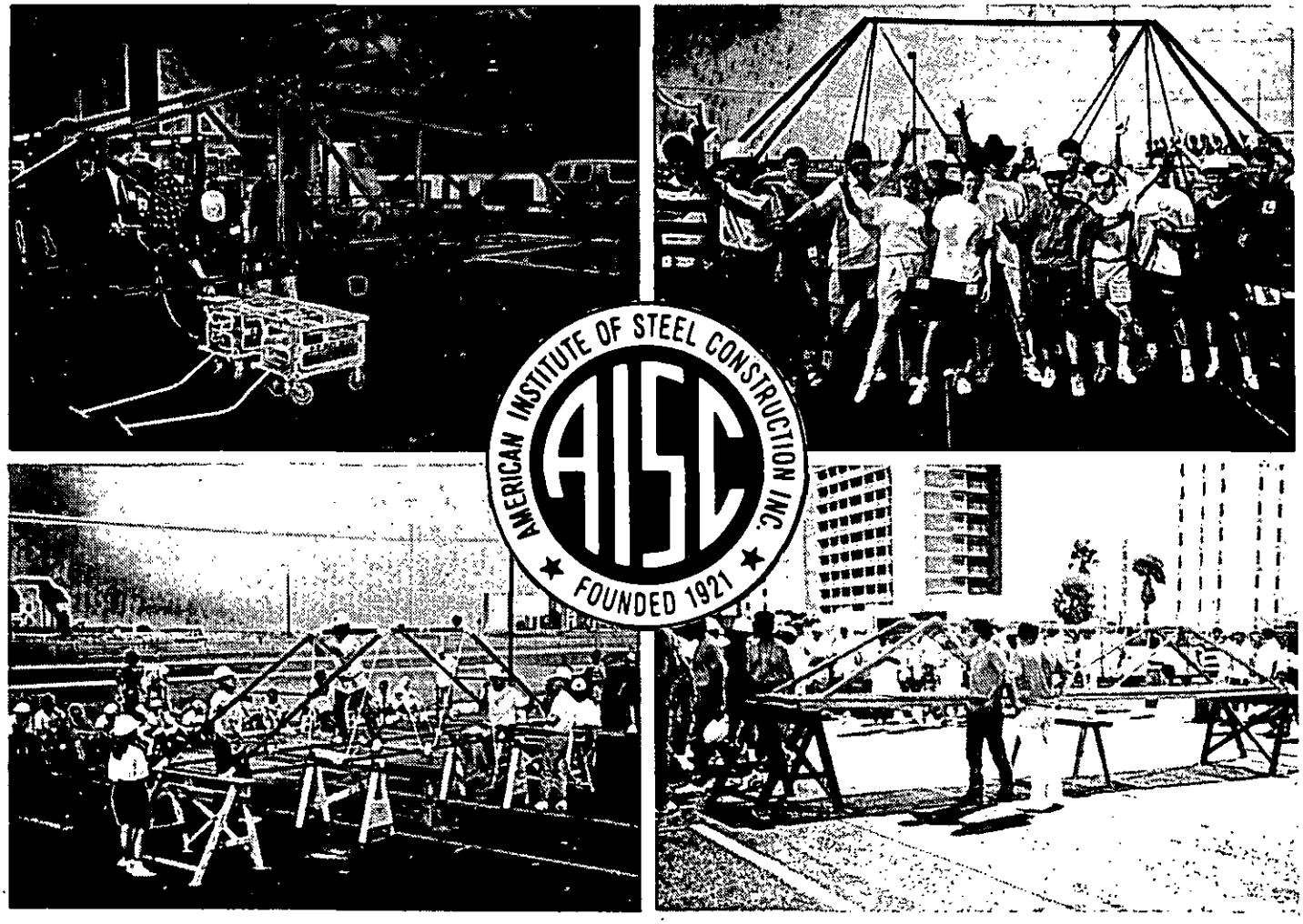
Stiffness _____ Aesthetics _____

Overall Performance (Efficiency + Economy) = _____

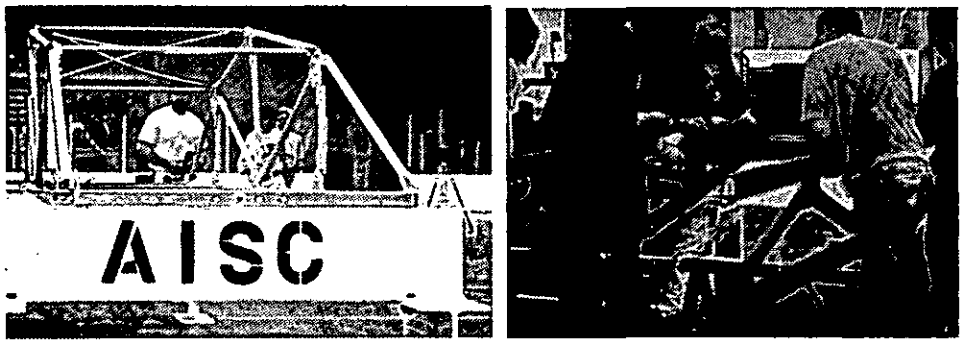
Use aesthetics as tie breaker

REVISED

1994 STEEL BRIDGE BUILDING COMPETITION



FOR STUDENT CHAPTERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS



IN COOPERATION WITH ASCE AMERICAN SOCIETY OF CIVIL ENGINEERS

STATEMENT

The Steel Bridge-Building Competition is sponsored by the American Institute of Steel Construction. It challenges civil engineering students to a competition that includes design and hands-on experience with structural steel.

Since the educational intent of the competition is to give engineering students exposure to designing, fabricating and erecting a steel bridge, AISC is recommending that the judging panel at each competition accepts only bridges substantially designed and built during the academic year in which the competition is held.

AISC places great emphasis on safety. The competing teams are asked to observe safety practices as covered in the competition rules.

AISC 1994 STEEL BRIDGE-BUILDING

COMPETITION RULES

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Civil Engineering students are challenged in a competition that includes design, hands-on experience with structural steel and the use of both actual and simulated construction practices in building a structure. Through the competition, you will utilize materials and design knowledge, construction planning, shop experience, training and teamwork.

In the opening Problem Statement, you are given an orientation into some of the real-life design and construction problems commonly encountered in actual practice. The Statement also establishes some background into the selection of the load tests and design/construction restrictions of the competition. The Problem Statement and related rules are basic to construction practices and are minimal when compared to the volumes of real-life regulations.

Member size and weight limitations are given for several reasons. First, it makes the competition representative of a real situation. Second, it causes you to look at several construction alternatives, rather than using a single member to span the entire 20-foot length. Third, it facilitates the handling and transportation of your structure to the competition site. Fourth, it minimizes the risk to you in handling and assembling the pieces.

Regulations and penalties have been established to maintain the integrity of the construction simulation. These rules are related to actual construction problems, just as members are scaled to model those size limitations found in an actual structure.

Several categories of competition are offered, so you should look at several design alternatives to win any or all of the categories. A latticework structure may be the lightest, but takes a long time to build. A cable-supported structure may be fast and light, but not meet deflection or stability considerations. Beam-type structures may be fast, but heavy and expensive. Several categories of competition allow you to target your objectives and design/build accordingly.

The competition promises design challenges, steel fabrication experience, the use of construction planning and practice, teamwork, plus the fun of competing against fellow students.

PROBLEM STATEMENT

A century-old bridge across a river valley in a mountainous rural region is in need of replacement. The bridge serves not only area residents, but also important heavy truck traffic for area mining. No other river crossing of adequate capacity is available for miles in either direction, therefore, a quick replacement is necessary.

The State Department of Transportation has sought design/build proposals to construct a replacement bridge. Any type of steel structure will be permitted, but it must meet the following minimum design loads and construction restrictions:

1. The bridge must accommodate two lanes of traffic,

2. the bridge must be able to resist various patterns of gravity load,

3. the bridge must be able to resist a lateral force of 100,000 pounds from river flooding and/or wind forces,

4. no interior piers are permitted, easing environmental clearances,

5. no lateral thrusts or uplift can be applied to the existing abutments, nor can they be reinforced to accommodate such forces,

6. no backstays or anchorages are available beyond the abutment,

7. construction and live load deflection limits must be met,

8. and the bridge must accommodate state-supplied modular bridge deck units salvaged from another bridge, without modification to any unit.

The existing bridge spans in the north-south direction a distance of 200 feet, resting on simple stone abutments. The valley below is relatively flat, roughly 30 feet below the top of the abutments. The north river bank is 50 feet wide, the river itself is 70 feet wide, and the south bank is 80 feet wide.

The river is fast, not navigable and environmentally sensitive. Flash flooding and environmental concerns prohibit the use of barges, causeways or scaffolding across the river. Temporary shoring can be safely placed on the solid banks of the river.

Storage and staging yards 150 feet square will be cleared for the contractor's use at both ends of the bridge. The yard at the north end of the bridge will be located just 100 feet from the abutment. The yard at the south end will be 300 feet from the abutment. The service road from both yards to the bridge will be widened to 50 feet, and will extend around one end of the abutment wingwalls down to the river banks.

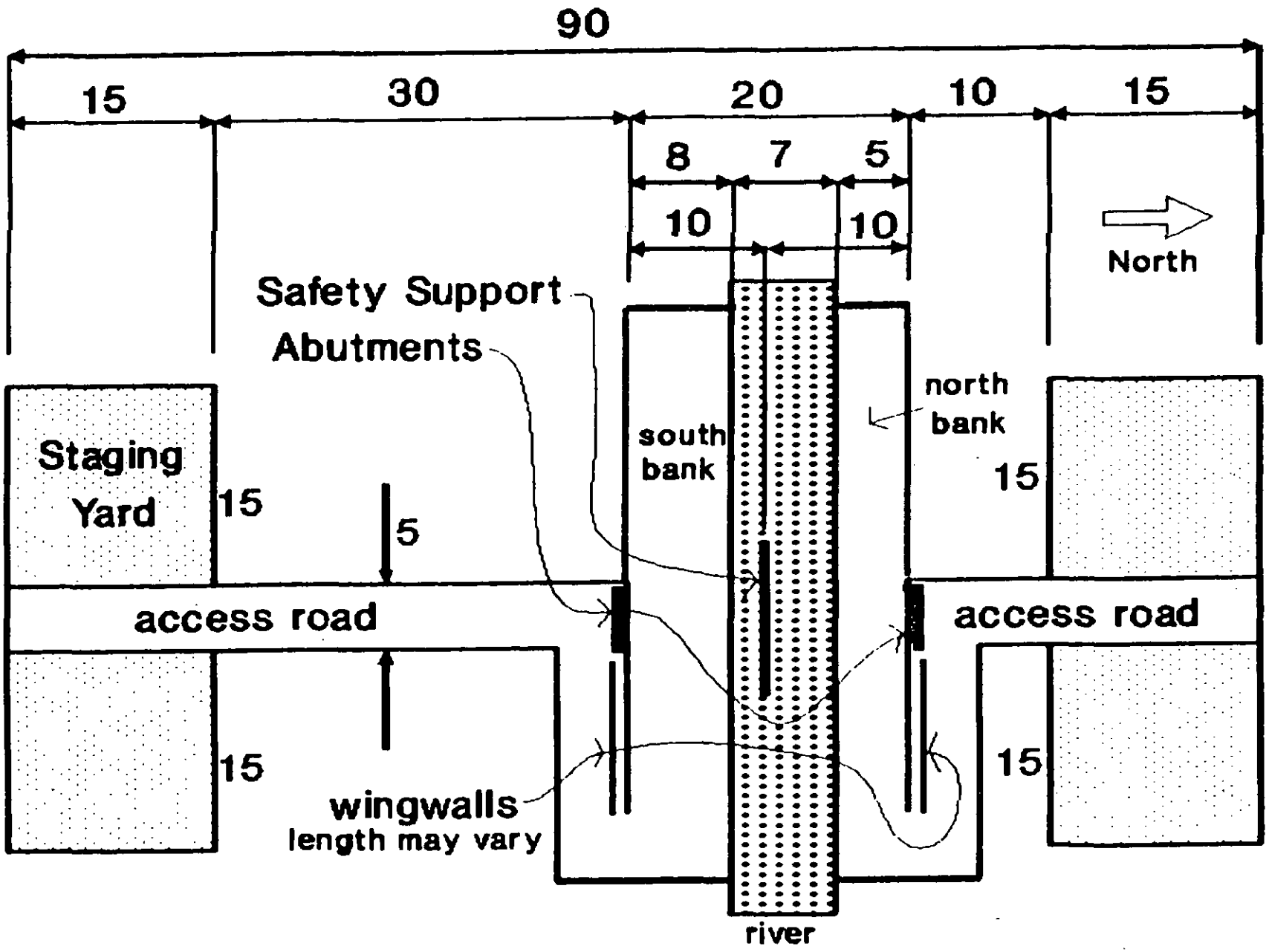
Soil conditions, rough terrain and tight site conditions limit the lifting capacity of cranes. Materials may be delivered by crane to the river valley by using the access roads constructed around the wingwall, or by transferring the materials over the abutments or wingwalls from one crane to the next.

Narrow, winding roads lead to the yards from both directions. Because of this, the length of an individual member is limited to 55 feet, with a maximum width and depth of 6'-3". This enables the trucks to make the required turns. Smaller bridges on both sides of the main bridge being replaced limit the weight of an individual piece to 20 tons (40,000 pounds).

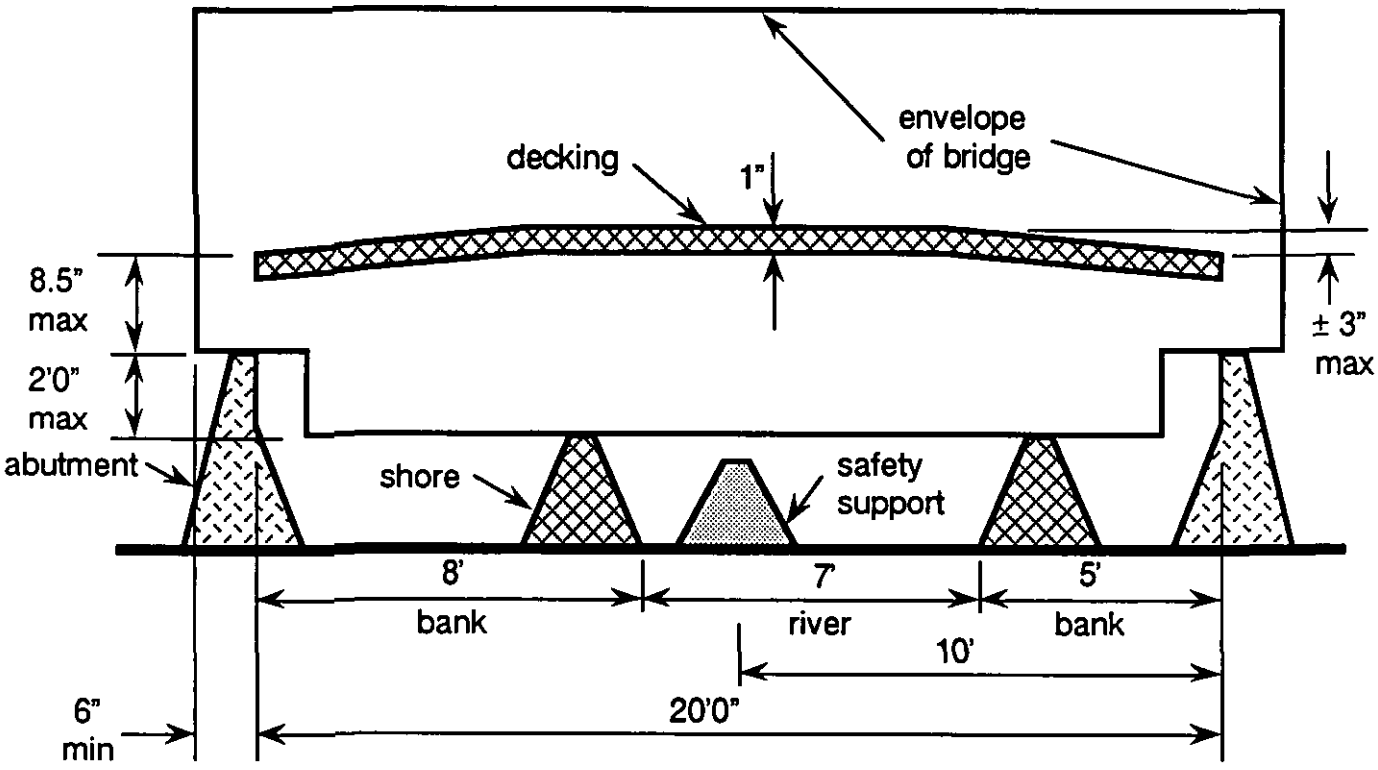
The state will provide prefabricated, 10" deep modular bridge deck units that were salvaged from another bridge. They are the required roadway width, 35 feet in the transverse direction. They are capable of spanning a 35-foot clear distance between supports, and are also capable of cantilevering 5 feet beyond a support.

To allow for a new bridge design, new approaches will be constructed that can go as high as 7'-1" above the top of the existing abutment. Allowing for the 10" depth of the state-supplied modular deck unit, the structure depth at abutments can be as deep as 6'-3", the same as the maximum member depth.

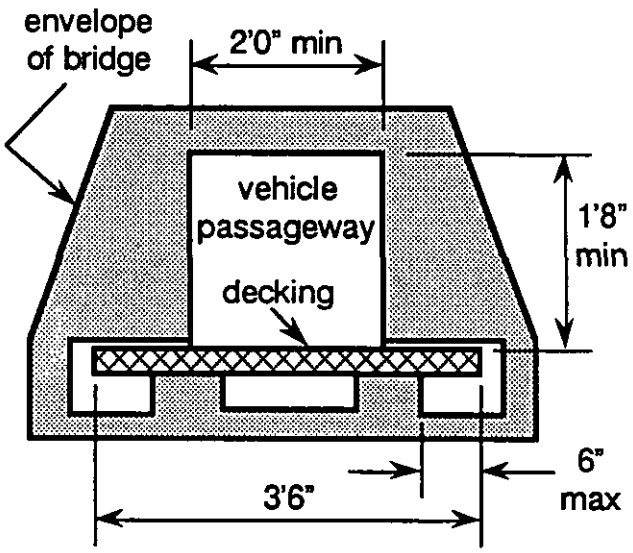
Your company's design/build proposal has been deemed responsive by the State Department of Transportation. To make a selection, the state has asked your firm and the other competing firms to construct a 1:10 model bridge, demonstrate the erection method to be used, then subject it to load testing. The state is concerned about many things in its evaluation -- strength, speed of construction, cost, stiffness, weight and aesthetics. Using a ranking system, it will use the competition to select a contractor winner. If your bridge is judged the best, your firm will receive a negotiated contract to build this bridge, and possibly several others. You and your firm could become leaders in the national bridge replacement market.


90
15
30
20
10
15
8
7
5
10
10
North
Safety Support
Abutments
Staging
Yard
15
5
south
bank
north
bank
15
access road
access road
15
15
wingwalls
length may vary
river

SITE PLAN



Side Elevation



Clearance and
Deck Support

QUALIFICATION

In order to compete for awards, a bridge must qualify by satisfying the following minimum standards for durability, constructability, usability, strength and serviceability.

Durability

The bridge must be constructed entirely of steel.

Constructability

The bridge may be constructed only of components conforming to the restrictions on size and weight as specified in "Components". The bridge must be constructable without violating requirements listed in "Safety Regulations".

Usability

The bridge must conform to the specifications described in "Dimentions and Support".

Strength and Serviceability

The bridge must pass load tests 1 and 2 described in "Load Tests".

AWARD COMPETITION

Only qualified bridges are eligible to complete for awards. Categories of competition are stiffness, lightness, construction speed, aesthetics, efficiency and economy. In addition, overall performance is rated.

Stiffness

The bridge with the lowest incremental vertical deflection will win in the stiffness category. Incremental vertical deflection is determined from load test 3. A bridge that fails load test 3 will be eliminated from the stiffness and efficiency categories of competition.

Lightness

The bridge with the least total weight will win in the lightness category. Decking and temporary shores are not included in total weight.

Construction Speed

The bridge with the lowest construction time will win in this category. Construction time is the product of the size of the construction team and the duration of construction. The construction team includes everyone who handles the bridge or any of its components during timed construction. A bridge that accumulates $150,000 or more in penalties will be eliminated from competition in the construction speed and economy categories (see "Accidents").

Aesthetics

Is judged by a non-partisan jury following the competition of the bridge, but *prior to load testing. Please see Judging Form (suggested) for items to consider.*

Efficiency

The bridge with the smallest sum of normalized weight and deflection ratios (SNWD) will win in the efficiency category. The sum of normalized weight and deflection ratios is computed as

$$SNWD = \frac{Incrementalverticaldeflection\ (in)}{0.10\ (in)} + \frac{Totalweight\ (lb)}{100\ (lb)}$$

Economy

The bridge with the smallest cost (C) will win in the economy category. Cost is computed as

C = Total weight (lb) x 1000 ($/lb) +

Construction time (pers-min) x 3000 ($/pers-min) +

[$80,000 if temporary shores are used] + [Penalty costs]

Penalty costs are listed in "Accidents."

Overall Performance

The overall performance rating of a bridge is determined by adding the rank of the bridge in the efficiency category to its rank in the economy category. The bridge with the lowest sum will win the overall competition. A bridge that was eliminated from the efficiency and/or economy categories is not eligible for the

overall performance competition. In the case of a tie, judges may use aesthetics as the tie breaker.

COMPONENTS

A bridge may be constructed only of components made entirely of steel, and conforming to the following descriptions of members, cables with fittings, assemblies, and fasteners.

A member may not weigh more than 40 pounds, nor exceed overall dimensions of 5'6" x 7.5" x 7.5" (that is, it must fit inside a cylinder with a diameter of 7.5"). A member may consist of parts connected together before timed construction begins, but it must be rigid (that is, hinged, articulated or telescoping members are not permitted).

A cable with fittings may not weigh more than 40 pounds and must be capable of being coiled to a diameter not exceeding two feet. Fittings are clamps, clevises, turnbuckles and similar parts used for connecting cables, and not exceeding 7.5" in any dimension. A cable with fittings may consist of parts connected together before timed construction begins; there is no limit on the number of ends.

An assembly is no more than 3 members and/or cables that are connected together in the staging yards during timed construction.

Fasteners are bolts and nuts, pins, shims and similar parts used for connection members, cables and assemblies, and not exceeding 7.5" in any dimension.

CONSTRUCTION

Construction Site

See the figure titled "Site Plan" for layout of river, banks, and other features that affect construction.

Temporary Shores

Shores are temporary support on the river banks, and are provided by the builders. There are no restrictions on the materials and design for shores, other than that they be sufficiently strong and stable to support the bridge and builders.

There is a cost assigned to temporary shores; their advantage is that builders may be supported by the bridge only if shores are in place. If shores are used, they must be used on both banks.

Start

Before construction begins, all members, cables with fittings, fasteners, tools and builders are in the staging yards. Temporary shores, if used, have been constructed and are in place on both river banks. The safety support is in place at the middle of the span and adjusted so that it will be close to the bottom of the bridge, unless the style of the bridge makes that impossible. Timing and construction begin when the builders signify that they are ready, and the judge declares the start.

Time

Time is kept from the start to finish of construction. The clock will be stopped:

1. if a builder or judge sees a condition that could cause personal injury;

2. when a safety regulation has been violated, and

3. if the safety support must be moved or adjusted.

Construction ceases while the clock is stopped. The clock is restarted after the situation has been corrected.

Finish

Construction ends when the bridge is complete and all tools, builders and shores are in the staging yards, and the builders signify that they are finished. Decking will be installed after the bridge is complete; installation is not included in timed construction.

Tools

Builders provide their own tools. Only hand tools are permitted. Field welding, and power tools (electric and pneumatic) are prohibited. Ropes are permitted, but gin poles, jacks, winches, come-alongs, counterweights and other hoisting devices are prohibited. Stools, ladders, and similar objects for elevating builders are prohibited.

SAFETY REGULATIONS

If one of the following safety regulations is violated, the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools and bridge components will be returned to the positions they occupied before the violation. Construction that necessitates violation of safety regulations is not permitted.

1. If temporary shores are not used, a builder may not stand on the bridge or occupy it in any other way such that the bridge supports the builder's body weight. However, a builder may lean on the bridge if both feet remain on the river bank.

2. A builder may lift or carry only one member or cable with fittings at a time.

3. An assembly may not be lifted nor carried by one builder alone.

4. Two or more builders may lift or carry only one assembly at a time.

5. Nothing may be thrown.

6. A builder may not stand in the river.

7. A builder must stay within the limits of the access roads and river banks.

8. A builder may not cross the wingwalls.

9. The safety support as well as shores on both banks must be in place and properly adjusted before a builder climbs onto the bridge.

10. A builder may not cross the abutments except to climb onto the bridge with shores and safety support in place.

11. No member, cable or assembly may be carried while climbing onto the bridge.

12. A builder may not cross the river by jumping, by temporary scaffolding, or any other way except on a substantially completed bridge with shores and safety support in place.

13. A member, cable or assembly may not be laid down except in the staging yards, on the abutments, on the temporary shores and on the bridge. A member, cable or assembly may not be leaned against an abutment, shore, safety support, or the bridge.

14. A constructed portion of the bridge may be slid horizontally, provided that it is supported by any combination of two or more shores and abutments.

15. One side or end of a constructed portion of the bridge may be moved a few inches in any direction in order to align a connection.

Accidents

In general, the clock is not stopped when an "accident" occurs. Builders involved in accidents may continue to build, and components involved in accidents may be recovered and used. Types of accidents and the corresponding cost penalties are:

1. A builder touches the river or the safety support. $50,000 for each occurrence.

2. A member, cable, assembly, shore, or the bridge touches the river or the safety support. $20,000 for each occurrence.

3. A tool or fastener is dropped into the river. $1,000 for each occurrence.

DIMENSIONS AND SUPPORT

The figures titled "Side Elevation" and "Clearance and Deck Support" illustrate some of the following specifications.

1. The bridge must span the abutments, which are fixed in place so that the distance between faces is 20'.

2. The bridge must provide at least 6" of bearing length behind the face of each abutment.

3. A 2'0" wide by 1'8" high rectangular vehicle passageway must be provided along the full length of the bridge.

4. No part of the bridge may extend more than 2'0" below the top of the abutments at any point on the span.

5. The surface of the deck must be no more than 8.5" above the top of the abutments, measured at the abutments.

6. The absolute value of camber must be less than 3".

7. The bridge must provide support of the decking such that the edges of the decking that run it the longitudinal direction of the bridge are cantilevered no more than 6".

8. The deck must be sufficiently even and smooth to allow a wheeled vehicle to pass from one end of the bridge to the other. Sections of decking must be butted together without gap or overlap. Small elevation differences, such as those caused by decking resting on bolt heads, are acceptable.

9. The decking must not be attached or anchored to the bridge.

10. The bridge may not be attached or anchored to the abutments, and it may bear only on the top surface of the abutments.

11. The bridge may not be anchored to the ground.

LOAD TESTS

CAUTION: A bridge could collapse suddenly during load tests. Therefore, minimize the number of people near the bridge while it is being tested, and use a safety support positioned about 6" below the center of the bridge.

Load tests are conducted without shores. Load test 1 is conducted without decking; load tests 2 and 3 are conducted with decking installed.

The judge selects a side of the bridge and designates three target points on that side, as close to the level of the decking as possible, but not on the decking itself. The target points are located at mid- and quarter-spans (that is 10, 5 and 15 feet from the faces of the abutments.) All lateral deflection measurements are made to the mid-span target point. Vertical deflection measurements are made to all three target points; vertical deflection is the maximum absolute value of the three measurements.

Total lateral deflection is the absolute value of the horizontal distance of the mid-span target point from its position at the beginning of load test 2. Incremental vertical deflection is the maximum absolute value of the vertical distances of the three target points from their positions at the beginning of load test 3.

Load tests are conducted in numerical order.

Load Test 1 - Qualifying , Lateral

As close as practical to the mid-span target point, apply a 100-pound force in the lateral direction. To pass load test 1, the lateral deflection of the bridge must not exceed 1.0". If the bridge does not pass load test 1, do not conduct any other load test. Remove the lateral load; it is not part of the remaining load tests.

Load Test 2 - Qualifying, Vertical

Uniformly distribute load over an area symmetric about the middle of the deck and not exceeding 3 feet in the span direction. Terminate load test 2 when lateral deflection reaches 1.0" or vertical deflection reaches 2.0" or 500 pounds of load has been placed. A bridge passes load test 2 if 500 pounds of load was placed without a deflection limit being exceeded. If the bridge does not pass load test 2, do not conduct any other load test.

Load Test 3 - Competition, Vertical

With the load from test 2 remaining in place, uniformly distribute additional load over an area symmetric about the middle of the deck and not exceeding 6 feet in the span direction. Terminate load test 3 when total lateral deflection reaches 2.0" or incremental vertical deflection reaches 2.0" or 2,000 pounds of additional load has been placed. A bridge passes load test 3 if 2,000 pounds of additional load was placed without a deflection limit being exceeded. If the bridge passes load test 3, record the incremental vertical deflection.

EQUIPMENT PROVIDED BY HOST CHAPTER

Decking

The decking is steel bar grating identified as W-19-4 (1 x 1/8). The dimensions of a piece of grating are 3'6" x 2'11-3/4" x 1". Grating has 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 must be provided along the edges that are parallel to the length of the bridge. No support is needed for the edges of the grating that are perpendicular to the length of the bridge.

For the load tests, do not exceed 400 psf uniform load nor 500 pounds concentrated load. Do not load on a cantilevered portion of the grating.

Abutments

The top surface of each abutment should be at least 5' long, 3" to 12" wide, level, smooth, and approximately 3' above the ground.

Safety Support

The safety support is intended to limit the consequences of a bridge collapsing during construction or load tests, but should not come in contact with the bridge unless there is a collapse or excessive deflection. The safety support is placed at the middle of the span and adjusted so that the top of the support is close to the bottom of the bridge.

The safety support should be placed and adjusted to the proper height before the start of timed construction, if possible. If the style of the bridge requires that the safety support be placed or adjusted when the bridge is partially constructed, the clock will be stopped while the safety support is positioned. Builders are prohibited from being on the bridge unless the safety support is in place, as well as temporary shores on both banks.

MODIFYING THE RULES

Modification of the rules is discouraged, so that bridges from all regions may compete nationally without disqualification and/or disadvantage. If the rules absolutely must be modified to accommodate local restrictions, the host chapter should notify competing chapters as early as possible. Changes in the rules must not compromise safety.

BRIDGE-BUILDING TIPS

There are many bridge designs which could be suitable for the competition. Among these are beam-and-girder bridges, trusses of endless varieties, king-post and queen-posts, box girders, arches and cable-supported bridges.

Some bridge-building tips have been learned in previous competitions:

1. Try to keep the number of pieces to be field-assembled to a minimum. Match-mark those pieces whenever possible to insure proper installation.

2. Keep the number of field bolts to a minimum. It may not be necessary to have a minimum two-bolt connection at every joint, especially for secondary members. Consider color-coding bolt heads if two different bolt diameters are used. It may not be necessary to fully tighten every bolt. Some may need to be only finger-tight.

3. Make your bolt holes sufficiently larger than the bolt diameter to ease installation. Putting 5/16 inch diameter bolts through holes drilled 21/64th in two or more layers of steel is not an easy task.

4. Try to keep your bridge weight below 400 pounds. Bridges in the range of 150 to 300 pounds are common.

5. Practice your bridge erection under simulated erection conditions to reduce your construction time and uncover fabrication and construction errors. Make sure you practice all safety guidelines. Competitive bridges usually have construction times less than 50 person-minutes.

6. Do not stand, sit or lie on your bridge unless a safety support and both shores are in place. Do not load the bridge unless a safety support is in place.

7. Bridge painting is a nice touch for aesthetics. School colors, names, logos and similar items add to the spirit of competition.

8. To speed things along on competition day, have a preset plan for unloading, staging and erecting your bridge. Know in advance the required elevations of shoring and Safety Support, relative to the abutments, so that they can be quickly placed and adjusted.

9. Allow some tolerance for the grating or other bridge deck to be slightly larger than planned. Make sure you have enough clearance between structural members, bolt heads and shanks to place the grating on the bridge. Review the required orientation of the grating to make sure you have supported it near the ends of the main bearing bars, along the sides of the bridge.

10. If using cable for primary structural elements, remember that cable can stretch considerably under load. Loosely wound cable strands stretch the most. Rods or small, flat stock bars may be a suitable alternative.

11. Tubes that use "sleeve type" compression joints go together quickly and may not need bolting together. Finding the right size tubing material may be more difficult than finding other structural shapes.

12. Start design early in the year and find a nearby supplier for your materials. This will minimize costs for everyone and eliminate the last-minute rush.

Several factors should be considered when you determine the type of bridge you will build. What facilities are available to you to build your bridge? Are welders, torches, drills and other tools available in your shop or laboratory? How thick can the pieces be for the equipment you have? Do you have a nearby scrap yard, steel fabricator, steel erector, machine shop or contractor for materials and to help with difficult pieces?

Designing, fabricating and building your bridge can be a fun learning experience. Start early, plan, design, evaluate, build and practice. Enjoy the challenge and the competition.

NOTES FOR HOST CHAPTER

1. Judges can come from a variety of sources, including your local ASCE Chapter. They can be local designers, engineers, contractors or unbiased faculty and students. Select one person to be the Chief Official to be the final voice for rules interpretation.

2. The safety support is intended to support the bridge and its load if the bridge collapses during construction or load testing. The safety support should have a capacity of at least 6,000 pounds, should have a broad base to assure stability, and should be sufficiently wide at the top to accommodate a sidesway failure. The height of the safety support must be adjustable.

Safety supports can be constructed from steel, timber, concrete blocks, and/or automotive jack stands.

3. Abutments can be of any convenient material such as steel sawhorses or beams, timber blocking, masonry blocks or some combination of these materials. If the abutments are not level, twisting of the bridge along its length could make fit-up and assembly difficult and could affect its strength. Use of a carpenter's level and string or a surveying level is recommended. If your Regional Conference has not already secured a set of abutments for use in bridge-building competitions, local steel fabricators are generally willing to loan steel sawhorses from their shops.

Each abutment should be capable of supporting 2,000-pound point loads, and at least 4,000 pounds total. Make sure the abutments are stable and will not fall if inadvertently laterally loaded during construction or load testing. The abutments should rest on solid pavement or ground to minimize the possibility of sinking during loading.

4. The method of applying loads during load testing is very important. Your available resources will determine this for you. Steel scrap beams, steel scrap pieces or hole punching in gunny sacks, concrete blocks, sand bags, tractor weights, water in drums, hydraulic jacks, etc., are possibilities. The time needed to apply loads, the safety of the students working with the loading material, measurability and repeatability are important. Therefore, it is recommended that the same people, as provided by the Host Chapter, are used to load the bridges. Make each unit of weight low enough that one individual can lift the weight. Load materials, equipment (and people) should not be damaged if the bridge suddenly fails onto the Safety Support.

5. Spectators should have visual access to the competition. However, it is recommended that spectators should be kept at a safe distance from the construction site.

6. The competition site should be fairly accessible for delivery of materials. It should be relatively level to help leveling abutments, shoring and the Safety Support. Parking lots generally work well. In grassy areas, bolts and small parts can be lost, and abutments can sink into the ground. Permit the layout of materials in the staging yards and the placement of shoring and Safety Support in advance of the timed competition. Use a taut string line between abutments to set the line for placing shoring and the Safety Support.

Markings noting the staging yards, access roads, river, wingwall and other areas can be done with chalk, broad masking tape or anything else available. A wooden strip toeboard, at river's edge, can serve as a definitive line for the river and also help judges detect violations.

7. Camber can best be determined by string line attached to the abutments. A string line attached to the bridge ends with a C-clamp can be used for lateral sidesway measurement. For deflections under load testing, use a string line, dial gages, or level observing a marker attached to the bridge or a rod placed periodically on the bridge in the identical location each time.

8. The roadway decking as described for this competition is steel bar grating, generically identified as "W-19-4 (1 x 1/8) steel". Seven pieces 3'-6" in length and 2'-11 3/4" wide are required for a complete bridge. As these pieces of grating are reusable, one set of seven pieces should be sufficient for the competition unless you plan a simultaneous load testing. You may wish to consider getting one extra piece in case one gets damaged. You should be able to secure this grating from a local steel fabricator or supplier.

Alternative roadway decking materials could be timber planking, heavy plywood, or some other suitable product. If alternative decking is used, all competing schools will need plenty of advance notice regarding its size, support requirements, clearance needs and strength.

9. Depending upon the number of entries, you should determine an appropriate schedule for the competition. You may wish to schedule simultaneous construction of two or more bridges, on separate abutments, if you have several entrants. The more bridge-building sites you have available, the faster the competition will go.

Unloading, set-up and layout in the staging yards can be time-consuming for complicated bridges and unpracticed teams. Two separate staging yards are provided at each end of a site. This enables two schools to get set up for the competition at each abutment, saving set-up time.

One way to speed the competition along is to remove each completed bridge, without grating, from the abutments into a temporary storage area. Several students will be needed to lift and carry a bridge, of course. By doing this, all bridges will be built first, then all bridges will be load-tested. You may have to provide short blocks on which to set the bridges during storage.

10. If available, platform scales are preferred. However, bathroom scales will probably be accurate enough to weigh each bridge. In the unloaded condition, without grating, lift up one end of the bridge and place a scale underneath each support point (typically two). Then do this at the other end of the bridge and sum the readings.

11. All bridges that qualify should be recognized, for example, by a "certificate of quality". Awards should be given in each of the categories of competition (stiffest, lightest, fastest construction, aesthetics, most efficient, and most economic), and for overall performance.

JUDGING FORM (SUGGESTED)

Penalties for Accidents

Builder touches river or safety support ($50,000 each) $_____

Bridge part touches river or safety support ($20,000 each) $_____

Tool or fastener dropped in river ($1,000 each) $_____

TOTAL PENALTIES $_____

Construction Time

_____ builders x _____ min = _____ person-min

Weight

_____ pounds

Deflection (incremental vertical, test 3) _____ in

Efficiency

Total weight (lb) _____/100 = _____

Incremental vert. deflect. (in) _____/0.10 = _____

SNWD (add) _____

Cost

Shores: $80,000 if used $_____

Const Time _____ x $3,000 = +$_____

Weight _____ x $1,000 = +$_____

Total Penalties $_____

TOTAL COST (add) $_____

Aesthetics

Suggested Items to Consider in Judging Aesthetics:

- General Appearance
- Blending with the Environment
- Quality of Workmanship - Fabrication and Finish
- Construction Organization and Teamwork
- Balance of Design
- Proportions
- Cleanliness of Line

Aesthetics Score: _____

Rank

Construction Speed _____ Efficiency _____

Lightness _____ Economy _____

Stiffness _____ Aesthetics _____

Overall Performance (Efficiency + Economy) = _____

(may use aesthetics as tie breaker)

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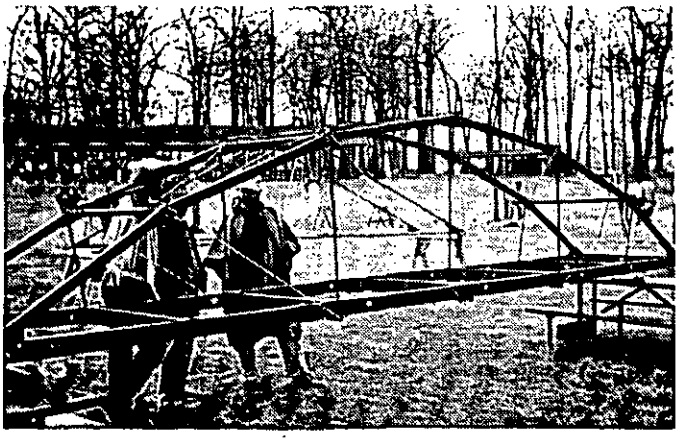
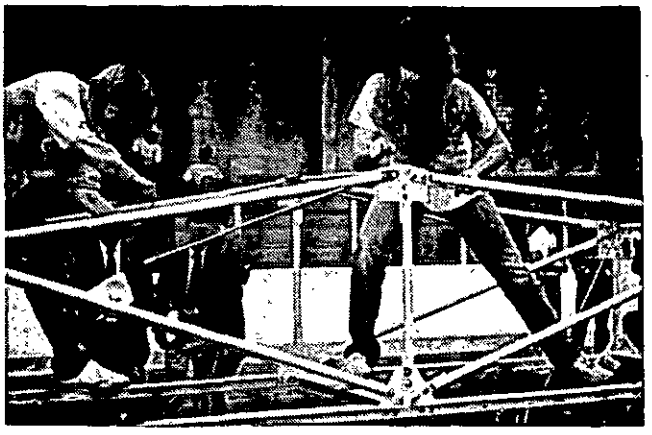
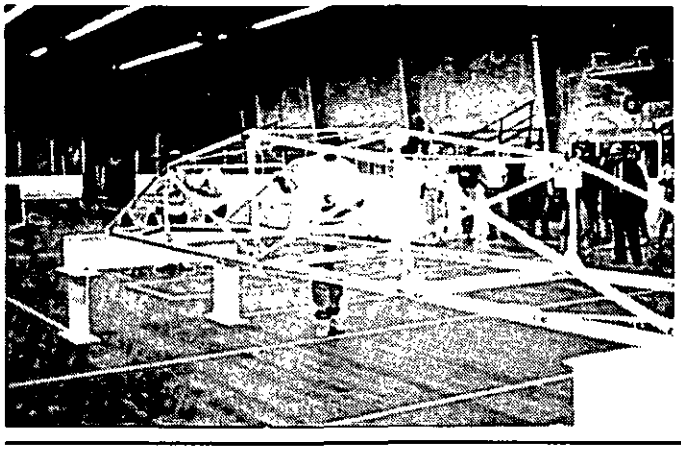
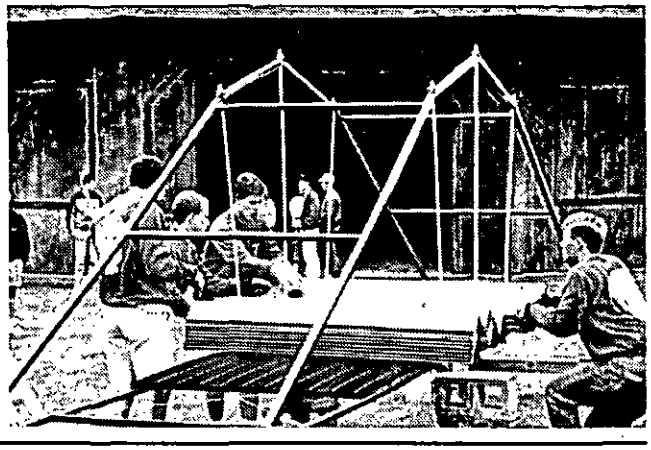




STEEL BRIDGE BUILDING COMPETITION





FOR STUDENT CHAPTERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

IN COOPERATION WITH
ASCE AMERICAN SOCIETY OF CIVIL ENGINEERS

STATEMENT

The Steel Bridge-Building Competition is sponsored by the American Institute of Steel Construction. It challenges civil engineering students to a competition that includes design and hands-on experience with structural steel.

Since the educational intent of the competition is to give engineering students exposure to designing, fabricating and erecting a steel bridge, AISC is recommending that the judging panel at each competition accepts only bridges substantially designed and built during the academic year in which the competition is held.

AISC places great emphasis on safety. The competing teams are asked to observe safety practices as covered in the competition rules.

AISC 1993 STEEL BRIDGE-BUILDING

COMPETITION RULES

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Civil Engineering students are challenged in a competition that includes design, hands-on experience with structural steel and the use of both actual and simulated construction practices in building a structure. Through the competition, you will utilize materials and design knowledge, construction planning, shop experience, training and teamwork.

In the opening Problem Statement, you are given an orientation into some of the real-life design and construction problems commonly encountered in actual practice. The Statement also establishes some background into the selection of the load tests and design/construction restrictions of the competition. The Problem Statement and related rules are basic to construction practices and are minimal when compared to the volumes of real-life regulations.

Member size and weight limitations are given for several reasons. First, it makes the competition representative of a real situation. Second, it causes you to look at several construction alternatives, rather than using a single member to span the entire 20-foot length. Third, it facilitates the handling and transportation of your structure to the competition site. Fourth, it minimizes the risk to you in handling and assembling the pieces.

Regulations and penalties have been established to maintain the integrity of the construction simulation. These rules are related to actual construction problems, just as members are scaled to model those size limitations found in an actual structure.

Several categories of competition are offered, so you should look at several design alternatives to win any or all of the categories. A latticework structure may be the lightest, but takes a long time to build. A cable-supported structure may be fast and light, but not meet deflection or stability considerations. Beam-type structures may be fast, but heavy and expensive. Several categories of competition allow you to target your objectives and design/build accordingly.

The competition promises design challenges, steel fabrication experience, the use of construction planning and practice, teamwork, plus the fun of competing against fellow students.

PROBLEM STATEMENT

A century-old bridge across a river valley in a mountainous rural region is in need of replacement. The bridge serves not only area residents, but also important heavy truck traffic for area mining. No other river crossing of adequate capacity is available for miles in either direction, therefore, a quick replacement is necessary.

The State Department of Transportation has sought design/build proposals to construct a replacement bridge. Any type of steel structure will be permitted, but it must meet the following minimum design loads and construction restrictions:

1. The bridge must accommodate two lanes of traffic,

2. the bridge must be able to resist various patterns of gravity load,

3. the bridge must be able to resist a lateral force of 100,000 pounds from river flooding and/or wind forces,

4. no interior piers are permitted, easing environmental clearances,

5. no lateral thrusts or uplift can be applied to the existing abutments, nor can they be reinformed to accommodate such forces,

6. no backstays or anchorages are available beyond the abutment,

7. construction and live load deflection limits must be met,

8. and the bridge must accommodate state-supplied modular bridge deck units salvaged from another bridge, without modification to any unit.

The existing bridge spans in the north-south direction a distance of 200 feet, resting on simple stone abutments. The valley below is relatively flat, roughly 30 feet below the top of the abutments. The north river bank is 50 feet wide, the river itself is 70 feet wide, and the south bank is 80 feet wide.

The river is fast, not navigable and environmentally sensitive. Flash flooding and environmental concerns prohibit the use of barges, causeways or scaffolding across the river. Temporary shoring can be safely placed on the solid banks of the river.

Storage and staging yards 150 feet square will be cleared for the contractor's use at both ends of the bridge. The yard at the north end of the bridge will be located just 100 feet from the abutment. The yard at the south end will be 300 feet from the abutment. The service road from both yards to the bridge will be widened to 50 feet, and will extend around one end of the abutment wingwalls down to the river banks.

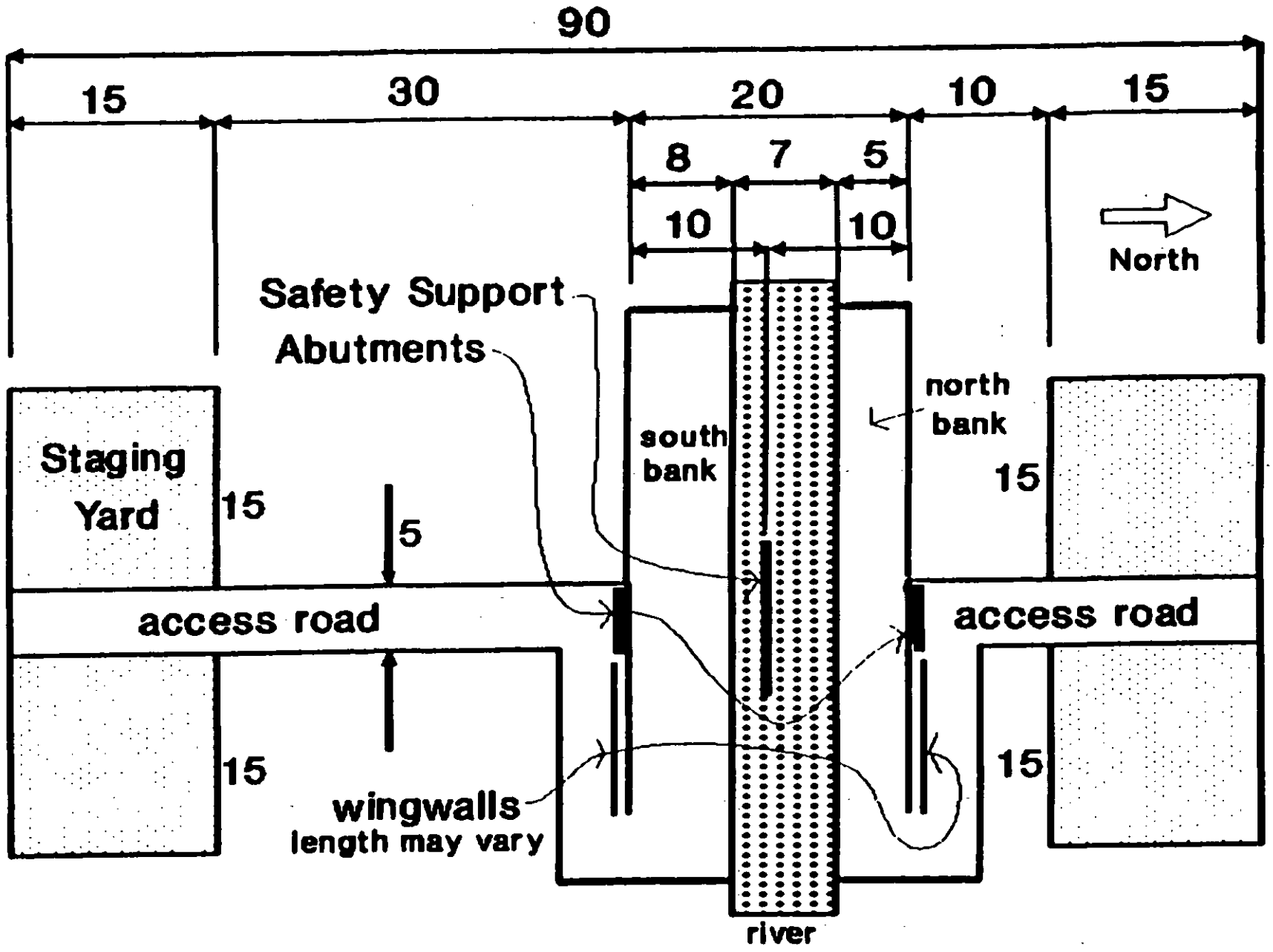
Soil conditions, rough terrain and tight site conditions limit the lifting capacity of cranes. Materials may be delivered by crane to the river valley by using the access roads constructed around the wingwall, or by transferring the materials over the abutments or wingwalls from one crane to the next.

Narrow, winding roads lead to the yards from both directions. Because of this, the length of an individual member is limited to 55 feet, with a maximum width and depth of 6'-3". This enables the trucks to make the required turns. Smaller bridges on both sides of the main bridge being replaced limit the weight of an individual piece to 20 tons (40,000 pounds).

The state will provide prefabricated, 10" deep modular bridge deck units that were salvaged from another bridge. They are the required roadway width, 35 feet in the transverse direction. They are capable of spanning a 35-foot clear distance between supports, and are also capable of cantilevering 5 feet beyond a support.

To allow for a new bridge design, new approaches will be constructed that can go as high as 7'-1" above the top of the existing abutment. Allowing for the 10" depth of the state-supplied modular deck unit, the structure depth at abutments can be as deep as 6'-3", the same as the maximum member depth.

Your company's design/build proposal has been deemed responsive by the State Department of Transportation. To make a selection, the state has asked your firm and the other competing firms to construct a 1:10 model bridge, demonstrate the erection method to be used, then subject it to load testing. The state is concerned about many things in its evaluation -- strength, speed of construction, cost, stiffness, weight and aesthetics. Using a ranking system, it will use the competition to select a contractor winner. If your bridge is judged the best, your firm will receive a negotiated contract to build this bridge, and possibly several others. You and your firm could become leaders in the national bridge replacement market.


90
15
30
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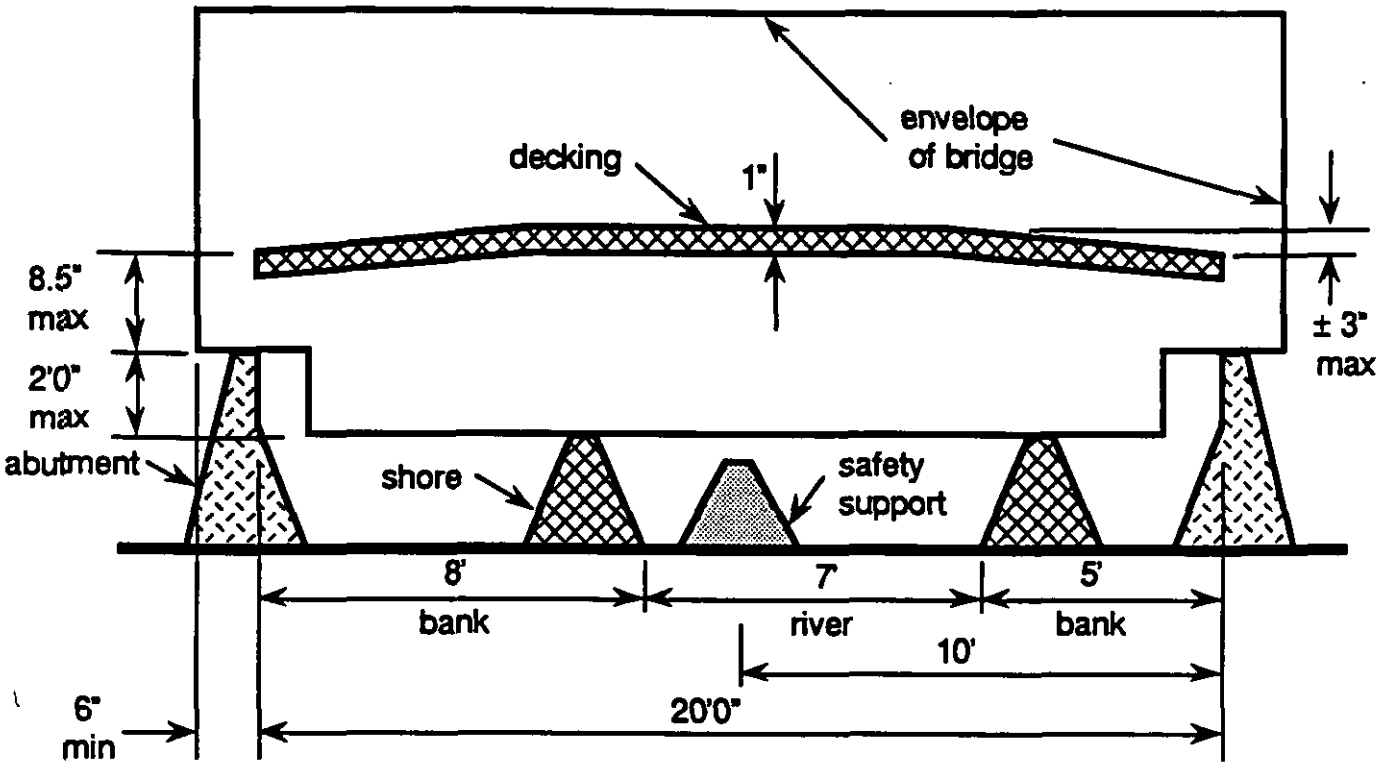
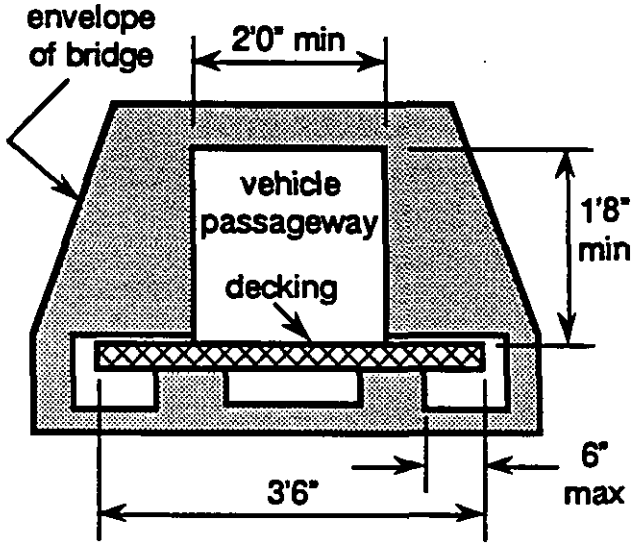
North
Safety Support
Abutments
north
bank
south
bank
Staging
Yard
15
5
15
access road
access road
15
15
wingwalls
length may vary
river

SITE PLAN



Side Elevation



Clearance and
Deck Support

QUALIFICATION

In order to compete for awards, a bridge must qualify by satisfying the following minimum standards for durability, constructability, usability, strength and serviceability.

Durability

The bridge must be constructed entirely of steel.

Constructability

The bridge may be constructed only of components conforming to the restrictions on size and weight as specified in "Components". The bridge must be constructable without violating requirements listed in "Safety Regulations".

Usability

The bridge must conform to the specifications described in "Dimensions and Support."

Strength and Serviceability

The bridge must pass load tests 1 and 2 described in "Load Tests."

AWARD COMPETITION

Only qualified bridges are eligible to compete for awards. Categories of competition are stiffness, lightness, construction speed, aesthetics, efficiency and economy. In addition, overall performance is rated.

Stiffness

The bridge with the lowest incremental vertical deflection will win in the stiffness category. Incremental vertical deflection is determined from load test 3. A bridge that fails load test 3 will be eliminated from the stiffness and efficiency categories of competition.

Lightness

The bridge with the least total weight will win in the lightness category. Decking and temporary shores are not included in total weight.

Construction Speed

The bridge with the lowest construction time will win in this category. Construction time is the product of the size of the construction team and the duration of construction. The construction team includes everyone who handles the bridge or any of its components during timed construction. A bridge that accumulates $150,000 or more in penalties will be eliminated from competition in the construction speed and economy categories (see "Accidents").

Aesthetics

Is judged by a non-partisan jury following the completion of the bridge, but prior to load testing. Please see Judging Form (Suggested) for items to consider.

Efficiency

The bridge with the smallest product of incremental vertical deflection and total weight will win in the efficiency category.

Economy

The bridge with the lowest cost will win in the economy category. Cost is computed as material cost plus labor cost plus penalties for accidents. Material cost is computed by multiplying the total weight of the bridge (in pounds) by $800, and adding $80,000 if temporary shores were used. Labor cost is computed by multiplying construction time (in person-minutes) by $1,000. Penalty costs are listed in "Accidents."

Overall Performance

The overall performance rating of a bridge is determined by adding the rank of the bridge in the efficiency category to its rank in the economy category and aesthetics. The bridge with the lowest sum will win the overall competition. A bridge that was eliminated from the efficiency and/or economy categories is not eligible for the overall performance competition. In the case of a tie, it is up to the panel of judges to either accept the tie or select a winner.

COMPONENTS

A bridge may be constructed only of components made entirely of steel, and conforming to the following descriptions of members, cables with fittings, assemblies, and fasteners.

A member may not weigh more than 40 pounds, nor exceed overall dimensions of 5' 6" x 7.5" x 7.5" (that is, it must fit inside a cylinder with a diameter of 7.5"). A member may consist of parts connected together before timed construction begins, but it must be rigid (that is, hinged, articulated or telescoping members are not permitted).

A cable together with its fittings may weigh no more than 40 pounds. Fittings are clamps, clevises, turnbuckles and similar parts used for connecting cables, and not exceeding 7.5" in any dimension. Fittings may be attached to the cable before the timed construction.

An assembly is no more than 3 members and/or cables that are connected together in the staging yards during timed construction.

Fasteners are bolts and nuts, pins, shims and similar parts used for connecting members, cables and assemblies, and not exceeding 7.5" in any dimension.

CONSTRUCTION

Construction Site

See the figure titled "Site Plan" for layout of river, banks, and other features that affect construction.

Temporary Shores

Shores are temporary support on the river banks, and are provided by the builders. There are no restrictions on the materials and design for shores, other than that they be sufficiently strong and stable to support the bridge and builders. There is a cost assigned to temporary shores; their advantage is that builders may be supported by the bridge only if shores are in place. If shores are used, they must be used on both banks.

Start

Before construction begins, all members, cables, fasteners, tools and builders are in the staging yards. Temporary shores, if used, have been constructed and are in place on both river banks. The safety support is in place at the middle of the span and adjusted so that it will be close to the bottom of the bridge, unless the style of the bridge makes that impossible. Timing and construction begin when the builders signify that they are ready, and the judge declares the start.

Time

Time is kept from the start to finish of construction. The clock will be stopped:

1. if a builder or judge sees a condition that could cause personal injury;

2. when a safety regulation has been violated, and

3. if the safety support must be moved or adjusted.

Construction ceases while the clock is stopped. The clock is restarted after the situation has been corrected.

Finish

Construction ends when the bridge is complete and all tools, builders and shores are in the staging yards, and the builders signify that they are finished. Decking will be installed after the bridge is complete; installation is not included in timed construction.

Tools

Builders provide their own tools. Only hand tools are permitted. Field welding, and power tools (electric and pneumatic) are prohibited. Ropes are permitted, but gin poles, jacks, winches, come-alongs, counterweights and other hoisting devices are prohibited.

SAFETY REGULATIONS

If one of the following safety regulations is violated, the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools and bridge components will be returned to the positions they occupied before the violation. Construction that necessitates violation of safety regulations is not permitted.

1. If temporary shores are not used, a builder may not stand on the bridge or occupy it in any way such that the bridge supports the builder's body weight. However, a builder may lean on the bridge if both feet remain on the river bank.

2. A builder may lift or carry only one member at a time. No bundling allowed.

3. An assembly may not be lifted nor carried by one builder alone.

4. Two or more builders may lift or carry only one assembly at a time.

5. Nothing may be thrown.

6. A builder may not stand in the river.

7. A builder must stay within the limits of the access roads and river banks.

8. A builder may not cross the wingwalls.

9. The safety support as well as shores on both banks must be in place and properly adjusted before a builder climbs onto the bridge.

10. A builder may not cross the abutments except to climb onto the bridge with shores and safety support in place.

11. No member, cable or assembly may be carried while climbing onto the bridge.

12. A builder may not cross the river by jumping, by temporary scaffolding, or any other way except on the substantially completed bridge with shores and safety support in place.

13. A member, cable or assembly may not be laid down except in the staging yards, on the abutments, and on the shores. A member, cable or assembly may not be leaned against an abutment, shore or safety support.

14. A constructed portion of the bridge may be slid horizontally, provided that it is supported by any combination of two or more shores and abutments.

15. One side or end of a constructed portion of the bridge may be moved a few inches in any direction in order to align a connection.

Accidents

In general, the clock is not stopped when an "accident" occurs. Builders involved in accidents may continue to build, and components involved in accidents may be recovered and used. Types of accidents and the corresponding cost penalties are:

1. A builder touches the river or the safety support. $50,000 for each occurrence.

2. A member, cable, assembly, shore, or the bridge touches the river or the safety support. $20,000 for each occurrence.

3. A tool or fastener is dropped into the river. $1000 for each occurrence.

DIMENSIONS AND SUPPORT

The figures titled "Side Elevation" and "Clearance and Deck Support" illustrate some of the following specifications.

1. The bridge must span the abutments, which are fixed in place so that the distance between faces is 20'.

2. The bridge must provide at least 6" of bearing length behind the face of each abutment.

3. A 2'0" wide by 1'8" high rectangular vehicle passageway must be provided along the full length of the bridge.

4. No part of the bridge may extend more than 2'0" below the top of the abutments at any point on the span.

5. The surface of the deck must be no more than 8.5" above the top of the abutments, measured at the abutments.

6. The absolute value of camber must be less than 3".

7. The bridge must provide support for the decking such that the edges of the decking that run in the longitudinal direction of the bridge are cantilevered no more than 6".

8. The deck must be sufficiently even and smooth to allow a wheeled vehicle to pass from one end of the bridge to the other. Sections of decking must be butted together without gap or overlap. Small elevation differences, such as those caused by decking resting on bolt heads, are acceptable.

9. The decking may not be attached or anchored to the bridge.

10. The bridge may not be attached or anchored to the abutments, and it may bear only on the top surface of the abutments.

11. The bridge may not be anchored to the ground.

LOAD TESTS

CAUTION: A bridge cold collapse suddenly during load tests. Therefore, minimize the number of people near the bridge while it is being tested, and use a safety support positioned about 6" below the center of the bridge.

Load tests are conducted with decking installed and without shores.

The judge designates a target point on the bridge at midspan as close to the level of the deck as is practical, but not on the decking itself. All deflection measurements are made to that target point.

Total lateral deflection is the absolute value of the horizontal distance of the target point from its position at the beginning of load test 2. Incremental vertical deflection is the absolute value of the vertical distance of the target point from its position at the beginning of lead test 3.

Load tests are conducted in numerical order.

Load Test 1 - Qualifying, Lateral

As close as practical to the target point, apply a 100 pound force in the lateral direction. To pass load test 1, the lateral deflection of the bridge must not exceed 1.0". If the bridge does not pass load test 1, do not conduct any other load test. Remove the lateral load; it is not part of the remaining load tests.

Load Test 2 - Qualifying, Vertical

Uniformly distribute load over an area symmetric about the middle of the deck and not exceeding 3 feet in the span direction. Terminate load test 2 when lateral deflection reaches 1.0" or vertical deflection reaches 2.0" or 500 pounds of load has been placed. A bridge passes load test 2 if 500 pounds of load was placed without a deflection limit being exceeded. If the bridge does not pass load test 2, do not conduct any other load test.

Load Test 3 - Competition, Vertical

With the load from test 2 remaining in place, uniformly distribute additional load over an area symmetric about the middle of the deck and not exceeding 6 feet in the span direction. Terminate load test 3 when total lateral deflection reaches 2.0" or incremental vertical deflection reaches 2.0" or 2000 pounds of additional load has been placed. A bridge passes load test 3 if 2000 pounds of additional load was placed without a deflection limit being exceeded. If the bridge passes load test 3, record the incremental vertical deflection.

EQUIPMENT PROVIDED BY HOST CHAPTER

Decking

The decking is steel bar grating identified as W-19-4 (1 x 1/8). The dimensions of a piece of grating are 3'6" x 2'11-3/4" x 1". Grating has 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 must be provided along the edges that are parallel to the length of the bridge. No support is needed for the edges of the grating that are perpendicular to the length of the bridge.

For the load tests, do not exceed 400 psf uniform load nor 500 pounds concentrated load. Do not load on a cantilevered portion of the grating.

Abutments

The top surface of each abutment should be at least 5' long, 3" to 12" wide, level, smooth, and approximately 3' above the ground.

Safety Support

The safety support is intended to limit the consequences of a bridge collapsing during construction or load tests, but should not come in contact with the bridge unless there is a collapse or excessive deflection. The safety support is placed at the middle of the span and adjusted so that the top of the support is close to the bottom of the bridge.

The safety support should be placed and adjusted to the proper height before the start of timed construction, if possible. If the style of the bridge requires that the safety support be placed or adjusted when the bridge is partially constructed, the clock will be stopped while the safety support is positioned. Builders are prohibited from being on the bridge unless the safety support is in place, as well as temporary shores on both banks.

MODIFYING THE RULES

The host chapter may modify the rules to accommodate local conditions. However, safety must not be compromised. It is recommended that load tests and dimensional limits of bridges not be modified significantly, so that bridges from the host's region could qualify to compete in other regions or in a national contest. The host chapter must review the rules as early as possible, and promptly inform competing chapters of any modifications.

BRIDGE-BUILDING TIPS

There are many bridge designs which could be suitable for the competition. Among these are beam-and-girder bridges, trusses of endless varieties, king-post and queen-posts, box girders, arches and cable-supported bridges.

Some bridge-building tips have been learned in previous competitions:

1. Try to keep the number of pieces to be field-assembled to a minimum. Match-mark those pieces whenever possible to insure proper installation.

2. Keep the number of field bolts to a minimum. It may not be necessary to have a minimum two-bolt connection at every joint, especially for secondary members. Consider color-coding bolt heads if two different bolt diameters are used. It may not be necessary to fully tighten every bolt. Some may need to be only finger-tight.

3. Make your bolt holes sufficiently larger than the bolt diameter to ease installation. Putting 5/16 inch diameter bolts through holes drilled 21/64th in two or more layers of steel is not an easy task.

4. Try to keep your bridge weight below 400 pounds. Bridges in the range of 150 to 300 pounds are common.

5. Practice your bridge erection under simulated erection conditions to reduce your construction time and uncover fabrication and construction errors. Make sure you practice all safety guidelines. Competitive bridges usually have construction times less than 50 person-minutes.

6. Do not stand, sit or lie on your bridge unless a safety support and both shores are in place. Do not load the bridge unless a safety support is in place.

7. Bridge paining is a nice touch for aesthetics. School colors, names, logos and similar items add to the spirit of competition.

8. To speed things along on competition day, have a present plan for unloading, staging and erecting your bridge. Know in advance the required elevations of shoring and Safety Support, relative to the abutments, so that they can be quickly placed and adjusted.

9. Allow some tolerance for the grating or other bridge deck to be slightly larger than planned. Make sure you have enough clearance between structural members, bolt heads and shanks to place the grating on the bridge. Review the required orientation of the grating to make sure you have supported it near the ends of the main bearing bars, along the sides of the bridge.

10. If using cable for primary structural elements, remember that cable can stretch considerably under load. Loosely wound cable strands stretch the most. Rods or small, flat stock bars may be a suitable alternative.

11. Tubes that use "sleeve type" compression joints go together quickly and may not need bolting together. Finding the right size tubing material may be more difficult than finding other structural shapes.

12. Start design early in the year and find a nearby supplier for your materials. This will minimize costs for everyone and eliminate the last-minute rush.

Several factors should be considered when you determine the type of bridge you will build. What facilities are available to you to build your bridge? Are welders, torches, drills and other tools available in your shop or laboratory? How thick can the pieces be for the equipment you have? Do you have a nearby scrap yard, steel fabricator, steel erector, machine shop or contractor for materials and to help with difficult pieces?

Designing, fabricating and building your bridge can be a fun learning experience. Start early, plan, design, evaluate, build and practice. Enjoy the challenge and the competition.

NOTES FOR HOST CHAPTER

1. Judges can come from a variety of sources, including your local ASCE Chapter. They can be local designers, engineers, contractors or unbiased faculty and students. Select one person to be the Chief Official to be the final voice for rules interpretation.

2. The safety support is intended to support the bridge and its load if the bridge collapses during construction or load testing. The safety support should have a capacity of at least 6,000 pounds, should have a broad base to assure stability, and should be sufficiently wide at the top to accommodate a sidesway failure. The height of the safety support must be adjustable.

Safety supports can be constructed from steel, timber, concrete blocks, and/or automotive jack stands.

3. Abutments can be of any convenient material such as steel sawhorses or beams, timber blocking, masonry blocks or some combination of these materials. If the abutments are not level, twisting of the bridge along its length could make fit-up and assembly difficult and could affect its strength. Use of a carpenter's level and string level, or transit, is recommended. If your Regional Conference has not already secured a set of abutments for use in bridge-building competitions, local steel fabricators are generally willing to loan steel sawhorses from their shops.

Each abutment should be capable of supporting 2,000-pound point loads, and at least 4,000 pounds total. Make sure the abutments are stable and will not fall if inadvertently laterally loaded during construction or load testing. The abutments should rest on solid pavement or ground to minimize the possibility of sinking during loading.

4. The method of applying loads during load testing is very important. Your available resources will determine this for you. Steel scrap beams, steel scrap pieces or hole punching in gunny sacks, concrete blocks, sand bags, tractor weights, water in drums, hydraulic jacks, etc., are possibilities. The time needed to apply loads, the safety of the students working with the loading material, measurability and repeatability are important. Therefore, it is recommended that the same people, as provided by the Host Chapter, are used to load the bridges. Make each unit of weight low enough that one individual can lift the weight. Load materials, equipment (and people) should not be damaged if the bridge suddenly fails onto the Safety Support.

5. Spectators should have visual access to the competition. However, it is recommended that spectators should be kept at a safe distance from the construction site.

6. The competition site should be fairly accessible for delivery of materials. It should be relatively level to help leveling abutments, shoring and the Safety Support. Parking lots generally work well. In grassy areas, bolts and small parts can be lost, and abutments can sink into the ground. Permit the layout of materials in the staging yards and the placement of shoring and Safety Support in advance of the timed competition. Use a taut string line between abutments to set the line for placing shoring and the Safety Support.

Markings noting the staging yards, access roads, river, wingwall and other areas can be done with chalk, broad masking tape or anything else available. A wooden strip toeboard, at river's edge, can serve as a definitive line for the river and also help judges detect violations.

7. Camber can best be determined by string line attached to the abutments. A string line attached to the bridge ends with a C-clamp can be used for lateral sidesway measurement. For deflections under load testing, use a string line or level observing a marker attached to the bridge or a rod placed periodically on the bridge in the identical location each time.

8. The roadway decking as described for this competition is steel bar grating, generically identified as "W-19-4 (1 x 1/8) steel". Seven pieces 3'-6" in length and 2'-11 3/4" wide are required for a complete bridge. As these pieces of grating are reusable, one set of seven pieces should be sufficient for the competition unless you plan a simultaneous load testing. You may wish to consider getting one extra piece in case one gets damaged. You should be able to secure this grating from a local steel fabricator or supplier.

Alternative roadway decking materials could be timber planking, heavy plywood, or some other suitable product. If alternative decking is used, all competing schools will need plenty of advance notice regarding its size, support requirements, clearance needs and strength.

9. Depending upon the number of entries, you should determine an appropriate schedule for the competition. You may wish to schedule simultaneous construction of two or more bridges, on separate abutments, if you have several entrants. The more bridge-building sites you have available, the faster the competition will go.

Unloading, set-up and layout in the staging yards can be time-consuming for complicated bridges and unpracticed teams. Two separate staging yards are provided at each end of a site. This enables two schools to get set up for the competition at each abutment, saving set-up time.

One way to speed the competition along is to remove each completed bridge, without grating, from the abutments into a temporary storage area. Several students will be needed to lift and carry a bridge, of course. By doing this, all bridges will be built first, then all bridges will be load-tested. You may have to provide short blocks on which to set the bridges during storage.

10. If available, platform scales are preferred. However, bathroom scales will probably be accurate enough to weigh each bridge. In the unloaded condition, without grating, lift up one end of the bridge and place a scale underneath each support point (typically two). Then do this at the other end of the bridge and sum the readings.

11. All bridges that qualify should be recognized, for example, by a "certificate of quality". Awards should be given in each of the categories of competition (stiffest, lightest, fastest construction, aesthetics most efficient, and most economic), and for overall performance.

JUDGING FORM (Suggested)

Penalties for Accidents

Builder touches river of safety support ($50,000 each) $_____

Bridge part touches river or safety support ($20,000 each) $_____

Tool or fastener dropped in river ($1000 each) $_____

TOTAL PENALTIES $_____

Construction Time

_____ builders x _____ min = _____ person-min

Weight _____ pounds

Deflection (incremental vertical, test 3) _____ in

Efficiency

Weight _____ x deflect _____ = _____ lb-in

Cost

Shores: $80,000 if used $_____

Const Time _____ x $1000 = +$_____

Weight _____ x $800 = +$_____

Total Penalties (add) +$_____

TOTAL COST $_____

Aesthetics

Suggested Items to Consider in Judging Aesthetics:

General Appearance
Blending with the Environment
Quality of Workmanship - Fabrication and Paint Job
Quality of Workmanship - Erection
Balance of Design
Proportions
Cleanliness of Line

Aesthetics Score: _____

Rank

Construction Speed _____ Efficiency _____

Lightness _____ Economy _____

Stiffness _____ Aesthetics _____

Overall Performance (Efficiency + Econonmy + Aesthetics) = _____

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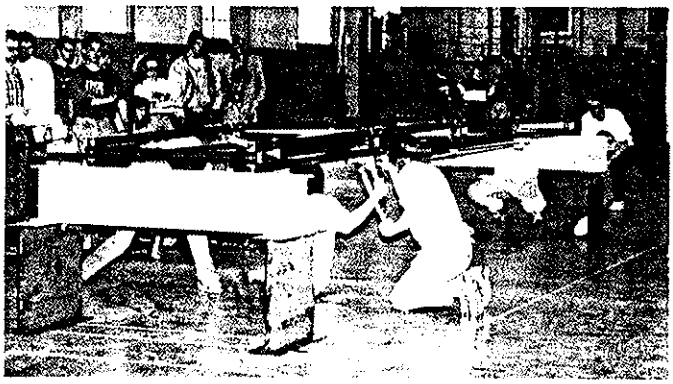
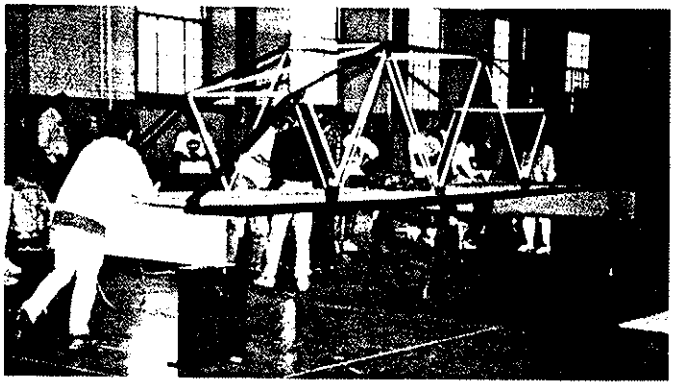
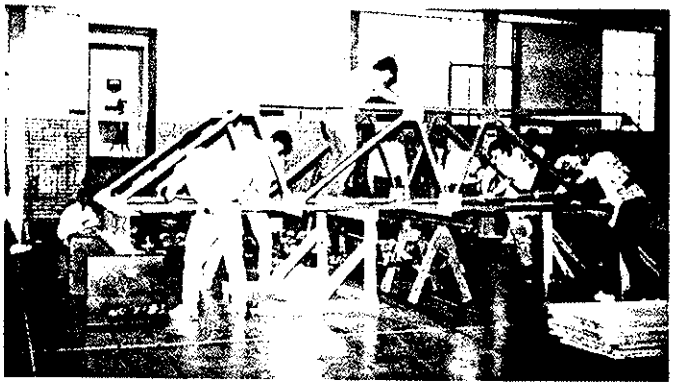
STEEL BRIDGE BUILDING COMPETITION







FOR STUDENT CHAPTERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

IN COOPERATION WITH
AMERICAN SOCIETY
OF CIVIL ENGINEERS

STATEMENT

The Steel Bridge-Building Competition is sponsored by the American Institute of Steel Construction. It challenges civil engineering students to a competition that includes design and hands-on experience with structural steel.

Since the educational intent of the competition is to give engineering students exposure to designing, fabricating and erecting a steel bridge, AISC is recommending that the judging panel at each competition accepts only bridges substantially designed and built during the academic year in which the competition is held.

AISC places great emphasis on safety. The competing teams are asked to observe safety practices as covered in the competition rules.

AISC 1992 STEEL BRIDGE-BUILDING

COMPETITION RULES

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Civil Engineering students are challenged in a competition that includes design, hands-on experience with structural steel and the use of both actual and simulated construction practices in building a structure. Through the competition, you will utilize materials and design knowledge, construction planning, shop experience, training and teamwork.

In the opening Problem Statement, you are given an orientation into some of the real-life design and construction problems commonly encountered in actual practice. The Statement also establishes some background into the selection of the load tests and design/construction restrictions of the competition. The Problem Statement and related rules are basic to construction practices and are minimal when compared to the volumes of real-life regulations.

Member size and weight limitations are given for several reasons. First, it makes the competition representative of a real situation. Second, it causes you to look at several construction alternatives, rather than using a single member to span the entire 20-foot length. Third, it facilitates the handling and transportation of your structure to the competition site. Fourth, it minimizes the risk to you in handling and assembling the pieces.

Material handling rules and related penalties have been established to maintain the integrity of the construction simulation. These rules are related to actual construction problems, just as members are scaled to model those size limitations found in an actual structure.

Several categories of competition are offered, so you should look at several design alternatives to win any or all of the categories. A latticework structure may be the lightest, but take a long time to build. A cable supported structure may be fast and light, but not meet deflection or stability considerations. Beam-type structures may be fast, but heavy and expensive. Several categories of competition allow you to target your objectives and design/build accordingly.

The competition promises design challenges, steel fabrication experience, the use of construction planning and practice, teamwork, plus the fun of competing against fellow students.

PROBLEM STATEMENT

A century-old bridge across a river valley in a mountainous rural region in is need of replacement. The bridge serves not only area residents but also important heavy truck traffic for area mining. No other river crossing of adequate capacity is available for miles in either direction, therefore a quick replacement is necessary.

The State Department of Transportation has sought design/build proposals to construct a replacement bridge. Any type of steel structure will be permitted, but it must meet the following minimum design loads and construction restrictions.

1. the bridge must support a single 75 ton truck at any point on the bridge,
2. the bridge must support a stationary load applied at or near the center of the bridge totalling 250 tons,
3. the bridge must be able to resist a lateral force of 100,000 pounds from river flooding and/or wind forces,
4. no interior piers are permitted, easing environmental clearances,
5. no lateral thrusts or uplift can be applied to the existing abutments, nor can they be reinforced to accommodate such forces,
6. no backstays or anchorages are available beyond the abutment,
7. construction and live load deflection limits must be met,
8. and the bridge must accommodate state-supplied modular bridge deck units salvaged from another bridge, without modification to any unit.

The existing bridge spans in the north-south direction a distance of 200 feet, resting on simple stone abutments. The valley below is relatively flat, roughly 30 feet below the top of the abutments. The north river bank is 50 feet wide, the river itself is 70 feet wide, and the south bank is 80 feet wide. To allow for mining traffic on the banks below the bridge, and also for river flooding, a minimum clear height of 20 feet from river bank to bottom of bridge must be maintained.

The river is fast, not navigable and environmentally sensitive. Flash flooding and environmental concerns prohibit the use of barges, causeways or scaffolding across the river. Temporary shoring can be safely placed on the solid banks of the river.

Storage and staging yards 150 feet square will be cleared for the contractor's use at both ends of the bridge. The yard at the north end of the bridge will be located just 100 feet from the abutment. The yard at the south end will be 300 feet from the abutment. The service road from both yards to the bridge will be widened to 50 feet, and will extend around one end of the abutment wingwalls down to the river banks.

Soil conditions, rough terrain and tight site conditions limit the lifting capacity of all cranes to 30 tons (60,000 pounds). Working in tandem, two cranes could lift a combined total of 50 tons (100,000 pounds). Materials may be delivered by crane to the river valley by using the access roads constructed around the wingwall, or by transferring the materials over the abutments from one crane to the next.

A narrow, winding road leads to the bridge from both directions. Because of this, the length of an individual bridge section is limited to 55 feet, with a maximum width and depth of 6'-3". This enables the trucks to make the required turns. Smaller bridges on both sides of the main bridge being replaced limit the weight of an individual piece to 30 tons (60,000 pounds).

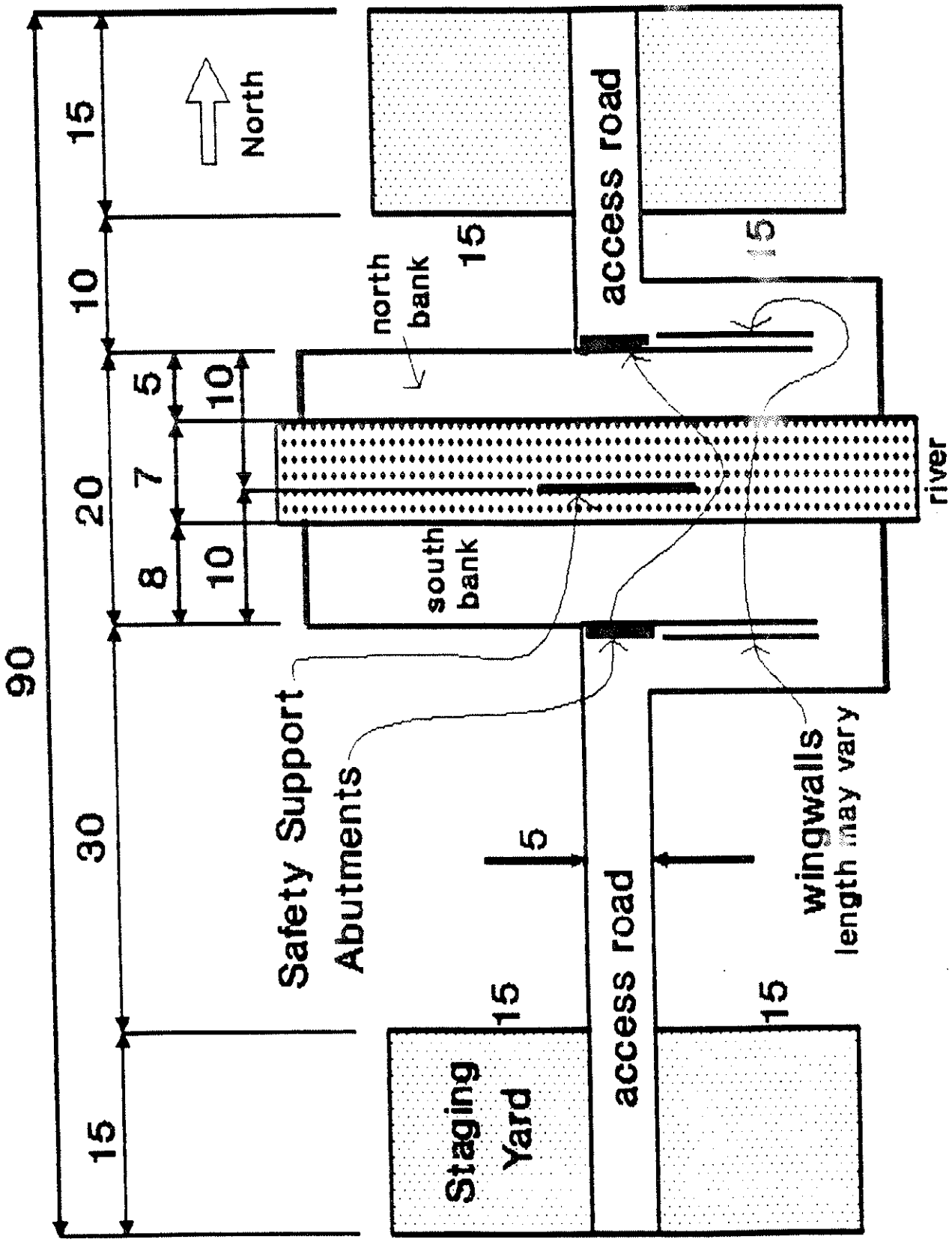
The State will provide prefabricated, 10" deep modular bridge deck units that were salvaged from another bridge. They are the required roadway width, 35 feet in the transverse direction. They are capable of spanning a 35 foot clear distance between supports, and are also capable of cantilevering 5 feet beyond a support. One design drawback to using these units is that can provide no lateral support to the bridge.

To allow for a new bridge design, new approaches will be constructed that can go as high as 7'-1" above the top of the existing abutment. Allowing for the 10" depth of the state-supplied modular deck unit, the structure depth at abutments can be as deep as 6'-3", the same as the maximum member depth.

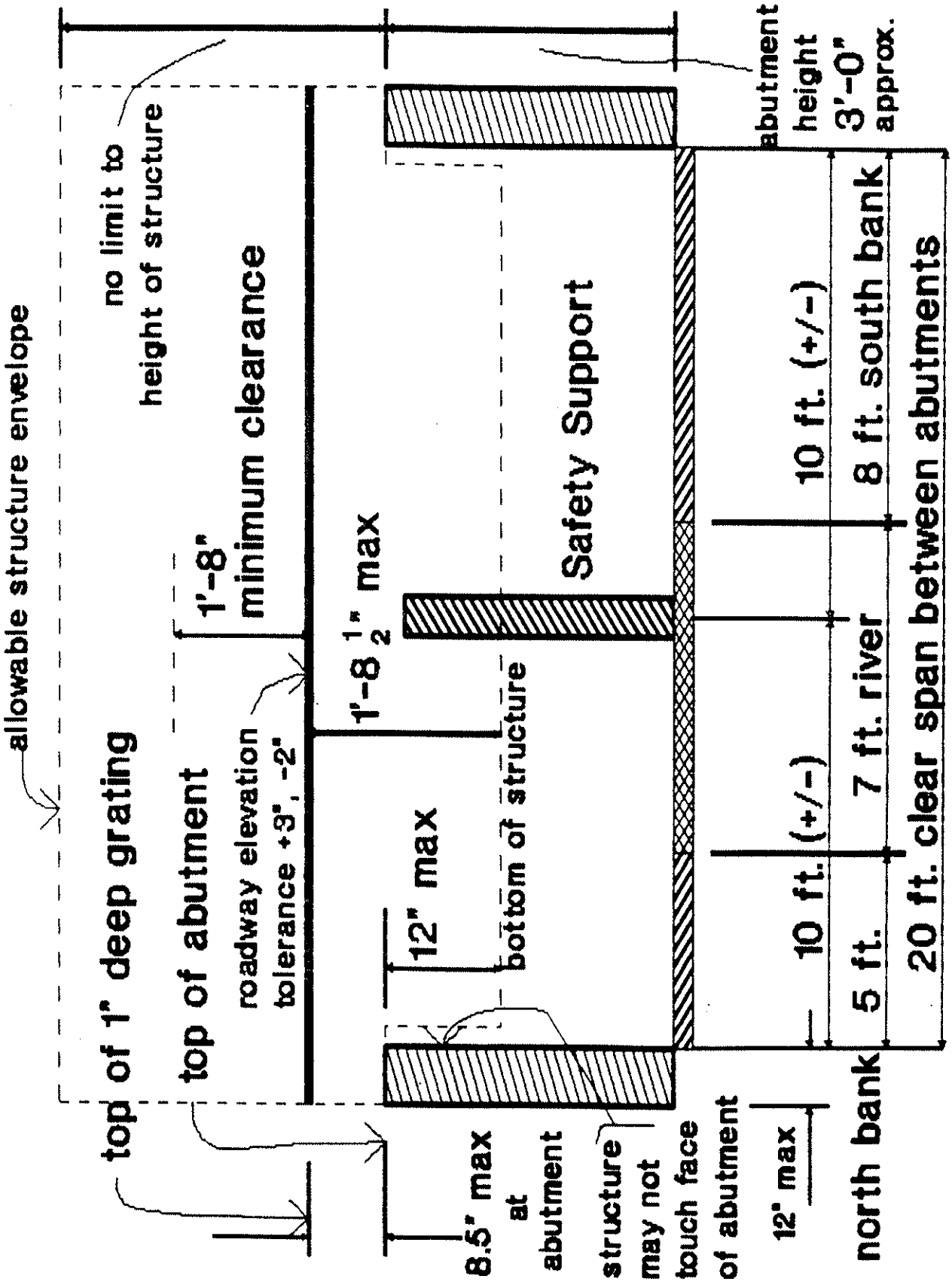
Your company's design/build proposal has been deemed responsive by the State Department of Transportation. To make a selection, the State has asked your firm and the other competing firms to construct a 1:10 model bridge, demonstrate the erection method to be used, then subject it to load testing. The State is concerned about many things in its evaluation -- strength, speed of construction, cost, stiffness and aesthetics. Using a ranking system, it will use the competition to select a contractor winner. If your bridge is judged the best, your firm will receive a negotiated contract to build this bridge, and possibly several others. You and your firm could become leaders in the national bridge replacement market.

(SEE NEXT TWO PAGES FOR SITE PLAN
AND BRIDGE AREA CROSS-SECTION)

SITE PLAN


North
15
10
5
10
7
8
10
20
30
15
90
north bank
15
access road
5
river
south bank
Safety Support Abutments
5
wingwalls
length may vary
15
15
Staging Yard
access road

BRIDGE AREA CROSS-SECTION



CATEGORIES OF COMPETITION

1. Fastest bridge construction
2. Lightest bridge
3. Highest capacity
4. Best capacity-to-weight ratio
5. Lowest cost bridge
6. Aesthetics

The bridge must pass the minimum design load tests (Tests 1, 2 and 3) to qualify in Categories 1 through 5. Grating weight is not considered to be part of the bridge weight, and is not used in determining bridge weights or capacities.

JUDGING GUIDELINES

The "fastest bridge construction" category uses total team time, in person-minutes. This is the number of team members times the amount of time used to erect the bridge.

For the "highest capacity" category, in the likely event that more than one bridge supports the total 2,500 pound applied live load in Test 4, the least vertical deflection will determine the winner.

To establish a capacity for the "best capacity-to-weight ratio" category, in the event more than one bridge supports the 2,500 pound load, use the following formula:

Capacity = 3"/actual deflection in inches * 2,500 pounds

The "lowest cost" category is a combination of weight and time. Basis for cost evaluation:

Structural steel, including bolts and welds	$0.40 / pound
Steel cable, including fittings	6.00 / pound
Field labor cost	$0.50 / person-minute
Temporary shoring	No cost
Safety support	No cost

Aesthetics is judged by a non-partisan jury following completion of the bridge, but prior to load testing. It is not necesary to pass the minimum load tests (Test 1, 2 and 3) to win the individual category of aesthetics. (See Judging Form for items to consider.)

SCALE FOR MODEL

for dimensions -- 10:1 (except deflections and tolerances)	10 ft. = 1 ft. 1 ft. = 1.2 in. 1 in. = 0.1 in.
for design loads -- 1000:1	1000 # = 1 # 1 ton = 2 #

PIECE AND UNIT SIZE AND LIFTING LIMITS

Individual Pieces

maximum length	5'-6"	(55')
maximum width and depth	7.5 in.	(6'-3")
maximum piece weight	60 #	(30 tons)

Cable length is not limited, but weight is still limited to 60 # per individual length. Cable may not be pre-attached to structural steel units.

Steel parts may be pre-assembled and treated as an individual piece provided that the assembled unit meets the above criteria and is rigidly bolted or welded together.

It is recommended to the judging panel to penalize accordingly the situations where unit sizes are exceeded. (See Safety and Material Handling Violations.)

Units Assembled in Yard - Handled by 2 or More People

maximum length	11'-0"	(110')
maximum width and depth	3'-6"	(35')
maximum weight	100 #	(50 tons)

Units assembled in yard may consist of combined steel and cable pieces, steel pieces in which the hinge pin has been inserted, or steel units field-bolted together.

It is recommended to the judging panel to penalize accordingly the situations where unit sizes are exceeded. (See Safety and Material Handling Violations.)

Temporary Shoring

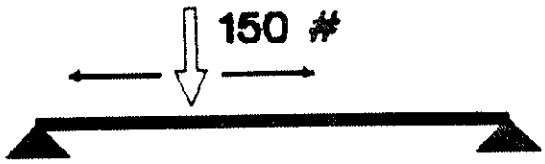
The size and weight of temporary shoring units is not limited. They should be pre-assembled and placed in position prior to the start of competition.

LOAD TESTS

The Safety Support must be in place 3 to 4 inches below the primary bridge steel prior to the start of load testing.

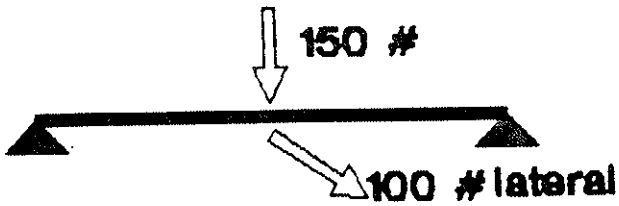
Test 1

Place a single 150# cart or other loading device (representing the 75 ton truck) anywhere on the bridge. Check vertical deflection limits and sidesway limits.



Test 2

With the 150# load still applied from Load Test 1, located at the center of the bridge, tie a rope to a primary structural element near the center of the span. The member shall be designated by the design team. Apply approximately 100# tension to the rope (representing 100,000# lateral force on the bridge.) The 100# tension is roughly equal to a person pulling on the rope horizontally with full effort. Check lateral sidesway limits.

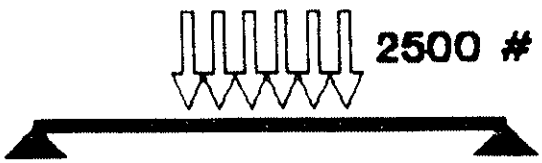


Test 3

Remove the lateral loading from Load Test 2. Add 350# of concentrated load, for a total of 500# (representing the 250 tons), to the center of the bridge. Spread the load over an area not to exceed 3 feet long and 3 feet wide. Check for vertical deflection limits and sidesway.

Test 4

Gradually increase the load, starting at the 500# from Load Test 3, up to 2,500# maximum. Apply this load over an area not to exceed 6 feet long and 3.5 feet wide. Make periodic checks of vertical deflection and sidesway.



TEST DEFLECTION AND SIDESWAY LIMITS

Load Tests 1 through 3 are for the minimum requirements and are conducted first. Deflections are measured at mid-span from the initial as-built position of the bridge, following the placement of the grating or other roadway surface. The vertical deflection under Tests 1, 2 and 3 must not exceed 2 inches. The horizontal sway must not exceed 1 inch.

Load Test 4 is also measured at mid-span from the initial as-built position of the bridge, following placement of the grating. The bridge does not have to pass Load Test 4 to qualify in the competition. The loading is applied until the 2,500# load limit, the maximum permitted vertical deflection of 3 inches, or the maximum permitted sidesway of 2 inches is reached. At 3 inches of vertical deflection, the bridge should be close to resting on its Safety Support.

CONSTRUCTION TOLERANCE

Vertical Alignment

Vertical alignment is measured along the top of the roadway. Establish a theoretical straight line at the top of grating at each abutment. From this line, the actual position of the roadway may be 3 inches higher or 2 inches lower.

Horizontal Alignment

There is no limit to how far the bridge may be out of alignment horizontally. However, bridges out of alignment generally will encounter stability problems.

Grating Placement

The grating (or other roadway surface) must be sufficiently even and smooth to allow for a rolling cart to pass from one end of the bridge to the other. Grating may not be lapped upon itself. Uneven conditions caused by grating placed on bolt heads and nuts will be considered acceptable.

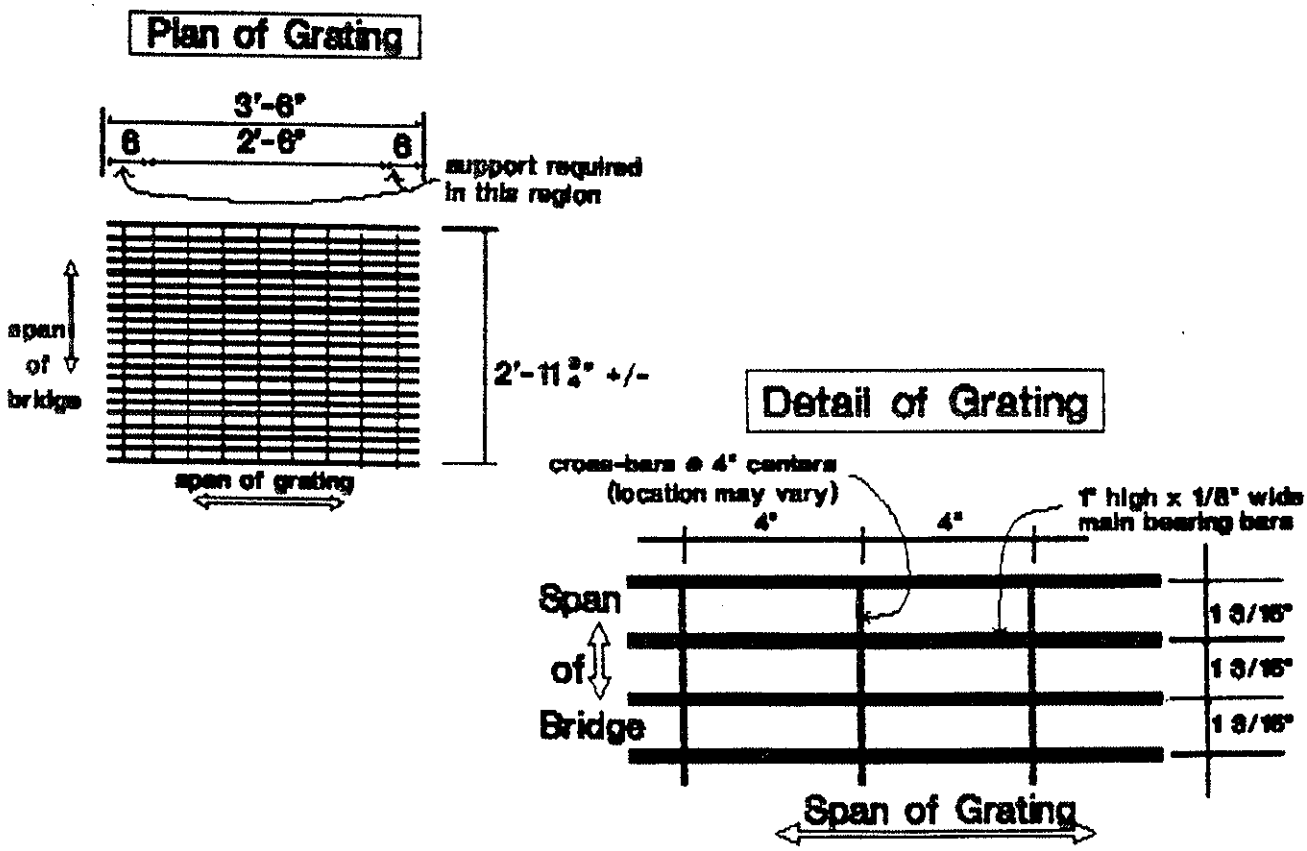
MODULAR DECK UNIT (GRATING)

This item will be supplied by the Host Chapter. If another form of roadway unit is supplied, the Host Chapter will notify entrants.

The grating is generically identified as "W-19-4 (1 x 1/8) steel." Steel bar grating has strength in one direction only, the direction in which the main bearing bars span. Grating will be 3'-6" long, the width of the roadway, spanning this direction. In other words, the grating must span perpendicular to the length of the bridge. Support must be provided under each end of the grating per the sketch on the next page. It is not necessary to support the grating along the sides of the grating. The grating cannot be attached or anchored to the bridge in any way. Each section of grating will be approximately 2'-11-3/4" wide. The grating weighs 4.9 pounds per square foot, so the total weight of each piece of grating will be close to 52 pounds.

For the Load Tests, do not exceed 400 psf uniform load or a 500 pound concentrated point load. Do not load in any cantilever region of the grating.

The maximum clear span for the grating is 3'-6", the entire width of the roadway. The maximum clear cantilever beyond a support is 6 inches.



GENERAL RULES

1. Beginning of Competition

To begin the competition, all bridge materials should be placed in the staging yards. Bridge pieces should be unassembled except within individual piece size and weight limits. For example, gusset plates could be attached to the main member as long as the total individual limits are not exceeded. Structural steel should be sorted and may be pre-arranged in assembly order. Bolts should be sorted according to size and stored in containers or "nail aprons", but not pre-arranged in the steel sections. Grating sections, if included in final construction, should be stacked. Cable should be coiled. Cable may not be pre-attached to the structural steel elements. Cable connecting items such as clamps and sockets may be pre-attached to the cable.

Tools should be in the staging yard. All team members are to start in a staging yard. Shoring, if used, and the Safety Support should be pre-assembled and placed in their final positions on the river banks and river prior to the start of the timed competition.

2. Measurement of Time

Total team time, the numer of team members times the elapsed time, is used. Timing starts when the Team Captain declares the team ready and the Timing Official declares the start. Time stops when the Team Captain declares the bridge construction complete and all team members, tools, and shoring have been returned to a staging yard. The Safety Support is not to be removed. If an unsafe condition arises, the time should be stopped to allow the team to rectify the unsafe condition. If adjustment to the Safety Support is needed, all work shall stop, the clock stopped, and the adjustment made.

3. Measurement of Weight

The total weight of bridge, materials, exclusive of grating or other bridge decking materials, shall be used. Weigh-in of individual pieces may be made prior to assembly, or a weight taken as the bridge sits on the abutments. Cable weight measurement, including cable fittings, clamps, etc., shall be made separately for use in the "cost" category.

4. Materials

All bridge materials must be steel, including framing members, bolts and cable. Cable is defined as a flexible strand material that is easily coiled.

5. Shoring

Each school is responsible for providing its own temporary shoring. Temporary shoring may be of wood or steel, and should be strong enough to support the weight of the bridge. Its weight is not considered a part of the final bridge weight, nor is the time to assemble and place the shoring in advance of the timed competition counted.

Shoring should be made vertically adjustable to compensate for variations in the height of abutments and uneven conditions in the river bank. Particular care should be exercised when making minor adjustments to shoring in order to maintain safe conditions. The use of solid wood blocking and/or steel shims is suggested for minor adjustments.

Shoring must be the final item removed from the erection site to the storage yard, following completion of the bridge erection. Final bolting and adjustments may be made following the removal of shoring, but once the shoring is removed, climbing or sitting on the bridge is not permitted.

6. Safety Support

The Host Chapter will make final design and provide a Safety Support for use in erection and load testing of the bridges. The purpose of this Safety Support is to provide a "fail-safe" support to the bridge and students should the bridge or shoring collapse during construction or during load testing. The Safety Support should have a capacity of at least 6,000 pounds. This is the estimated total of bridge weight, grating weight, load test limit weight, multiplied by a factor of safety of 1.7. The width of the Safety Support should be enough to prevent collapse to the ground, considering possible lateral sidesway of the bridge. The height of the Safety Support should be adjustable, just as shoring is adjustable.

The support is to be placed in the river at mid-span of the bridge, but may be offset as required to miss any bridge elements. The Safety Support is not to be used as a temporary construction shore (see Material Handling Violations.)

The Safety Support should be placed prior to the start of the timed competition, if at all possible. Prior calculation of the required Support elevation, and adjustment to that level, should be made. If the bridge design is such that the Safety Support must be placed after partial assembly of the bridge (say between chords of a truss), the Support must be in place prior to any students sitting or climbing on the bridge. In this situation, the bridge-building team shall stop all work and the clock shall be stopped. The team shall place the Safety Support in position, with material handling rules suspended for this purpose. Following placement, the clock will restart and work may be resumed by the full crew.

7. Tools

Each school is responsible for providing its own tools. Tools must start in the staging yard, but may be stored on the river banks and access roads after the competition begins. Tools may not be tossed or handed across the river except when carried by an individual across the substantially complete bridge. Only hand tools are permitted. Field welding, electric and pneumatic tools are not permitted. Ginpoles, jacks, winches, come-alongs, counterweights and other hoisting devices are not permitted. Simple ropes are permitted as hand tools.

8. Material Handling

Pieces may not be carried by an individual over an abutment. Pieces may be carried by an individual around the wingwall to the river bank. Pieces may also be handed over the abutment from one individual to another.

Materials may not be stored or laid down on the river bank or access roads. The exception to this rule is for bolts, nuts, washers and tools. Materials may be rested on abutments.

9. Movement by Individuals

Individuals must stay within the access road, staging yard and river bank limits. Stepping over the abutment is not permitted, except to climb onto the bridge. If climbing onto the bridge, no materials may be carried with the individual.

Crossing the river at any time is not permitted, except after the bridge is substantially complete. This is defined as when the bridge superstructure will support the full weight of the individual. Temporary scaffolding may not be used across the river, nor can an individual jump across the river.

10. Safety and Material Handling Violations

Violations of material handling and individual movement rules are listed below. Should a team accumulate more than 50 penalty points, the team is eliminated from the "fastest bridge" category. Also, $40.00 will be added to the "cost" of the bridge in the "lowest cost" category. For each additional increment of 50 penalty points, add another $40.00.

A. If an individual drops a tool, bolt, washer or nut into the river, 2 points are assessed, representing the lost time to get a replacement.

B. If a piece or unit, including cable, drops or touches the river, or touches the Safety Support, 5 points are assessed, representing the lost time to repair or replace the item.

C. For other material handling violations, or individual movement violations, 5 points are assessed, representing crane overloads or other safety hazards.

D. If an individual steps into the river, 20 points are assessed, representing a loss of life.

E. If the team exceeds the piece and unit size and lifting limits criteria, 15 points should be assessed.

1991 STEEL BRIDGE BUILDING COMPETITION

for Student Chapters of the American Society of Civil Engineers

SPONSORED BY:
American Institute
of Steel Construction

IN COOPERATION WITH:
American Society
of Civil Engineers

Table of Contents

EXECUTIVE SUMMARY

Civil Engineering students are challenged in a competition that includes design, hands-on experience with structural steel and the use of both actual and simulated construction practices in building a structure. Through the competition, you will utilize materials and design knowledge, construction planning, shop experience, training and teamwork.

In the opening Problem Statement, you are given an orientation into some of the real-life design and construction problems commonly encountered in actual practice. The Statement also establishes some background into the selection of the load tests and design/construction restrictions of the competition. The Problem Statement and related rules, although seemingly complex, are basic to construction practices and are minimal when compared to the volumes of real-life regulations.

Member size and weight limitations are given for several reasons. First, it makes the competition representative of a real situation. Second, it causes you to look at several construction alternatives, rather than using a single member to span the entire 20-foot length. Third, it facilitates the handling and transportation of your structure to the competition site. Fourth, it minimizes the risk to you in handling and assembling the pieces.

Material handling rules and related penalties have been established to maintain the integrity of the construction simulation. These rules are related to actual construction problems, just as members are scaled to model those size limitations found in an actual structure.

Several categories of competition are offered, so you should look at several design alternatives to win any or all of the categories. A latticework structure may be the lightest, but take a long time to build. A cable supported structure may be fast and light, but not meet deflection or stability considerations. Beam-type structures may be fast, but heavy and expensive. Several categories of competition allow you to target your objectives and design/build accordingly.

The competition promises design challenges, steel fabrication experience, the use of construction planning and practice, teamwork, plus the fun of competing against fellow students.

PROBLEM STATEMENT

A century-old bridge across a river valley in a mountainous rural region is in need of replacement. The bridge serves not only area residents but also important heavy truck traffic for area mining. No other river crossing of adequate capacity is available for miles in either direction, therefore a quick replacement is necessary.

The State Department of Transportation has sought design/build proposals to construct a replacement bridge. Any type of steel structure will be permitted, but it must meet the following minimum design loads and construction restrictions:

1. the bridge must support a single 75 ton truck at any point on the bridge,
2. the bridge must support a stationary load applied at or near the center of the bridge totalling 250 tons,
3. the bridge must be able to resist a lateral force of 100,000 pounds from river flooding and/or wind forces,
4. no interior piers are permitted, easing environmental clearances,
5. no lateral thrusts or uplift can be applied to the existing abutments, nor can they be reinforced to accommodate such forces,
6. no backstays or anchorages are available beyond the abutment,
7. construction and live load deflection limits must be met,
8. and the bridge must accommodate state-supplied modular bridge deck units salvaged from another bridge, without modification to any unit.

The existing bridge spans in the north-south direction a distance of 200 feet, resting on simple stone abutments. The valley below is relatively flat, roughly 30 feet below the top of the abutments. The north river bank is 50 feet wide, the river itself is 70 feet wide, and the south bank is 80 feet wide. To allow for mining traffic on the banks below the bridge, and also for river flooding, a minimum clear height of 20 feet from river bank to bottom of bridge is established.

The river is fast, not navigable and environmentally sensitive. Flash flooding and environmental concerns prohibit the use of barges, causeways or scaffolding across the river. Temporary shoring can be safely placed on the solid banks of the river.

Storage and staging yards 150 feet square will be cleared for the contractor's use at both ends of the bridge. The yard at the north end of the bridge will be located just 100 feet from the abutment. The yard at the south end will be 300 feet from the abutment. The service road from both yards to the bridge will be widened to 50 feet, and will extend around one end of the abutment wingwalls down to the river banks.

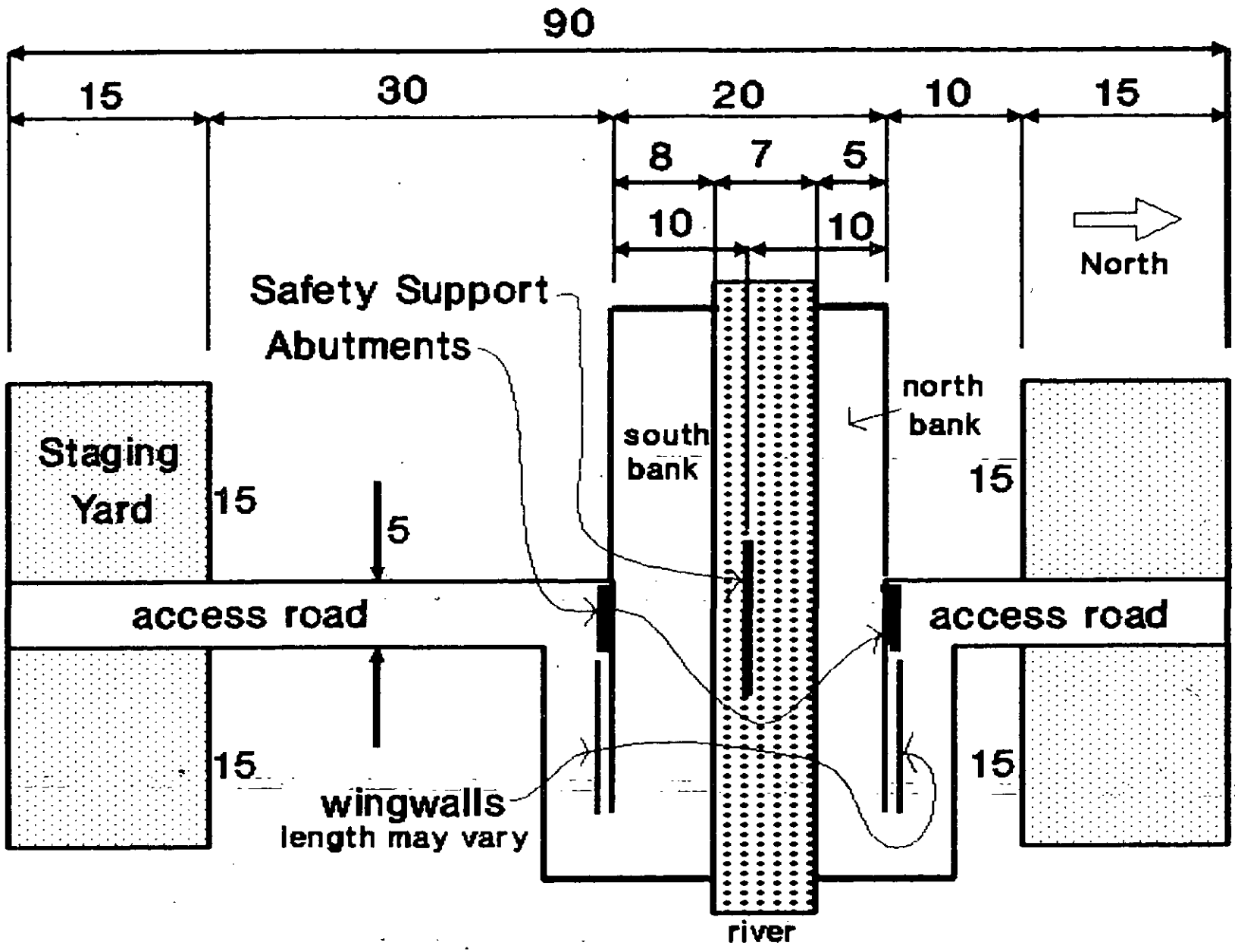
Soil conditions, rough terrain and tight site conditions limit the lifting capacity of all cranes to 30 tons (60,000 pounds). Working in tandem, two cranes could lift a combined total of 50 tons (100,000 pounds). Materials may be delivered by crane to the river valley by using the access roads constructed around the wingwall, or by transferring the materials over the abutments from one crane to the next.

A narrow, winding road leads to the bridge from both directions. Because of this, the length of an individual bridge section is limited to 55 feet, with a maximum width and depth of 6'-3". This enables the trucks to make the required turns. Smaller bridges on both sides of the main bridge being replaced limit the weight of an individual piece to 30 tons (60,000 pounds).

The State will provide prefabricated, 10" deep modular bridge deck units that were salvaged from another bridge. They are the required roadway width, 35 feet in the transverse direction. They are capable of spanning a 35 foot clear distance between supports, and are also capable of cantilevering 5 feet beyond a support. One design drawback to using these units is that can provide no lateral support to the bridge.

To allow for a new bridge design, new approaches will be constructed that can go as high as 7'-1" above the top of the existing abutment. Allowing for the 10" depth of the state-supplied modular deck unit, the structure depth at abutments can be as deep as 6'-3", the same as the maximum member depth.

Your company's design/build proposal has been deemed responsive by the State Department of Transportation. To make a selection, the State has asked your firm and the other competing firms to construct a 1:10 model bridge, demonstrate the erection method to be used, then subject it to load testing. The State is concerned about many things in its evaluation - strength, speed of construction, cost, stiffness, and esthetics. Using a ranking system, it will use the competition to select a contract winner. If your bridge is judged the best, your firm will receive a negotiated contract to build this bridge, and possibly several others. You and your firm could become leaders in the national bridge replacement market.


90
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North
Safety Support
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Staging
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access road
access road
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wingwalls
length may vary
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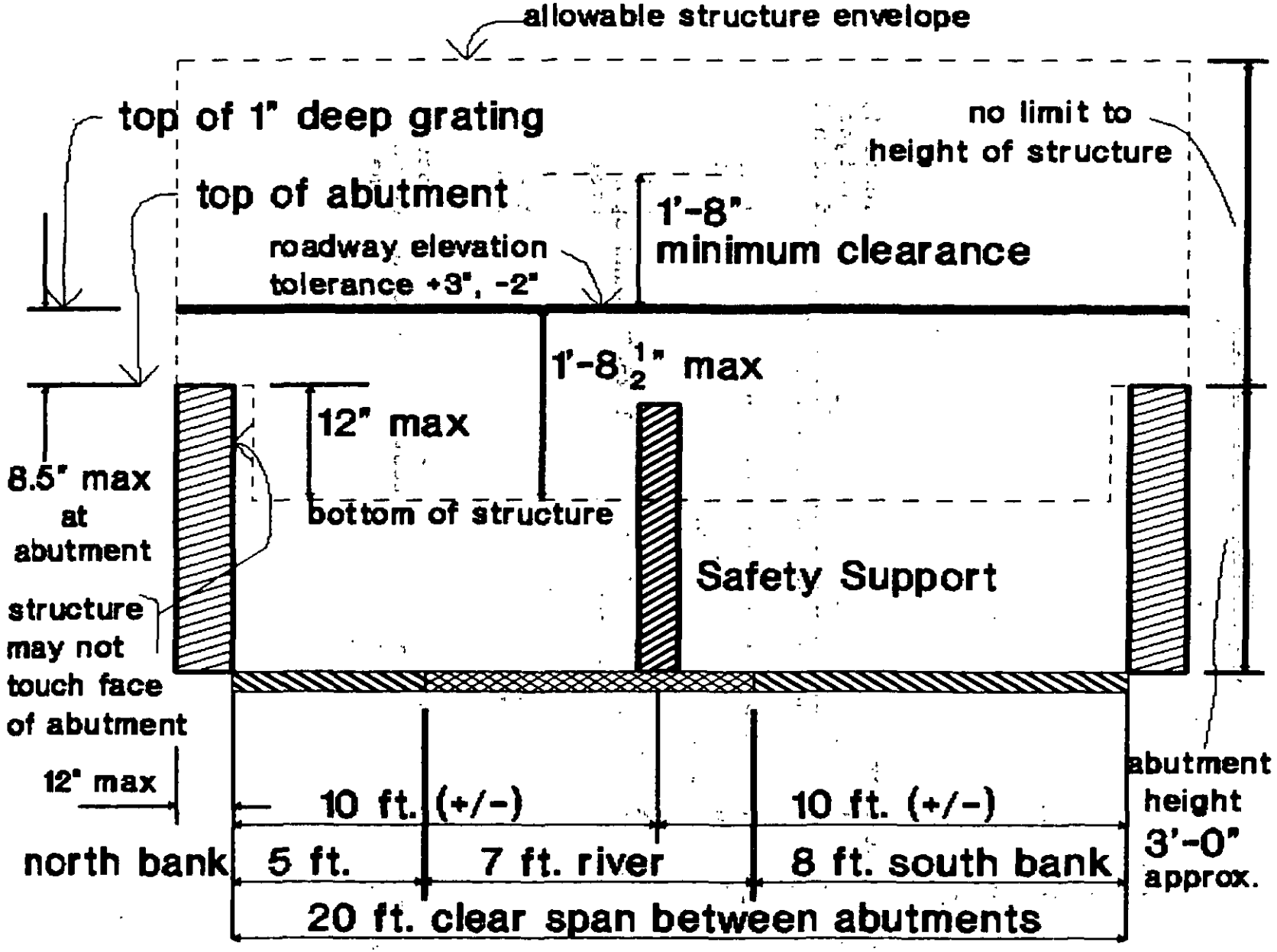
SITE PLAN



BRIDGE AREA CROSS-SECTION

CATEGORIES OF COMPETITION

1. Fastest bridge construction
2. Lightest bridge
3. Highest capacity
4. Best capacity-to-weight ratio
5. Lowest "cost" bridge
6. Esthetics

The bridge must pass the minimum design load tests (Tests 1, 2 and 3) to qualify in Categories 1 through 5. Grating weight is not considered to be a part of the bridge weight, and is not used in determining bridge weights or capacities.

The "fastest bridge construction" category uses total team time, in person-minutes. This is the number of team members times the amount of time used to erect the bridge.

For the "highest capacity" category, in the likely event that more than one bridge supports the total 2500 pound applied live load in Test 4, the least vertical deflection will determine the winner.

The "lowest cost" category is a combination of weight and time. See the "Basis for Total Cost Evaluation" section for more information.

Esthetics is judged by a non-partisan jury following completion of the bridge, but prior to load testing. It is not necessary to pass the minimum load tests (Test 1, 2 and 3) to win the individual category of esthetics.

SCALE FOR MODEL

for dimensions -- 10:1 (except deflections and tolerances)	10 ft. = 1 ft. 1 ft. = 1.2 in. 1 in. = 0.1 in.
for design loads -- 1000:1	1000 # = 1 # 1 ton = 2 #

PIECE AND UNIT SIZE AND LIFTING LIMITS

Individual Pieces

maximum length	5'-6"	(55')
maximum width and depth	7.5 in.	(6'-3")
maximum piece weight	60 #	(30 tons)

Cable length is not limited, but weight is still limited to 60 # per individual length. Cable may not be pre-attached to structural steel units.

Steel units may not be "pre-hinged" for "unfolding" to allow multiples of steel pieces to fit within these individual limits. Steel parts may be preassembled and treated as an individual piece provided that the assembled unit meets the above criteria and is rigidly bolted or welded together.

Units Assembled in Yard - handled by two or more people

maximum length	11'-0"	(110')
maximum width and depth	3'-6"	(35')
maximum weight	100 #	(50 tons)

Units assembled in yard may consist of combined steel and cable pieces, steel pieces in which the hinge pin has been inserted, or steel units field-bolted together.

Temporary Shoring

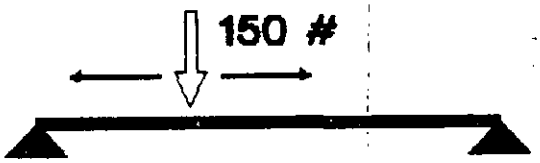
The size and weight of temporary shoring units is not limited. They should be pre-assembled and placed in position prior to the start of competition.

LOAD TESTS

The Safety Support must be in place 3 to 4 inches below the primary bridge steel prior to the start of load testing.

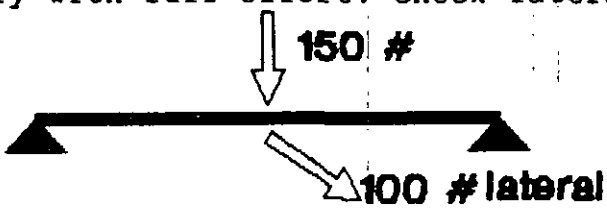
Test 1

Place a single 150# cart or other loading device (representing the 75 ton truck) anywhere on the bridge. Check vertical deflection limits and sidesway limits.



Test 2

With the 150# load still applied from Load Test 1, located at the center of the bridge, tie a rope to a primary structural element near the center of the span. The member shall be designated by the design team. Apply approximately 100# tension to the rope (representing 100,000# lateral force on the bridge). The 100# tension is roughly equal to a person pulling on the rope horizontally with full effort. Check lateral sidesway limits.

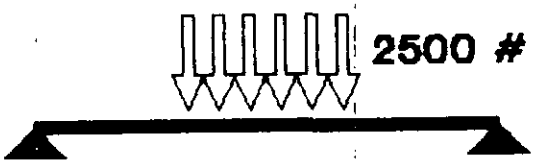


Test 3

Remove the lateral loading from Load Test 2. Add 350# of concentrated load, for a total of 500# (representing the 250 tons), to the center of the bridge. Spread the load over an area not to exceed 3 feet long and 3 feet wide. Check for vertical deflection limits and sidesway.

Test 4

Gradually increase the load, starting at the 500# from Load Test 3, up to 2500# maximum. Apply this load over an area not to exceed 6 feet long and 3.5 feet wide. Make periodic checks of vertical deflection and sidesway.



TEST DEFLECTION AND SIDESWAY LIMITS

Load Tests 1 through 3 are for the minimum requirements and are conducted first. Deflections are measured at mid-span from the initial as-built position of the bridge, following the placement of the grating or other roadway surface. The vertical deflection under Tests 1, 2 and 3 must not exceed 2 inches. The horizontal sway must not exceed 1 inch.

Load Test 4 is also measured at mid-span from the initial as-built position of the bridge, following placement of the grating. The bridge does not have to pass Load Test 4 to qualify in the competition. The loading is applied until the 2500# load limit, the maximum permitted vertical deflection of 3 inches, or the maximum permitted sidesway of 2 inches is reached. At 3 inches of vertical deflection, the bridge should be close to resting on its Safety Support.

CONSTRUCTION TOLERANCES

Vertical Alignment

Vertical alignment is measured along the top of the roadway. Establish a theoretical straight line at the top of grating at each abutment. From this line, the actual position of the roadway may be 3 inches higher or 2 inches lower.

Horizontal Alignment

There is no limit to how far the bridge may be out of alignment horizontally. However, bridges out of alignment generally will encounter stability problems.

Grating Placement

The grating (or other roadway surface) must be sufficiently even and smooth to allow for a rolling cart to pass from one end of the bridge to the other. Grating may not be lapped upon itself. Uneven conditions caused by grating placed on bolt heads and nuts will be considered acceptable.

BASIS FOR TOTAL COST EVALUATION
used for Competition Category 5

Structural steel, including bolts and welds	$0.40 / pound
Steel cable, including fittings	6.00 / pound

Shop labor cost is not a factor (assume paid by federal grant).

Field labor cost	$0.50 / person-minute
Temporary shoring	no cost
Safety Support	no cost

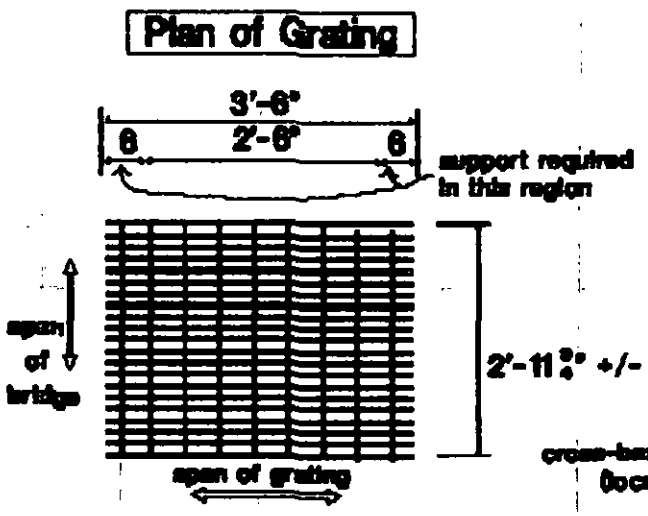
MODULAR DECK UNIT (GRATING)

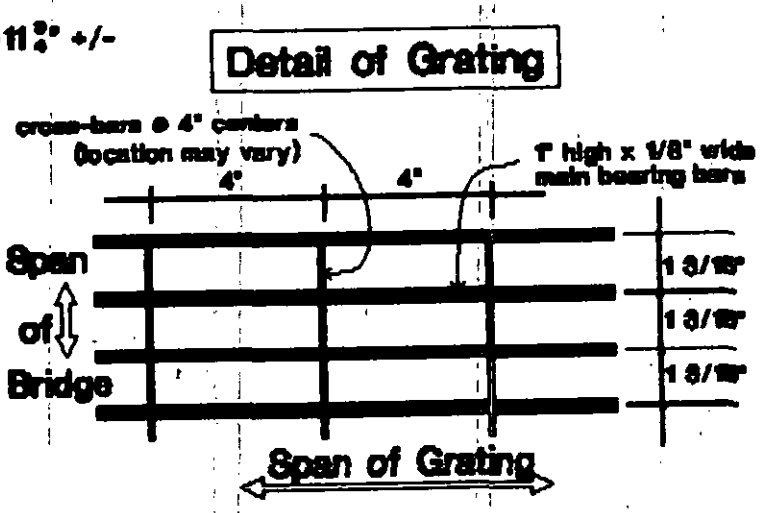
This item will be supplied by the Host Chapter. If another form of roadway unit is supplied, the Host Chapter will notify entrants.

The grating is generically identified as "W-19-4 (1 x 1/8) steel". Steel bar grating has strength in one direction only, the direction in which the main bearing bars span. Grating will be 3'-6" long, the width of the roadway, spanning this direction. In other words, the grating must span perpendicular to the length of the bridge. Support must be provided under each end of the grating per the sketch below. It is not necessary to support the grating along the sides of the grating. The grating cannot be attached or anchored to the bridge in any way. Each section of grating will be approximately 2'-11-3/4" wide. The grating weighs 4.9 pounds per square foot, so the total weight of each piece of grating will be close to 52 pounds.

For the Load Tests, do not exceed 400 psf uniform load or a 500 pound concentrated point load. Do not load in any cantilever region of the grating.

The maximum clear span for the grating is 3'-6", the entire width of the roadway. The maximum clear cantilever beyond a support is 6 inches.





General Rules

1. Beginning of Competition

To begin the competition, all bridge materials should be placed in the staging yards. Bridge pieces should be unassembled except within individual piece size and weight limits. For example, gusset plates could be attached to the main member as long as the total individual limits are not exceeded. Structural steel should be sorted and may be pre-arranged in assembly order. Bolts should be sorted according to size and stored in containers or "nail aprons", but not pre-arranged by the steel sections. Grating sections, if included in final construction, should be stacked. Cable should be coiled. Cable may not be pre-attached to the structural steel elements. Cable connecting items such as clamps and sockets may be pre-attached to the cable.

Tools should be in the staging yard. All team members are to start in a staging yard. Shoring, if used, and the Safety Support should be pre-assembled and placed in their final positions on the river banks and river prior to the start of the timed competition.

2. Measurement of Time

Total team time, the number of team members times the elapsed time, is used. Timing starts when the Team Captain declares the team ready and the Timing Official declares the start. Time stops when the Team Captain declares the bridge construction complete and all team members, tools, and shoring have been returned to a staging yard. The Safety Support is not to be removed. If an unsafe condition arises, he time should be stopped to allow the team to rectify the unsafe condition. If adjustment to the Safety Support is needed, all work shall stop, the clock stopped and the adjustment made.

3. Measurement of Weight

The total weight of bridge materials, exclusive of grating or other bridge decking materials, shall be used. Weigh-in of individual pieces may be made prior to assembly, or a weight taken as the bridge sits on the abutments. Cable weight measurement, including cable fittings, clamps etc., shall be made separately for use in the "cost" category.

4. Materials

All bridge materials must be steel, including framing members, bolts and cable. Cable is defined as a flexible strand material that is easily coiled.

5. Shoring

Each school is responsible for providing its own temporary shoring. Temporary shoring may be of wood or steel. Its weight is not considered a part of the final bridge weight, nor is the time to assemble and place the shoring in advance of the timed competition counted.

Shoring should be made vertically adjustable to compensate for variations in the height of abutments and uneven conditions in the river bank. The use of solid wood blocking and/or steel shims is suggested for minor adjustments.

Shoring must be the final item removed from the erection site to the storage yard, following completion of the bridge erection. Final bolting and adjustments may be made following the removal of shoring, but once the shoring is removed, climbing or sitting on the bridge is not permitted.

6. Safety Support

The Host Chapter will make final design and provide a Safety Support for use in erection and load testing of the bridges. The purpose of this Safety Support is to provide a "failsafe" support to the bridge and students should the bridge or shoring collapse during construction or during load testing. The Safety Support should have a capacity of at least 6000 pounds. This is the estimated total of bridge weight, grating weight, load test limit weight, multiplied by a factor of safety of 1.7. The width of the Safety Support should be enough to prevent collapse to the ground, considering possible lateral sidesway of the bridge. The height of the Safety Support should be adjustable, just as shoring is adjustable.

The Support is to be placed in the river at mid-span of the bridge, but may be offset as required to miss any bridge elements. The Safety Support is not to be used as a temporary construction shore (see Material Handling violations).

The Safety Support should be placed prior to the start of the timed competition, if at all possible. Prior calculation of the required Support elevation, and adjustment to that level, should be made. If the bridge design is such that the Safety Support must be placed after partial assembly of the bridge (say between chords of a truss, the Support must be in place prior to any students sitting or climbing on the bridge. In this situation, the bridge-building team shall stop all work and the clock shall be stopped. The team shall place the Safety Support in position, with material handling rules suspended for this purpose. Following placement, the clock will restart and work may resume by the full crew.

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Each school is responsible for providing its own tools. Tools must start in the staging yard, but may be stored on the river banks and access roads after the competition begins. Tools may not be tossed or handed across the river except when carried by an individual across the substantially complete bridge. Only hand tools are permitted. Field welding, electric and pneumatic tools are not permitted. Ginpoles, jacks, winches, come-alongs, counterweights and other hoisting devices are not permitted. Simple ropes are permitted as hand tools.

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C -- For other material handling violations or individual movement violations, 5 points are assessed, representing crane overloads or other safety hazards.

D -- If an individual steps into the river, 20 points are assessed, representing a loss of life.

BRIDGE-BUILDING TIPS

There are many bridge designs which could be suitable for the competition. Among these are beam-and-girder bridges, trusses of endless varieties, king-post and queen-posts, box girders, pre-tensioned steel, arches, and cable-supported bridges.

Some bridge-building tips have been learned in previous competitions:

1. Try to keep the number of pieces to be field-assembled to a minimum. Match-mark those pieces whenever possible to insure proper installation.

2. Keep the number of field bolts to a minimum. It may not be necessary to have a minimum two-bolt connection at every joint, especially for secondary members. Consider color-coding bolt heads if two different bolt diameters are used. It may not be necessary to fully tighten every bolt. Some may need to be only finger-tight.

3. Make your bolt holes sufficiently larger than the bolt diameter to ease installation. Putting 5/16 inch diameter bolts through holes drilled 21/64th in two or more layers of steel is not an easy task.

4. Try to keep your bridge weight below 500 pounds. Bridges in the range of 300 to 400 pounds are becoming more common. The lightest bridge to date has been less than 200 pounds.

5. Try to keep elapsed construction time under 20 minutes, not only to be competitive but to speed up the competition day's activities. The best elapsed time to date was under six minutes, and used a team of five. Practice your bridge erection under simulated erection conditions to reduce your construction time and uncover fabrication and construction errors. Make sure you practice all safety guidelines.

6. After you have completed your bridge superstructure and removed the shoring, preload your bridge with an appropriate number of team members to minimize the possibility of any joint slippage. Do not remove the Safety Support. Remember, once the shoring is removed, climbing or sitting on the bridge is prohibited. Make sure you don't overload your bridge or cause it to exceed the allowable construction tolerances. Having it sag down to the Safety Support will cause a penalty to be assessed.

7. Bridge painting is a nice touch for esthetics. School colors, names, logos and similar items add to the spirit of competition.

8. To speed things along on competition day, have a preset plan for unloading, staging and erecting your bridge. Know in advance the required elevations of shoring and Safety Support, relative to the abutments, so that they can be quickly placed and adjusted.

9. Allow some tolerance for the grating or other bridge deck to be slightly larger than planned. Make sure you have enough clearance between structural members, bolt heads and shanks to place the grating on the bridge. Review the required orientation of the grating to make sure you have supported it near the ends of the main bearing bars, along the sides of the bridge.

10. If using cable for primary structural elements, remember that cable can stretch considerably under load. Loosely wound cable strands stretch the most. Rods or small flat stock bars may be a suitable alternative.

11. Tubes that use "sleeve"-type compression joints go together quickly and may not need bolting together. Finding the right size tubing material may be more difficult than finding other structural shapes.

12. Start design early in the year and find a nearby supplier for your materials. This will minimize costs for everyone and eliminate the last-minute rush-job syndrome.

Several factors should be considered when you determine the type of bridge you will build. What facilities are available to you to build your bridge? Are welders, torches, drills and other tools available in your shop or laboratory? How thick can the pieces be for the equipment you have? Do you have a nearby scrap yard, steel fabricator, steel erector, machine shop or contractor for materials and to help with difficult pieces? These firms are to help you (note - not do it for you). Steel purchased outright can cost 25 cents per pound and up, unless subsidized by your supplier.

Designing, fabricating and building your bridge can be a fun learning experience. Start early, plan, design, evaluate, build, and practice. Enjoy the challenge and the competition.

NOTES FOR HOST CHAPTER

1. The problem statement, rules, dimensions, loads, competition categories, construction details, etc. given to you in this document have been previously tested in competition. A few items have been added from the 1988-1989 competitions to clear up rule ambiguities and correct gaps in the rules. You can use the rules verbatim, but you are free to modify the competition to suit your own abilities and facilities, and also those of the schools in your area. Make sure when making changes that you do not sacrifice safety with any changes you make.

2. Judges can come from a variety of sources, including your local ASCE Chapter. They can be local designers, engineers, contractors or unbiased faculty and students. Select one person to be the Chief Official to be the final voice for rules interpretation.

3. Abutments can be of any convenient material such as steel sawhorses or beams, timber blocking, masonry blocks or some other combination of these materials. Abutments should be 3 - 12 inches wide and a minimum of 5 feet long. The top should be smooth and dead level. The height of opposite abutments should be within 3 inches of one another. If the abutments are not level, twisting of the bridge along its length could make fit-up and assembly difficult and could affect its strength. Use of a carpenter's level and string level, or transit, is recommended. If your Regional Conference has not already secured a set of abutments for use in bridge-building competitions, local steel fabricators are generally willing to loan steel sawhorses from their shop.

Each abutment should be capable of supporting 2000 pound point loads, and at least 4000 pounds total. Make sure the abutments are stable and will not fall if inadvertently laterally loaded during construction or load testing. The abutments should rest on solid pavement or ground to minimize the possibility of sinking during loading.

4. The method of applying loads during load testing is very important. Your available resources will determine this for you. Steel scrap beams, steel scrap pieces or hole punchings in gunny sacks, concrete blocks, sand bags, tractor weights, water in drums, hydraulic rams, etc. are possibilities. The time needed to apply loads, the safety of the students working with the loading material, measurability and repeatability are important. Make each unit of weight low enough that one individual can lift the weight. Load materials, equipment (and people) should not be damaged if the bridge suddenly fails onto the Safety Support.

5. The competition site should be fairly accessible for delivery of materials. It should be relatively level to help leveling abutments, shoring and the Safety Support. Parking lots generally work well. In grassy areas, bolts and small parts can be lost, and abutments can sink into the ground. Permit the layout of materials in the staging yards and the placement of shoring and Safety Support in advance of the timed competition. Use a taut string line between abutments to set the line for placing shoring and the Safety Support.

Markings noting the staging yards, access roads, river, wingwall and other areas can be done with chalk, broad masking tape or anything else available. A wooden strip toeboard, at river's edge, can serve as a definitive line for the river and also help judges detect violations.

6. Straightness for construction tolerances can best be determined by string line attached to the abutments. A string line attached to the bridge ends with a C-clamp can be used for lateral sidesway measurement. For deflections under load testing, use a transit or level observing a marker attached to the bridge or a rod placed periodically on the bridge in the identical location each time. Make an initial reading after placement of the grating, then make and record periodic readings to detect when the bridge might fail, as well as determine the winner.

7. The roadway decking as described for this competition is steel bar grating, generically identified as "W-19-4 (1 x 1/8) steel". Seven pieces 3'-6" in length and 2'-11 3/4" wide are required for a complete bridge. As these pieces of grating are reusable, one set of seven pieces should be sufficient for the competition unless you plan simultaneous load testing. You may wish to consider getting one extra piece in case one gets damaged. You should be able to secure this grating from a local steel fabricator or supplier.

Alternative roadway decking materials could be timber planking, heavy or laminated plywood, or some other suitable product. If alternative decking is used, all competing schools will need plenty of advance notice regarding its size, support requirements, clearance needs and strength.

8. Depending upon the number of entries, you should determine an appropriate schedule for the competition. You may wish to schedule simultaneous construction of two or bridges, on separate abutments, if you have several entrants. The more bridge-building sites you have available, the faster the competition will go.

Unloading, set-up and layout in the staging yards can be time-consuming for complicated bridges and unpracticed teams. Two separate staging yards are provided at each end of a site. This enables two schools to get set up for the competition at each abutment, saving set-up time.

To help keep your competition on schedule, consider setting a cut-off time for bridge construction, say 30 minutes per bridge. Once this period is exceeded, suspend the construction rules and eliminate the bridge from "cost" and "speed" categories. It probably isn't competitive in these categories anyhow.

Another way to speed the competition along is to remove each completed bridge, without grating, from the abutments into a temporary storage area. Several students will be needed to lift and carry a bridge, of course. By doing this, all bridges will be built first, then all bridges will be load-tested. You may have to provide short blocks on which to set the bridges during storage.

9. Bathroom scales will probably be accurate enough to weigh each bridge. In the unloaded condition, without grating, lift up one end of the bridge and place a scale underneath each support point (typically two). Then do this at the other end of the bridge and sum the readings. If you have larger scales available, you may wish to weigh individual pieces prior to construction and sum the weights.

10. Record-keeping forms should be distributed to judges and each team. Suggested forms are available from AISC.

11. To determine an overall winner, use a point system. One suggestion is to award points for various places in each category, then add each team's points. A sample point system is also available from AISC.