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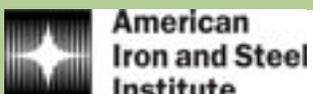
American Society of Civil Engineers

# STUDENT STEEL BRIDGE COMPETITION RULES



FOR STUDENT CHAPTERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS

## CO-SPONSORS



# STUDENT STEEL BRIDGE COMPETITION

## 2005 RULES

<http://www.aisc.org/steelbridge.html>

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## **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

$$C_c = \text{Construction time (minutes, including penalties)} \\ \times \text{Number of builders (persons)} \\ \times 50 \text{ thousand dollars per person-minute}$$

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

$$C_s = W \times \Delta \times 10 \text{ thousand dollars per pound-inch, where} \\ W = \text{the larger of total weight } \underline{\text{OR}} \text{ 80 pounds.} \\ \Delta = \text{the larger of aggregate deflection } \underline{\text{OR}} \text{ 0.25 inch.}$$

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  $DL = \text{absolute value of vertical deflection of the leftmost target from its position at the start of step 1}$ .

## 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<sub>c</sub> = \_\_\_\_\_ 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<sub>s</sub> = \_\_\_\_\_ thousand \$  
Lowest cost wins.

**16.7. Overall Performance**

C<sub>c</sub> (from part 16.5) \_\_\_\_\_ + C<sub>s</sub> (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.

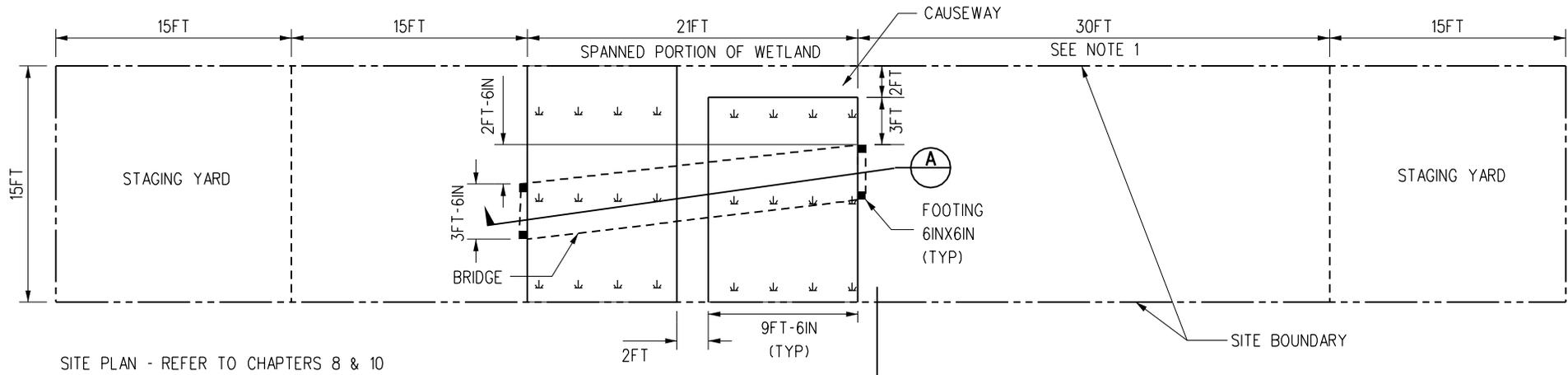
Aesthetics \_\_\_\_\_ Construction Speed \_\_\_\_\_

Lightness \_\_\_\_\_ Stiffness \_\_\_\_\_

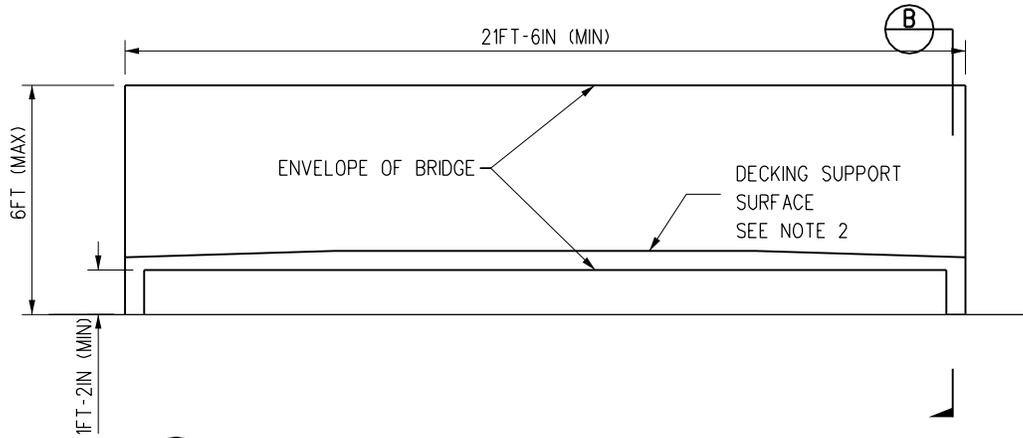
Construction Economy \_\_\_\_\_ Structural Efficiency \_\_\_\_\_

Overall Performance \_\_\_\_\_

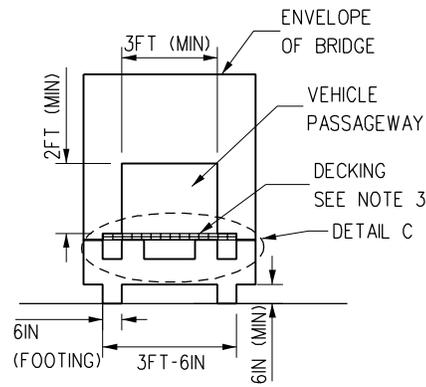
\_\_\_\_\_  
This Score Sheet implements chapter "6 Scoring." A comparable spreadsheet is available at <http://www.aisc.org/steelbridge.html>.



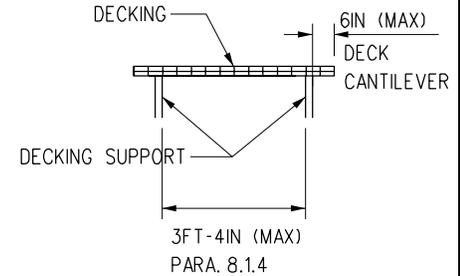
SITE PLAN - REFER TO CHAPTERS 8 & 10  
SCALE: 1IN = 10 FEET



**A** ELEVATION - REFER TO CHAPTER 8  
SCALE: 1IN = 5 FT

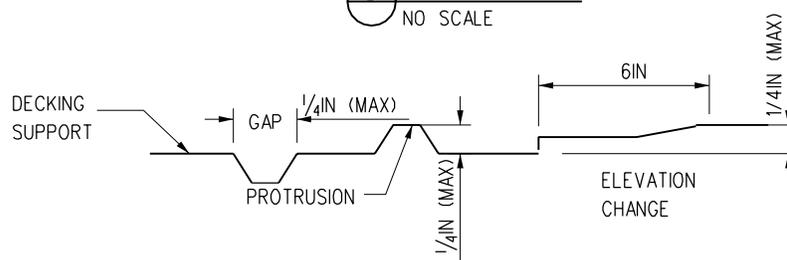


**B** END VIEW  
NO SCALE



**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"  $\pm$  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

CONTRACT NO  
2005

DRAWING NO  
EXHIBIT 1

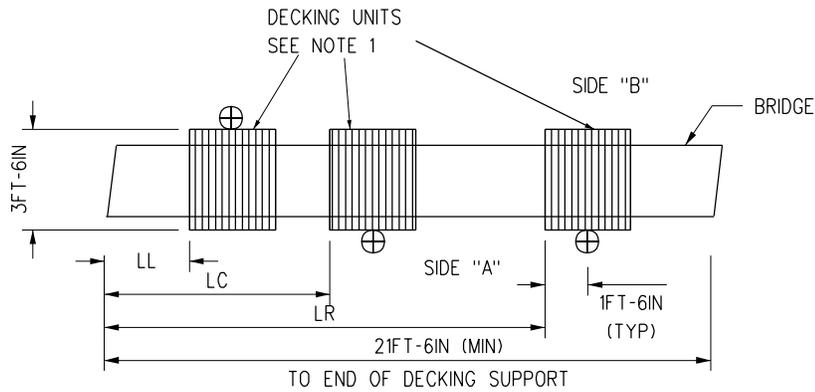
SCALE  
AS SHOWN

SHEET NO

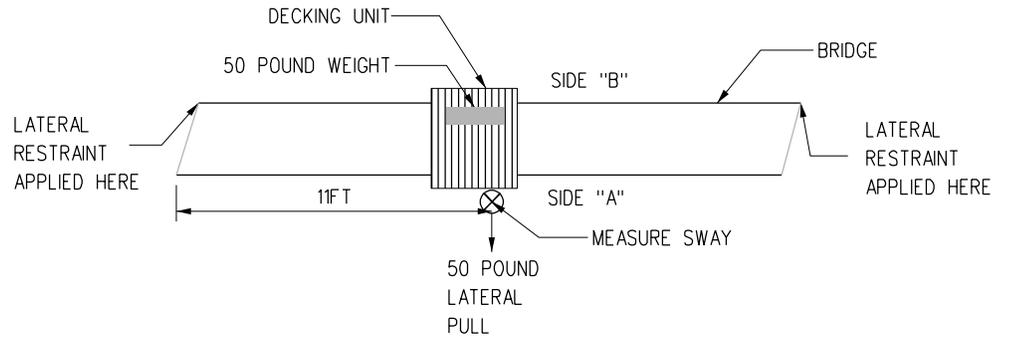
SITE AND BRIDGE  
DIAGRAM

CONTRACT NO 2005	REV
DRAWING NO EXHIBIT 1	
SCALE AS SHOWN	
SHEET NO	

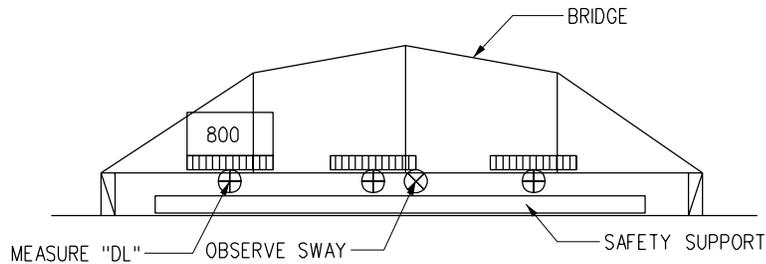
DRAWN BY: ROSENBERG



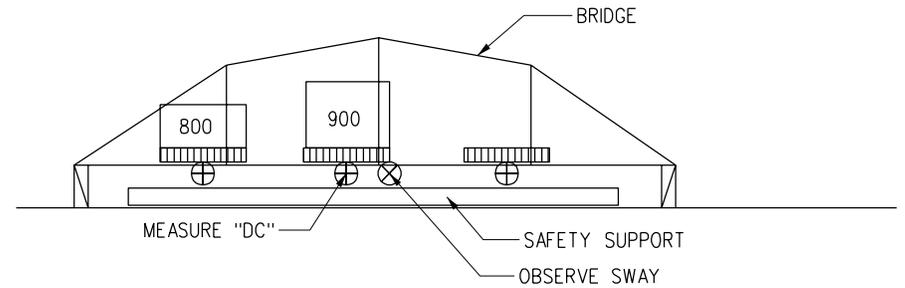
**A** LOCATIONS OF TARGETS AND DECKING - PLAN  
REFER TO CHAPTER 11, SECTIONS 3 & 5



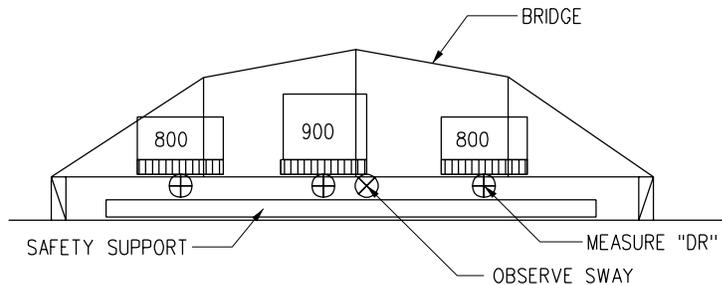
**B** LATERAL LOAD TEST - PLAN  
CHAPTER 11, SECTIONS 3 & 4



**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**

SUBMITTED \_\_\_\_\_  
 APPROVED \_\_\_\_\_

BRIDGE LOADING  
DIAGRAM

CONTRACT NO. 2005	REV
DRAWING NO. EXHIBIT 2	
SCALE AS SHOWN	
SHEET NO.	

DRAWN BY: RUSSELL