

STUDENT STEEL BRIDGE COMPETITION

2006 RULES

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

TABLE OF CONTENTS

	<u>page</u>
1. Introduction	2
2. Executive Summary	3
3. Rule Changes	3
4. Problem Statement	4
5. Safety	4
6. Scoring	5
7. Schedule of Competition	7
8. Dimensions and Support	8
9. Material and Components	10
10. Construction	13
11. Load Tests	18
12. Equipment Provided by Host	24
13. Interpretation of Rules	25
14. Judging	25
15. Appeals	26
16. Score Sheet	28
APPENDIX –	
Site and Bridge Diagram	30
Bridge Loading Diagram	31

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

$$C_C = \text{Total time (minutes)} \times \text{Number of builders (persons)} \\ \times 50 \text{ thousand dollars per person-minute} \\ + 100 \text{ thousand dollars if a temporary pier is used.}$$

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

$$C_S = \text{Total weight (pounds)} \times \text{Aggregate deflection (inches)} \\ \times 20 \text{ thousand dollars per pound-inch}$$

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 distribute 100 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)

- 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

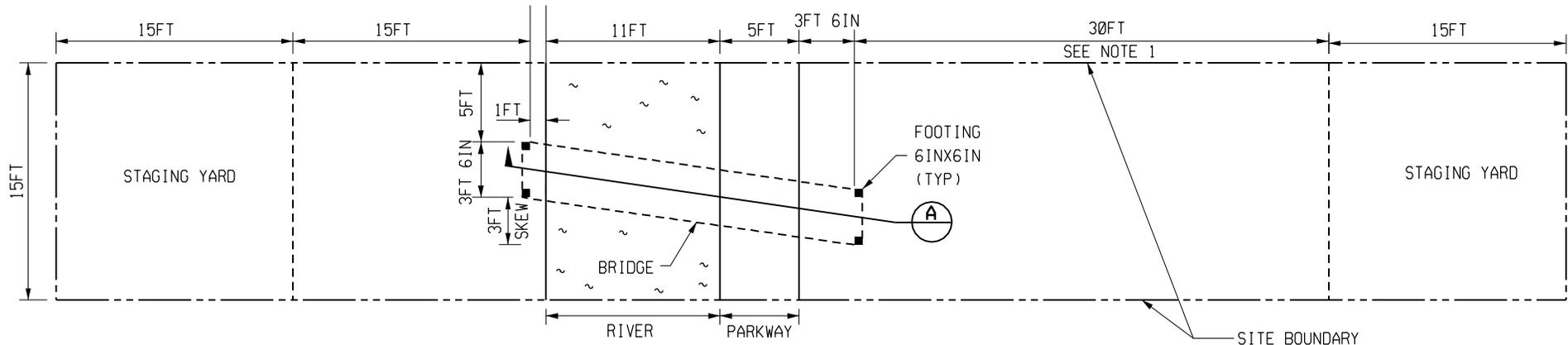
AESTHETICS SCORE = _____

16.2. Construction Speed and Time Penalties

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)		
Time penalties during construction (see 10.9)		_____ minutes
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.		

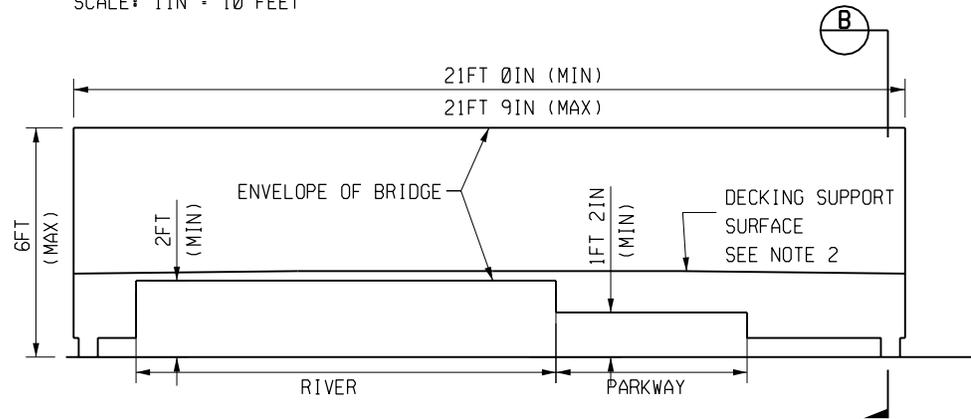
16.3. Construction Economy

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.		

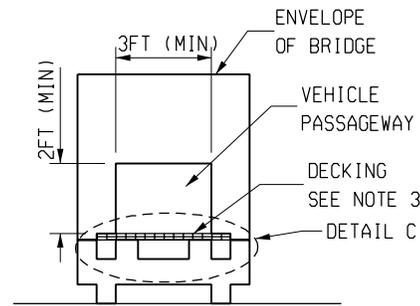


SITE PLAN - REFER TO CHAPTERS 8 & 10

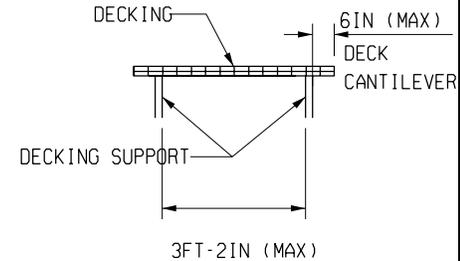
SCALE: 1IN = 10 FEET



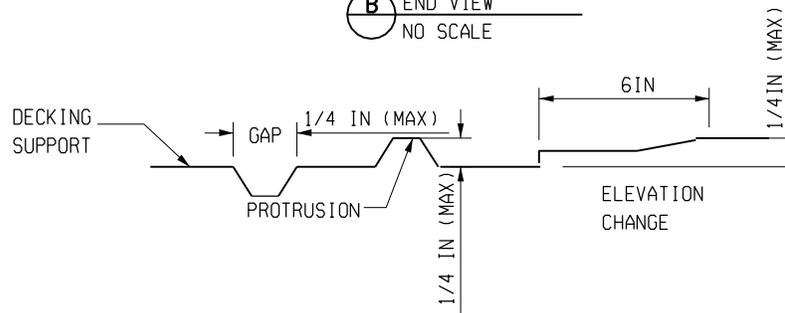
A ELEVATION - REFER TO CHAPTER 8
SCALE: 1 IN = 5 FT



B END VIEW
NO SCALE



C DECKING SUPPORT
NO SCALE



IRREGULARITIES IN DECKING SUPPORT - REFER TO CHAPTER 8

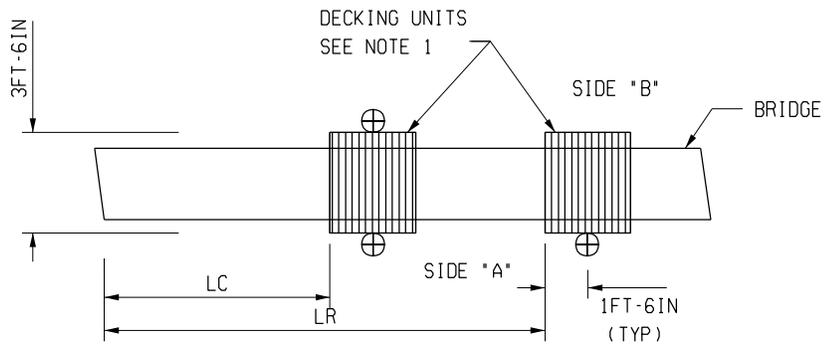
SCALE: NONE

NOTES:

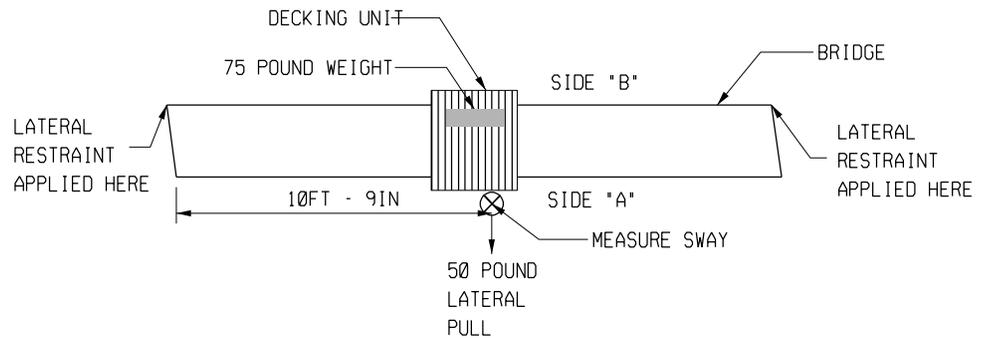
1. LENGTH CAN BE ADJUSTED TO FIT SITE CONDITIONS.
2. TOP OF THE DECKING SUPPORT SHALL BE BETWEEN 2FT-3IN AND 2FT - 6IN ABOVE GRADE.
3. BRIDGE SHALL ACCOMODATE 3FT- 9IN DECKING THROUGHOUT OVERALL LENGTH OF THE BRIDGE.

										DESIGNED BY F. HATFIELD	ACE - AISC NATIONAL STUDENT STEEL BRIDGE CONTEST  		CONTRACT NO 2005	
										DRAWN BY D. SEPULVEDA				
										CHECKED BY RULES COMM.	SUBMITTED _____ APPROVED _____		REV	
										IN CHARGE F. ROSENBERG			AS SHOWN	
										DATE 7-01-2005	SCALE AS SHOWN		SHEET NO	
REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION							
A	7-01-05						2006 NSSBC RULES							

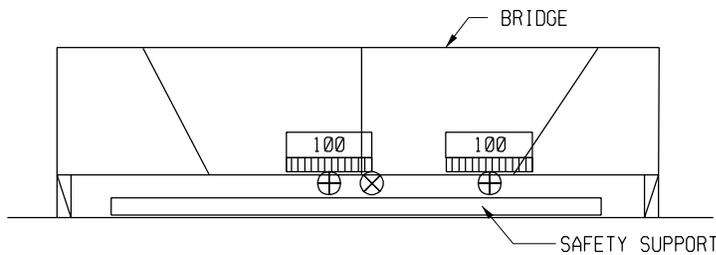
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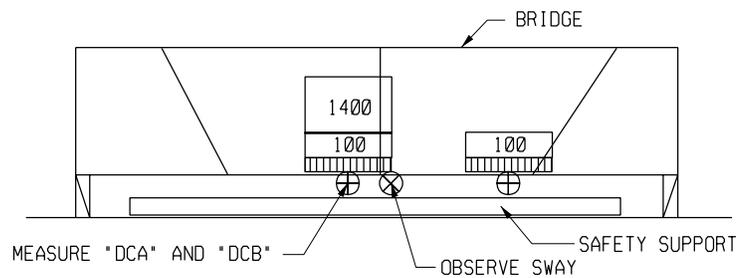
A LOCATIONS OF TARGETS AND DECKING - PLAN
REFER TO CHAPTER 11, SECTIONS 3 & 5



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



0 VERTICAL LOAD TEST - PRELOAD
REFER TO NOTES DURING LOADING PROCESS



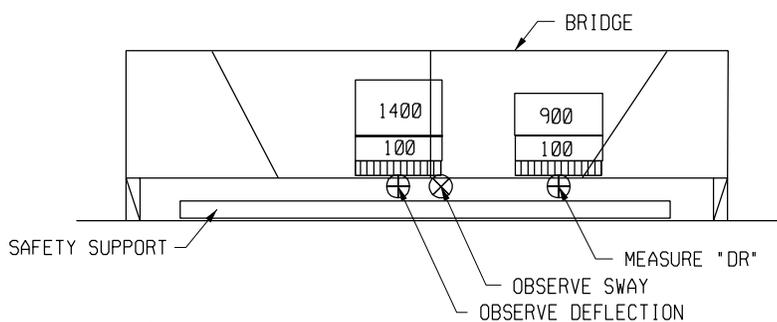
1 VERTICAL LOAD TEST - STEP 1
REFER TO NOTES DURING LOADING PROCESS

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.



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

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

ACE - AISC
 NATIONAL STUDENT STEEL BRIDGE CONTEST

SUBMITTED _____
 APPROVED _____

BRIDGE LOADING
 DIAGRAM

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

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