RULES

AISC STUDENT STEEL BRIDGE

COMPETITION

2001

Version 1.1

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I. INTRODUCTION

The Student Steel Bridge Competition is sponsored by the American Institute of Steel Construction and co-sponsored by the American Society of Civil Engineers, the American Iron and Steel Institute, the James F. Lincoln Arc Welding Foundation, the National Steel Bridge Alliance, Nucor Corporation and Chaparral Steel. This inter-collegiate challenge requires Civil Engineering students to design, fabricate and construct a steel bridge.

Safety is of primary importance. The AISC requests that competitors, hosts and judges take all necessary precautions to prevent injury.

The competition rules, particularly the scoring, have been changed for 2001 in order to improve the contest and assure that competitors design and build new bridges.

Students design the bridge themselves but may seek advice from faculty and other consultants.

Ideally, students should fabricate the entire bridge themselves. However, appropriate shop facilities and supervision may not be available at every college and university. Therefore, the services of a commercial fabricator may be used provided that students observe the operations. Students are encouraged to maximize their personal involvement in fabricating their bridge.

There are two levels of competition: regional and national. Regional winners and runners-up are invited to compete at the national level. These *Rules* govern competition at both regional and national levels. A university may enter more than one bridge in regional competition but only the best one may qualify for national competition.

This booklet describes the contest and states the official rules for this year. It is distributed to universities throughout the country. A companion booklet, *Guide for Hosts and Judges*, is distributed to hosts and provides directions for conducting a competition.

The rules are intended to be prescriptive but may require some interpretation. The procedure for requesting clarification of the rules is described in section “XI Interpretation of Rules” (**p. 20**).

The ASCE student chapters and clubs entering the contest are required to be, or to become, current with their chapter or club dues. Teams may consist only of undergraduate and/or graduate students.

II. EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication and construction. Participating students gain practical experience in structural design, fabrication processes, construction planning, organization and teamwork.

The "Problem Statement" describes challenges encountered in a representative structural engineering project. The competition is a scaled simulation of that project.

Standards for strength, durability, constructability, usability, functionality and safety reflect the volumes of regulations that govern the design and construction of full-scale bridges. Criteria for excellence are represented by the award categories of stiffness, lightness, construction speed, aesthetics, efficiency and economy. As with a full-scale construction project, safety is the primary concern.

The rules of the competition accommodate a large variety of designs and allow innovation. Designers must consider carefully the comparative advantages of various alternatives. For example, a truss bridge may be stiffer than a girder bridge but slower to construct.

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

III. RULE CHANGES

The following list covers some of the major changes from the 2000 rules. Minor changes are not listed. Contestants and judges are cautioned to read this entire *Rules* booklet carefully and disregard rules from previous years.

1. Computation of scores and rankings is changed. In particular, the height of a bridge will affect its score.

2. Span and minimum deck elevation are decreased. Length of cantilever, overall length, and maximum height are increased.

3. "Nut," "tool," and "temporary pier" are defined more precisely.

4. Tables, racks and other staging yard furniture are effectively eliminated.

5. Connection requirement is changed.

6. Limits are imposed on leaning and on support of builders.

7. Resistance to lateral load will be measured.

8. The construction team cannot have more than ten builders.

IV. PROBLEM STATEMENT

The main span of a century-old bridge that crosses a navigable river must be replaced. The bridge carries truck traffic serving the farms and agricultural processing industries that are the basis for the economy of this rural region, as well as providing access and emergency services to residences. A quick replacement is necessary because no other river crossing is available for miles.

The State Department of Transportation has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered, but the State DOT has specified steel as the material because of its durability and fast erection. The bridge must provide clearance for recreational navigation on the river and for access roads along the river banks. The bridge must be able to carry specified patterns of loads without exceeding sway and deflection limits. Based on past experience with performance and maintenance, the DOT prefers bridges that are relatively light and stiff, with low profiles. The new bridge must accommodate modular decking, which the DOT salvaged from another bridge. Decking units may not be modified.

Flood control and environmental concerns prohibit permanent piers in the river although a temporary pier would be allowed to facilitate construction. Soil conditions restrict the weight that may be lifted by cranes.

Your company's design/build proposal is among those that the State DOT has deemed responsive. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. The DOT will evaluate the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy and aesthetics. The contract will be awarded to the company that submits the best model. This is an opportunity to become leaders in the bridge replacement market.

V. SAFETY

Safety has the highest priority. Judges are empowered to halt any activity that they deem hazardous. Judges are directed to disqualify bridges that cannot be safely constructed or load tested using the equipment provided by the host, as described in this booklet. Collapse, sway or deflection in excess of limits specified in this booklet is incontrovertible evidence of an unsafe bridge and will result in disqualification. A disqualified bridge is not eligible for awards in any category and must be withdrawn from all subsequent participation in the contest.

VI. SCORING

A university may enter several bridges in a regional competition. However, if both first and second places are won by the same university, then only the best one of that university's bridges will be invited to participate in the national contest, together with the highest ranked bridge entered by another university.

Categories of competition are construction speed, lightness, aesthetics, stiffness, construction economy, and structural efficiency. In addition, overall performance is rated. Bridges that have been disqualified are not eligible for awards in any categories.

A. Construction Speed

The bridge with the lowest construction time will win in this category. Construction time is the clock time required to assemble the bridge, regardless of number of builders, plus time penalties prescribed in section "IX.I Construction: Accidents" (**p. 14**).

B. Lightness

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in sections "VII.B Dimensions and Support: Usability" (**p. 8**) and "VIII.B Material and Components: Durability and Constructability" (**p. 9**). Decking, tools and the temporary pier are not included in total weight.

C. Aesthetics

The full name of the college or university must appear on the bridge, or on a banner or placard attached to the bridge, in letters at least 2 inches high. The banner or placard is included in total weight but need not be installed during timed construction. It should be in place on the bridge during aesthetics judging and at other times when the bridge is on display.

In addition to the college or university name, other factors that may be considered include general appearance, balance and proportion of the design, elegance, and finish. Quality of fabrication should not be considered because some bridges may be fabricated professionally while others are student work.

Teams are encouraged, but not required, to prepare a poster illustrating and briefly describing their design and fabrication processes. The poster should be designed to be displayed within the floor area occupied by the bridge since space may be limited at the national competition.

Aesthetics is the tie-breaker for overall performance and for all other categories of competition. Judges should not declare ties in aesthetics.

D. Stiffness

The bridge with the lowest aggregate deflection will win in the stiffness category. Aggregate deflection is determined from measurements as prescribed in section "X Load Tests" (**p. 14**).

E. Construction Economy

The bridge with the lowest construction cost (C_C) will win in the construction economy category. Construction cost is computed as

C_C = Construction time (minutes, including penalties)
x Number of builders (persons) x 50 (thousand $ / person-minute)
+ 500 (thousand $) if a temporary pier is used.

The number of builders includes all participants who are within the construction site at any time during timed construction.

F. Structural Efficiency

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

$C_S = W \times \Delta \times D$, where

W = the larger of total weight OR 100 pounds.
Δ = the larger of aggregate deflection OR 1.000 inch.
D = maximum height of the bridge minus minimum clearance.

Total weight is the weight of the bridge plus weight penalties prescribed in sections "VII.B Dimensions and Support: Usability" (**p. 8**) and "VIII.B Material and Components: Durability and Constructability" (**p. 9**). Decking, tools and the temporary pier are not included in total weight.

Aggregate deflection is determined from measurements as prescribed in section "X Load Tests" (**p. 14**).

Maximum height of the bridge is the vertical distance from the ground or river surface to the highest point on the bridge structure (not including decking).

Minimum clearance is the smallest of the following three quantities: 18 inches OR vertical distance from the river surface to the lowest point on the bridge structure over the river OR vertical distance from the ground surface to the lowest point on the bridge structure over the access roads.

G. Overall Performance

The overall performance rating of a bridge is the product of construction cost and structural cost ($C_C \times C_S$). The bridge with the lowest cost product will win the overall competition.

VII. DIMENSIONS AND SUPPORT

A. Functionality and Safety

If any of the following regulations is violated, the bridge must be disqualified. The figures titled "Spans and Clearance" (**p. 7**) and "Deck Support, Roadway and Bearing" (**p. 7**) illustrate some of the requirements.

1. The bridge must span the river, which is 13 feet wide, without touching it. No part or accessory of the completed bridge may touch the river. Also see paragraph VII.B.1 (**p. 8**).

2. The overall length of the bridge must be at least 23 feet.

3. The bridge must provide continuous rigid support for the decking along both of the edges that run in the longitudinal direction of the bridge. The support must be continuous and rigid for the overall length of the bridge. This is easily verified by sliding a piece of decking along the full overall length of the bridge. Also see paragraph VII.B.3 (**p. 8**).

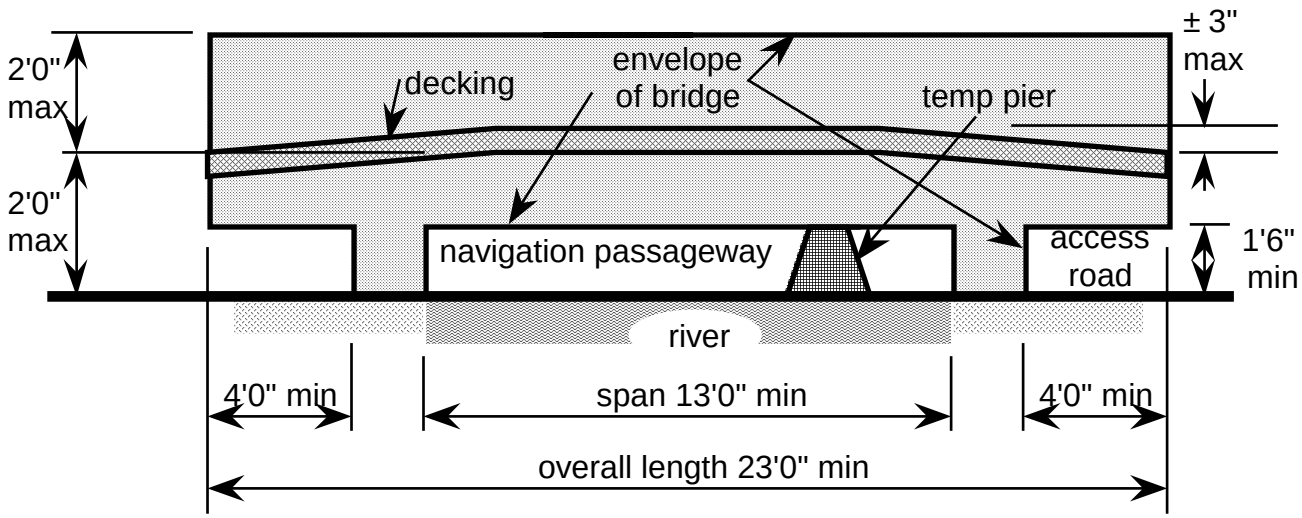
4. The edges of the decking that run in the longitudinal direction of the bridge may be cantilevered over their supports no more than 6 inches on each side.

5. The decking may not be attached nor anchored to the bridge.

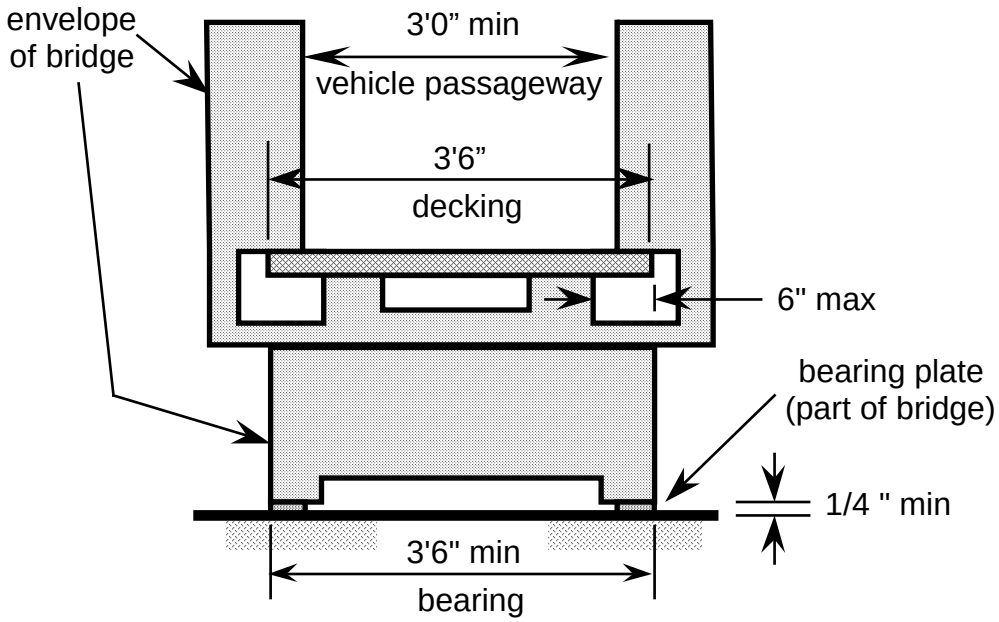
6. The bridge must provide access for placing the decking and load. Although decking is nominally 42 inches wide and 1 inch thick, actual widths range from 41.75 to 42.25 inches and thickness may be as large as 1.25 inches. Also see paragraph VII.B.4 (**p. 8**).

7. On each side of the river the bridge must bear on the ground over a width of at least 3'6". Bearing is not required to be continuous over that width. Also see paragraph VII.B.8 (**p. 8**).

8. The bridge may not be anchored or tied to the ground.



Spans and Clearance (Side View)



Deck Support, Roadway and Bearing (End View)

Hollow circular and oval tube and other curvilinear closed shapes

Fabricated sections including closed curvilinear components

Example Unacceptable Member Cross-Sections

B. Usability

A penalty of 200 pounds will be added to the weight of the bridge for each of the following rules that is violated. A penalty will be assessed for each rule that is violated, rather than for every violation of that rule. The figures titled “Spans and Clearance” (**p. 7**) and “Deck Support, Roadway and Bearing” (**p. 7**) illustrate some of the requirements. Dimensions will be checked without load on the bridge.

1. A rectangular navigation passageway must be provided under the bridge. The navigation passageway must be at least 1’6” high, measured from the surface of the river, and it must be at least 13’0” wide, coinciding with the width of the river. Also see paragraph VII.A.1 (**p. 6**).

2. At each end of the bridge there must be clearance for an access road running along the bank of the river. This clearance must completely traverse the width of the bridge; it must be at least 1’6” high, measured from the surface of the ground; it must be at least 4’0” wide, measured from the end of the bridge; and it must extend to the end of the bridge.

3. Decking must be supported without overlaps, gaps, abrupt elevation differences exceeding 1/4 inch, or protrusions exceeding 1/4 inch in height. Also see paragraph VII.A.3 (**p. 6**).

4. A vehicle passageway at least 3’0” wide must completely traverse the bridge from end to end, and must extend upward from the decking through the top of the bridge. Also see paragraph VII.A.6 (**p. 6**).

5. The top surface of the decking supports must be no more than 2’0” above the surface of the ground and river at any point. Note that the surfaces of the ground and river have the same elevation.

6. The absolute value of camber of the decking supports may not exceed 3 inches.

7. No part of the bridge may extend more than 2'0" above the top surface of the decking support at any point.

8. At each point where it bears on the ground the bridge will include a solid bearing plate at least 1/4 inch thick, 2 inches long and 2 inches wide. Also see paragraph VII.A.7 (**p. 6**). Bearing plates are part of the bridge.

9. A temporary pier, if used, must be made of steel and/or wood.

10. A temporary pier, if used, may not exceed overall dimensions of 4’0” (horizontal) x 4’0” (horizontal) x 2’0” (vertical). That is, it must fit in a three-dimensional prismatic box of those dimensions.

11. Only one temporary pier is permitted. The use of a temporary pier is optional and adds to the construction cost of the bridge.

VIII. MATERIAL AND COMPONENTS

A. Safety

If either of the following regulations is violated, the bridge must be disqualified.

1. A bridge member may not weigh more than 40 pounds. See section VIII.B (**p. 9**) for definition of "bridge member."

2. A temporary pier, if used, must not weigh more than 40 pounds. See section IX.D (**p. 11**) for definition of "temporary pier."

B. Durability and Constructability

Violation of each of the following rules will result in a weight penalty being added to the weight of the bridge. The penalty for each violation is 10 pounds plus 5 times the weight of the non-conforming components.

1. A bridge may be constructed only of structural steel. For the purposes of this contest, structural steel is defined as an iron alloy that is strongly attracted to a magnet. Exceptions: Paint, banners, placards and other purely decorative items.

2. A bridge may be constructed only of components conforming to the following definitions of bridge members and fasteners.

   a. A bridge member is a rigid component that retains its shape, dimensions and rigidity during timed construction and in the completed bridge.

   b. A fastener consists of two parts, namely one steel bolt and one matching solid steel nut, neither of which may be attached to a member or to one another before the start of timed construction.

3. A bridge member may not have a cross-section that is both closed (hollow) and curvilinear. For example, a bridge member may not be fabricated from pipe, conduit, circular tube or oval tube. The figure titled "Example Unacceptable Member Cross-Sections" (**p. 7**) shows examples of unacceptable cross-sections. Exception: washers, bushings and similar short sections pertaining to connections.

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

5. A bridge member must be rigid. That is, hinged, jointed, articulated and telescoping members are prohibited, as are those with moving parts. This prohibition includes members with parts that are intended to slide, rotate, deflect or bend relative to the member during construction, such as cams, latches, sliding pins, springs, and snap-lock devices. Cables and strapping are prohibited, as are similar materials that would not be damaged by coiling and uncoiling.

6. A bridge member may consist of several parts rigidly joined together (e.g. welded, bolted, screwed) before timed construction begins. Those parts must

remain rigidly joined throughout the construction process and in the completed bridge.

7. A bolt may not exceed 3 inches in overall length. It must be straight, threaded and have a hexagonal or square head that will accept a wrench. Eye bolts are not permitted.

8. A nut must be threaded internally to fit its bolt, and the threads must be continuous around the complete circumference of the hole in the nut. A nut may not have moving parts.

9. All connections of bridge members to the bridge or to other bridge members must be made during timed construction.

10. Each member must be connected to every other member that it touches by at least one fastener installed during timed construction so that the connection cannot be taken apart without first unscrewing the nut from the bolt and then removing both the nut and the bolt from the connection.

IX. CONSTRUCTION

A. Safety

If any of the following safety regulations is violated during timed construction, the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools and bridge components will be returned to the positions they occupied before the violation. Then the builders will be asked to resume construction using safe procedures. A bridge that cannot be constructed safely must be disqualified.

1. If a temporary pier is used, it must conform to the description given in section IX.D (**p. 11**).

2. The temporary pier must not break nor collapse during construction.

3. Only tools that are hand-held during use are permitted. Field welding and tools requiring external power connections are prohibited. Tools may not be used to support or elevate builders.

4. All builders must wear hardhats and safety glasses or goggles during timed construction.

5. A builder may not use the bridge, a portion of the bridge, a tool or the temporary pier to support the builder's body weight. For example, standing, sitting or kneeling on those objects is prohibited. However, a builder may lean on the bridge or temporary pier if the heels and toes of both of the builder’s feet remain on the ground.

6. A builder may not depend on another builder or builders for support or balance.

7. A builder may not cross the river by jumping, by temporary scaffolding, by crossing the bridge, or by any other means.

8. Outside the staging yard, moving a portion of the bridge requires the effort of as many builders as there are members in that portion of the bridge. The term "portion of the bridge" includes, but is not limited to, single and multiple bridge members, bridge members that are connected together, and the entire bridge. The word "moving" includes, but is not limited to, lifting, carrying, lowering, rolling, turning, sliding and tipping, as well as causing translation and/or rotation of one portion of the bridge relative to another. Exception: small movement (maximum 3 inches) of a portion of the bridge by as few as one builder will be allowed as necessary to facilitate connections.

9. Outside the staging yard, any portion of the bridge that is not moving must either be supported by as many builders as there are bridge members in that portion of the bridge, or must be supported without the assistance of builders by any combination of the following: the portion itself, other portions of the bridge, and temporary pier.

10. The temporary pier, if used, may not be moved by a builder who is also moving or supporting a portion of the bridge at the same time.

11. The temporary pier may be moved only twice during timed construction: first from the staging yard to a useful location, and then returned to the staging yard.

12. The temporary pier must be removed without lifting the bridge.

B. Team

Participation is limited to students. The construction team, also referred to as builders, consists of all participants who are within the construction site at any time during timed construction. There can be no more than ten participants on the construction team.

C. Tools and Safety Equipment

Competitors provide their own tools, hardhats and safety glasses or goggles. See paragraphs IX.A.3 and .4 (**p. 10**).

D. Temporary Pier

A temporary pier is a support in the river or on the ground, and is provided by the competitors. The use of a temporary pier is optional and adds to the cost of the bridge. Only one temporary pier is permitted. See sections VII.B (**p. 8**), VIII.A (**p. 9**) and IX.A (**p. 11**) for rules governing the temporary pier.

E. Construction Site

See the figure titled “Site Plan” (**p. 13**) for layout of the construction site. The reference line is provided to guide construction. It is perpendicular to the banks of the river and is located near the center of the construction site (the bridge is not required to be centered on the reference line).

Only builders and judges are permitted in the construction site during timed construction. Only judges are permitted near the construction site; coaches, managers and other spectators must observe from a safe distance that does not obstruct judges.

F. Start

Before construction begins, all of the following items, and nothing else, are in the staging yards: bridge members, nuts and bolts, tools, the temporary pier (if used) and builders. Builders will be wearing hardhats and safety glasses or goggles, as well as optional clothing such as pouches. Bridge members, tools and fasteners must be on the ground. Bridge members must not be connected nor in contact with one another. Tools and fasteners must not be in contact with bridge members.

Timing and construction begin when the builders signify that they are ready and the judge declares the start.

G. Time

Time is kept from the start to finish of construction. The clock will be stopped:

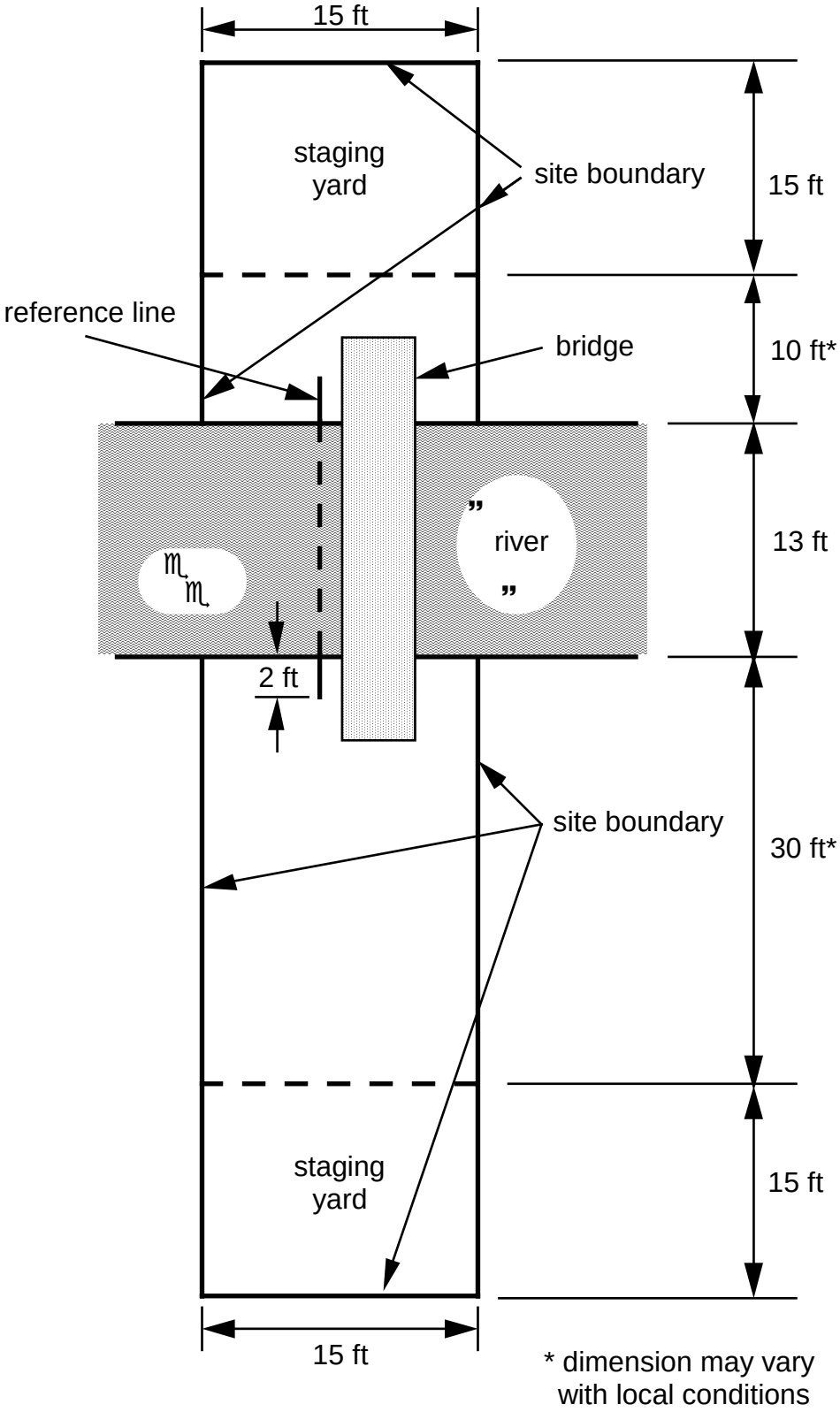
1. if a builder or judge sees a condition that could cause injury, or

2. when a safety regulation has been violated. See section IX.A (**p. 10 and 11**).

Construction ceases while the clock is stopped. The clock is restarted after the situation has been corrected.

H. Finish

Construction ends when the bridge has been completed over the river by connecting all the members, and all tools, the temporary pier (if used) and builders are back in the staging yards, and the builders signify that they are finished. Installation of decking is not included in timed construction.


15 ft
staging
yard
site boundary
15 ft
reference line
bridge
10 ft*
river
13 ft
2 ft
site boundary
30 ft*
staging
yard
15 ft
15 ft
* dimension may vary
with local conditions

Site Plan

I. Accidents

In general, the clock is not stopped when an "accident" occurs. Builders involved in accidents may continue to build, and components involved in accidents may be recovered and used. If an accident is continuous (for example, a builder stands in the river) it will be counted as multiple incidents. Types of accidents and the corresponding time penalties, which will be added to the construction time, are:

1. A builder touches the river. Penalty is 1/2 minute (30 seconds) per incident. Exception: Builders may step in the river without penalty to place or remove the temporary pier or to retrieve a dropped member, tool, nut, bolt or hardhat.

2. A builder throws something. Penalty is 1/2 minute (30 seconds) per incident.

3. A portion of the bridge touches the river or the ground outside a staging yard. Penalty is 1/3 minute (20 seconds) per incident. Exception: No penalty is assessed when the ground is touched by the bottom of a bearing plate that will be in contact with that place on the ground when the bridge is completed (see paragraph VII.B.8 (**p. 8**)).

4. A tool, nut, bolt or hardhat touches the river or the ground outside a staging yard. Penalty is 1/6 minute (10 seconds) per incident. Exception: a tool used exclusively for measuring may touch the ground during use while being held by a builder.

5. A builder steps outside the boundary of the construction site. Penalty is 1/6 minute (10 seconds) per incident.

X. LOAD TESTS

A. Safety Precautions

A bridge could suddenly collapse or sway in any direction during load tests. Therefore, minimize the number of people near the bridge while it is being tested. Usually, the load may be placed on the bridge by only two competitors.

While participating in load testing, **competitors must wear hardhats, safety glasses or goggles, gloves and leather construction boots**. This safety equipment is provided by the competitors. Similar equipment is recommended for judges who will be near the bridge during load testing.

During testing, safety supports must be in place below the bottom of the decking. The safety supports should be of sufficient height, strength, number and extent that none of the load will fall more than three inches if the bridge collapses. The safety support should extend beyond the end of the bridge to arrest the load if it slides off the overhanging span.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a portion of the decking that is cantilevered laterally over its support.

When any portion of the load is on the bridge, no one is permitted to crawl, reach or step under the bridge. If such an action is necessary, the load must first be removed.

B. Repairs

A bridge will not be tested in a condition that compromises its strength or stability. Therefore, prior to load testing, repairs may be made with the permission and supervision of a judge, according to the following provisions:

1. Damage occurring after construction will be repaired without penalty.

2. Construction errors will be repaired but a time penalty will be assessed in an amount, to be determined by the judge, that will exceed the incremental time required for careful initial construction.

C. Preparation

The provisions of this section are illustrated by the figure titled “Location of Targets and Decking” (**p. 16**).

Position the bridge in convenient proximity to load testing equipment.

Load tests are conducted without the temporary pier.

Place shims under the bearing plates of the bridge as necessary to compensate for sloping and/or rough ground surface. Shims may not be used to compensate for imprecise construction or fabrication of the bridge.

By a random process, the judge selects the side of the bridge to which lateral load will be applied in load test 1 and the end of the bridge that will be loaded in load test 3.

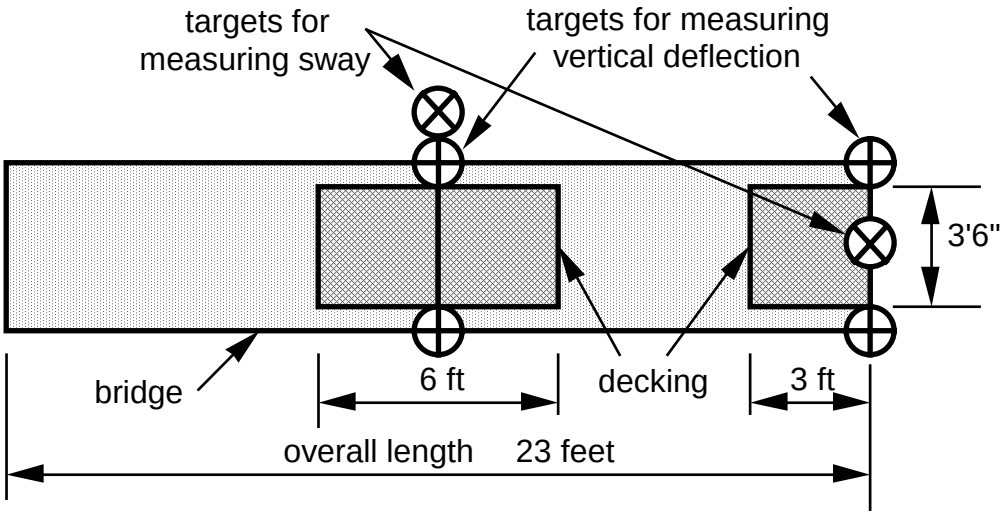
Safety supports are placed under the level of the decking so that no portion of the load will drop more than three inches if the bridge collapses. The safety support should extend beyond the end of the bridge that will be loaded.

Sway is translation in any horizontal direction. Two targets are established for sway measurements: one at the center of the span and the other at the end of the bridge that will be loaded. Both targets are located near the level of the decking.

Two targets are established for midspan vertical deflection measurements. These targets are located near the level of the decking on both sides of the bridge at the center of the span.

Two targets are established for end vertical deflection measurements. These targets are located near the level of the decking on both sides of the bridge at the end of the bridge that will be loaded.

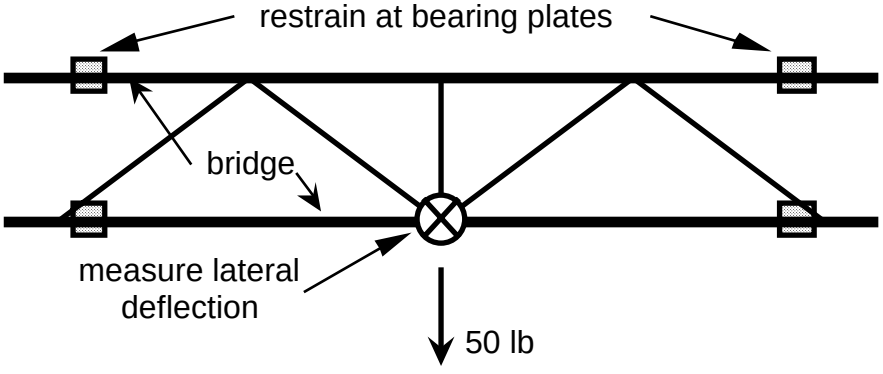
A BRIDGE THAT COLLAPSES DURING LOADING, DEFLECTION MEASUREMENTS OR UNLOADING MUST BE DISQUALIFIED.



Location of Targets and Decking (Plan)

D. Load Test 1 - Lateral

Load test 1 is conducted without decking but with restraint at the bearing plates to prevent the bridge from sliding or tipping. As shown in the figure titled “Load Test 1” (**p. 16**), apply a 50 pound lateral force as close as practical to midspan and to the level of the deck. To pass load test 1, the lateral deflection at midspan of the bridge must not exceed 1.0”. If the bridge does not pass load test 1 it is disqualified; do not conduct any other load test. Remove the lateral load; it is not part of the remaining load tests.



Load Test 1 (Plan)

E. Load Test 2 - Center Span

Place two units of decking symmetrically about the middle of the center span and extending 6 feet in the span direction. Place one unit of decking at the end of the bridge selected for loading.

Position measuring devices on the four targets for vertical deflection and either initialize to zero or record initial readings.

Uniformly distribute load on the two units of decking on the center span, as shown in the figure titled “Load Test 2” (**p. 17**).

As the load is being placed, observe sway and deflection. Stop loading and disqualify the bridge if

a. sway at the end exceeds 1/2 inch, or
b. sway at the center of the span exceeds 1 inch, or
c. vertical deflection at any deflection target exceeds 2 inches.

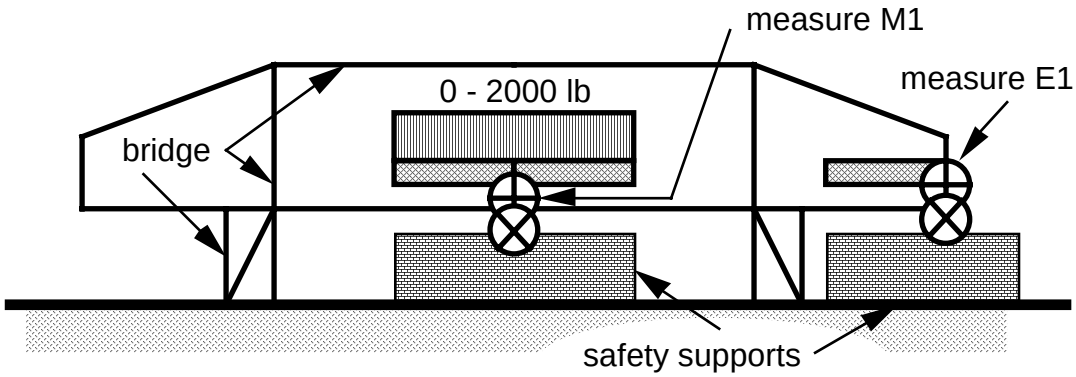
If 2000 pounds of load (in addition to decking) was successfully placed without exceeding sway or deflection limits, record the following measurements:

M1 = larger absolute value of the vertical distances of the two midspan deflection targets from their positions before any portion of the load was placed.

E1 = larger absolute value of the vertical distances of the two end deflection targets from their positions before any portion of the load was placed.

If a sway or deflection limit was exceeded, remove all load and disqualify the bridge. Do not proceed to the next test.

In preparation for the next load test, record the vertical deflections at both end deflection targets.



Load Test 2 (Side View)

F. Load Test 3 - Overhang

With the first 2000 pound load remaining in place on the center span, uniformly distribute additional load over the unit of decking on the overhanging end of the bridge, as shown in the figure titled “Load Test 3” (**p. 18**).

As the load is being placed, observe sway and deflection. Stop loading and disqualify the bridge if

a. sway at the end exceeds 1/2 inch measured from the position at the beginning of load test 2, or

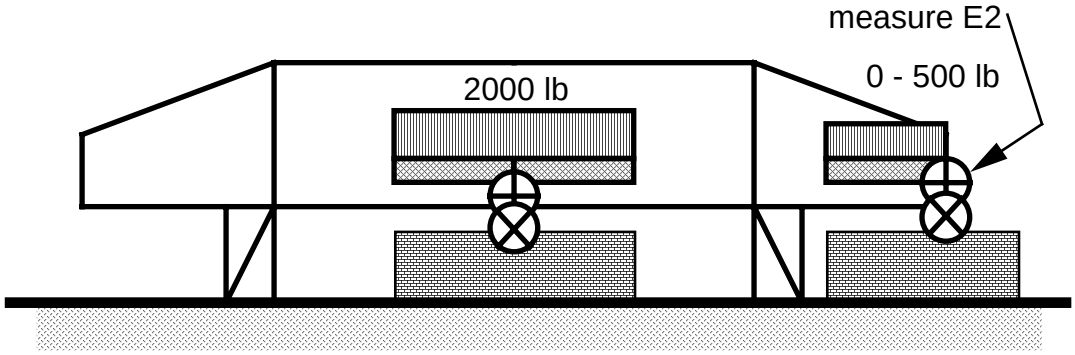
b. sway at the center of the span exceeds 1 inch measured from the position at the beginning of load test 2, or

c. vertical deflection at any deflection target exceeds 2 inches measured from the position at the beginning of load test 2.

If 500 pounds of load (in addition to decking) was successfully placed on the overhang without exceeding sway or deflection limits, record the following measurement:

E2 = larger absolute value of the vertical distances of the two end deflection targets from their positions at the end of load test 2 but before any load was placed on the overhang. That is, E2 measures deflection that occurred while the load on the overhang was being placed.

If a sway or deflection limit was exceeded, remove all load and disqualify the bridge.



Load Test 3 (Side View)

G. Unloading

Unload the overhang first, then the center span. The bridge must be disqualified if it collapses during unloading.

H. Computing Aggregate Deflection

Compute and record: Aggregate deflection = M1 + E1 + (5 x E2)

XI. EQUIPMENT PROVIDED BY HOST

The following equipment will be provided at the contest site by the host. Competitors should acquire similar equipment for use in practice and testing before the competition.

A. Lateral Load Device

Capable of applying 50 pound force in the horizontal direction.

B. Equipment for Measuring Sway

Sway is horizontal translation and is measured by any accurate method. A suggested method is to suspend plumb bobs from the sway target points and measure sway from points marked on the ground.

C. Equipment for Measuring Deflection

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

D. Decking

Preferred decking is steel bar grating identified as W-19-4 (1 x 1/8). The dimensions of a piece of grating are approximately 3'6" x 2'11-3/4" x 1" and the weight is approximately 50 pounds. However, the host may provide a different type of decking with the same dimensions. Grating has significant bending strength only in the direction of the main bars, which are 3'6" long. The grating will be installed with the main bars perpendicular to the length of the bridge, creating a roadway that is 3'6" wide. Therefore, support for the grating is needed for the edges that are parallel to the length of the bridge, but not for the edges of the grating that are perpendicular to the length.

E. Load

2500 pounds total. The load should be supplied in uniform pieces of size and weight that may be handled safely. When in place, the load should not provide significant stiffness in the longitudinal direction of the bridge. The recommended load consists of 25-pound lengths of 5 x 5 x 5/16 steel angle placed perpendicular to the length of the bridge. Sacks of material, containers of liquid, concrete blocks or jacking systems could be used. Decking is not included as part of the 2500 pound load.

F. Safety Supports

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

XII. INTERPRETATION OF RULES

Competitors, judges and host personnel who have questions are requested to consult web site http://www.engr.uaa.alaska.edu/nssbc/ and to reread this *Rules* booklet carefully in its entirety. If questions remain unanswered, they may be submitted by e-mail to Mr. Fromy Rosenberg (rosenber@aiscmail.com). Questions and answers will be posted on the web site.

XIII. JUDGING

The host will recruit judges. Judges are empowered to halt any activity that they deem to be hazardous. Judges have full authority over conduct of the competition and interpretation of the rules. Decisions, scoring, rating and disqualification are the sole responsibility of the judges and will be final. The host will assure that the judges are fully informed of the rules and procedures, and fully equipped for their tasks. The host and judges will follow directions in the *Guide for Hosts and Judges* provided by AISC.

XIV. PROTESTS AND APPEALS

A. Before the Contest

Each team will designate a student as team captain. The host will identify the head judge.

B. During the Contest

A penalty, disqualification, measurement, score, or condition of competition may be protested only by a team captain and only to the head judge. The protest must be made as soon as possible after the situation becomes apparent. The head judge will not hear the protest if he or she is approached by students other than the team captain. As soon as possible after a protest is made, the head judge will interrupt the contest if necessary, gather the other judges and the captains of the teams involved, and hear the protest. The decision of the head judge is final.

Participants are reminded that civility and ethical behavior are expected during the contest and particularly concerning protests.

C. After the Regional Contest

If a team wants to appeal the decision of the head judge regarding a protest it may do so in a letter mailed to Mr. Fromy Rosenberg (AISC, Suite 3100, One E. Wacker Dr., Chicago, IL 60601-2001) with a copy mailed to ASCE Student Activities Coordinator (ASCE, 1801 Alexander Bell Dr., Reston, VA 20191-4400). The letter should include the name of the college or university making the appeal; the names, addresses and telephone numbers of the faculty adviser and one team member; brief description of the problem, the action taken at the contest to deal with it, and the action that the appealing team feels should have been taken; and computation showing how the appealing team's rankings would have been improved if a different action had been taken.

Appeals must be made in writing. Only appeals received within one week after the regional contest will be considered.

The only redress that may be made is an invitation to participate in the national competition if the Rules Committee is convinced that the appeal is valid and that the appealing team should have placed first or second in its region. Decisions and rankings made by regional judges will not be overturned.

D. After the National Contest

Appeals will not be accepted. However, AISC welcomes written suggestions for improving future competitions.

XV. TIPS FOR COMPETITORS

1. Strive for challenging but realistic goals for design and construction. The following statistics from the 2000 National Student Steel Bridge Competition suggest the levels of performance that are possible. However, when reviewing these statistics keep in mind that the rules and scoring for 2001 differ from those for 2000.

	Winning bridge in category	Winning bridge, overall
Weight (pounds)	107.5	112.0
Construction time (person-minutes)	18.30	33.43
Aggregate deflection (inches)	0.440	0.682

2. It is strongly recommended that bridges be load tested before competition, if it can be done safely, so that weaknesses and instability can be corrected.

3. Start work on the design early, leaving adequate time to procure materials, fabricate the bridge, load test it and practice construction.

4. Design a bridge that may be fabricated, erected and load tested safely, using available materials, tools and facilities.

5. Structural analysis may fail to disclose instability, such as buckling of slender compression members, sway, and torsion of under-deck trusses of triangular cross-section.

6. Allow tolerances for all limiting dimensions in order to accommodate imprecise measurement, fabrication, thermal expansion, elastic and inelastic deformation, wear, etc. For example, if a bridge is required to provide at least 18 inches of clearance, and it is designed to provide exactly that clearance, then there is a high probability that the actual as-built clearance will be less than the specified minimum. That probability of error may be reduced by designing the bridge to provide slightly more than the required minimum clearance.

7. When fabricating your bridge, use safe tools, operate them carefully and with adequate supervision.

8. Follow all safety regulations and guidelines during construction practice and loading.

9. Make sure that the temporary pier is stable and strong enough (with a generous factor of safety) so that it will not tip or break, even if the bridge collapses.

10. When practicing construction, wear hardhats and safety glasses or goggles both for safety and to accustom yourself to contest conditions.

11. When load testing your bridge use safety supports under the decking, sufficient in height, strength, number and extent to prevent the load from dropping more than three inches if the bridge collapses. This will reduce risk of injury and limit damage to the bridge if it collapses. Keep hands and feet out from under the bridge.

12. When load testing your bridge wear hardhats, safety glasses or goggles, gloves and leather construction boots.

13. Don't stand, sit or lie on your bridge.

14. To expedite the competition have a preset plan for unloading and staging components of your bridge.

15. When packing for the competition, remember to bring hardhats, safety glasses or goggles, gloves and construction boots.

XVI. SCORE SHEET

A. Construction Speed and Time Penalties

Clock time = _____ minutes

Time penalties, see "IX.I Construction: Accidents" (**p. 14**):

items 1,2: violations _____ x 1/2 = + ___ minutes

item 3: violations _____ x 1/3 = + ___ minutes

items 4,5: violations _____ x 1/6 = + ___ minutes

CONSTRUCTION TIME (add) = _____ minutes
Lowest time wins.

B. Lightness and Weight Penalties

Bridge weight = pounds

Weight penalties, see "VII.B Dimensions and Support: Usability" (**p. 8**)

Number of violations _____ x 200 pounds = + _____ pounds

See "VIII.B Material and Components: Durability and Constructability" (**p. 9**)

Number of violations _____ x 10 pounds = + _____ pounds

Wt. of parts in violation _____ pounds x 5 = + _____ pounds

TOTAL WEIGHT (add) = _____ pounds
Lowest weight wins.

C. Aesthetics

Full name of college or university appears on bridge or on attached banner or placard in letters at least 2 inches high.

Other items that may be considered:

General appearance	Finish
Balance and proportion	Elegance

Judges should not declare ties in aesthetics

AESTHETICS SCORE = _____

D. Stiffness

AGGREGATE DEFLECTION: M1 + E1 + (5 x E2) = _____ inches
Lowest deflection wins.

E. Construction Economy

Number builders _____ x Const. Time (part A) _____ x 50 = _____ thousand $

If temporary pier is used, 500 = + _____ thousand $

C_c = CONSTRUCTION COST (add) = _____ thousand $
Lowest cost wins.

F. Structural Efficiency

W = larger of total weight (part B) or 100 = _____ pounds

Δ = larger of aggregate deflection (part D) or 1.00 = x _____ inches

D = maximum height - minimum clearance = x _____ inches

C_s = STRUCTURAL COST (multiply) = _____
Lowest cost wins.

G. Overall Performance

C_c (from part E) _____ x C_s (from part F) _____ = _____
Lowest cost product wins.

H. Ranks

Disqualified bridges will not be ranked.

Aesthetics is the tie-breaker for all categories

Construction Speed _____ Lightness _____

Aesthetics _____ Stiffness _____

Construction Economy _____ Structural Efficiency _

Overall Performance _____

This Score Sheet implements section "VI Scoring" (**p. 4,5**).