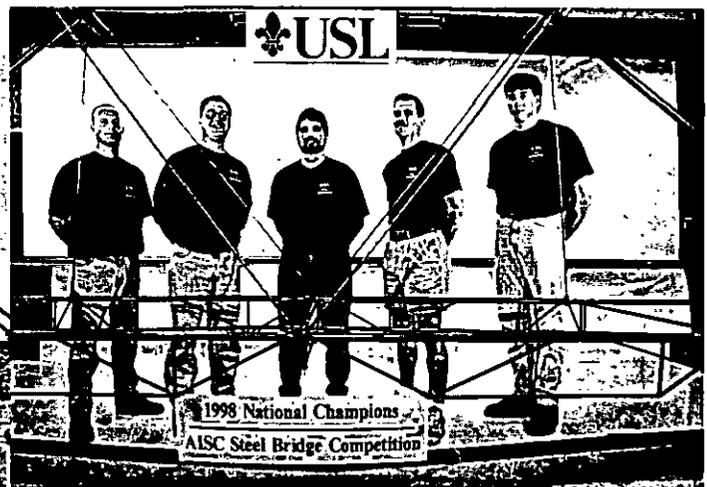
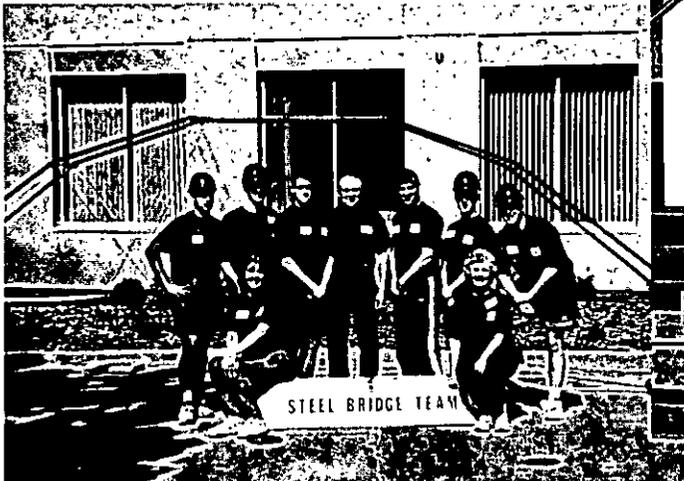
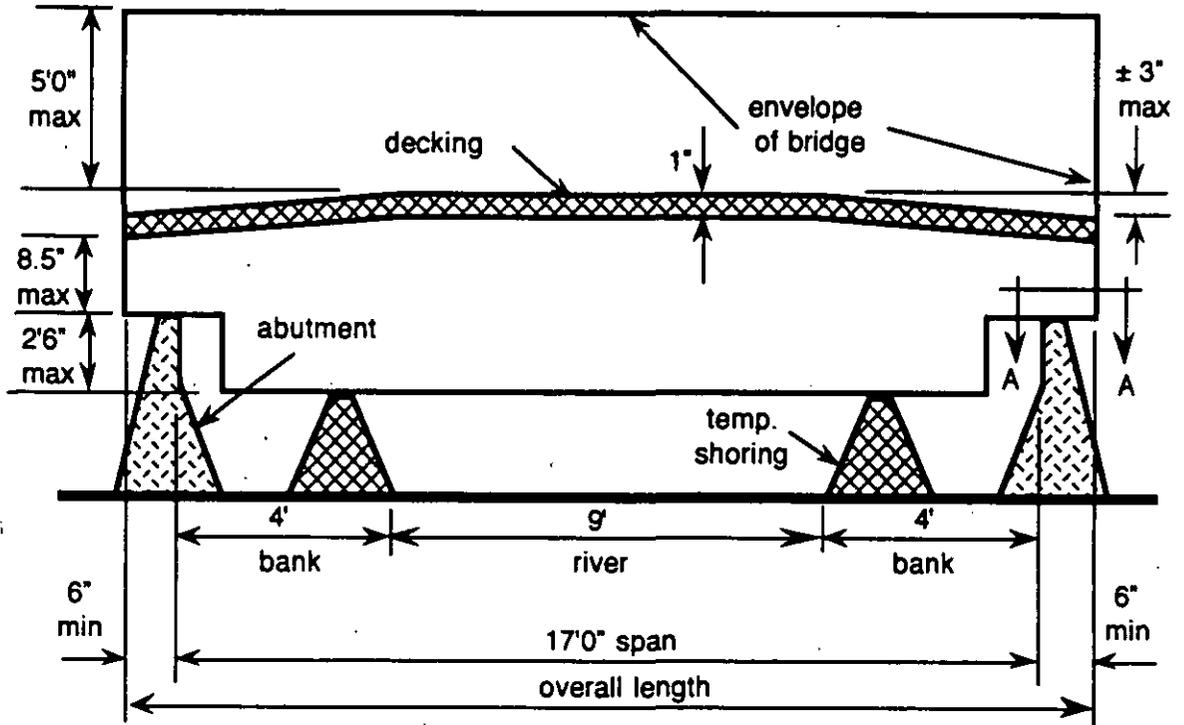


# 1999 STUDENT STEEL BRIDGE Competition

For Student Chapters Of  
The American Society Of Civil Engineers

Side  
Elevation

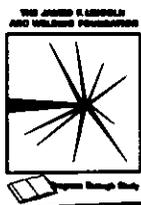


**Special thanks to: Steel Erectors Association of America**

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**COMPETITION**

**1999**

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## INTRODUCTION

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

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

The competition rules have been changed for 1999 in order to improve the contest and to assure that competitors design and build new bridges.

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

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

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

The rules are intended to be prescriptive but may require some interpretation. The host should promptly inform all competitors and judges of questions and interpretations concerning the rules and other aspects of the competition. Interpretations must be in writing.

## EXECUTIVE SUMMARY

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

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

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

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

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

## RULE CHANGES

The following list covers some of the major changes from the 1998 rules. Minor changes and reorganization are not covered. Contestants are advised to read this entire *Rules* booklet carefully.

1. The span is decreased.
2. The widths of the river and of one bank are decreased.
3. The height limit is increased.
4. The limit on deck height above abutments is increased.
5. The depth limit is increased.
6. The height of the vehicle passageway is increased.
7. The bearing requirement is more specific.
8. A penalty is imposed for placing members, assemblies, fasteners and tools on the abutments, wingwalls and temporary shoring.
9. A cost is assessed for temporary shoring.
10. Use of round and oval tubing is penalized.
11. A bolt must be straight and must either utilize a nut or screw into a threaded hole.
12. Temporary shoring may not extend above the river.
13. Computation of efficiency score is changed.
14. The length of the load is decreased.

## PROBLEM STATEMENT

A century-old bridge that crosses a river valley in a mountainous region must be replaced. The bridge carries heavy truck traffic to and from mines which are the basis for the economy of this rural region, as well as providing access and emergency services to residences. A quick replacement is necessary because no other river crossing is available for miles.

The State Department of Transportation has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered, but the State has specified steel as the material because of its durability and fast erection. The bridge must be able to carry specified patterns of traffic and wind loads without exceeding deflection limits. In order to expedite environmental approvals, no piers may be erected in the river, nor may temporary scaffolding or causeways be used in the river. However, temporary shoring may be erected on the banks. Construction barges and marine cranes are not feasible due to fast currents and flash floods.

The stone abutments of the existing bridge are in good condition and will serve for the new bridge, provided that no lateral thrust or uplift is applied to the abutments. The State DOT will not permit modification of the existing abutments. The new bridge, when complete, must be supported only by the existing abutments; for example, stays and anchorages to the river banks are prohibited.

The new bridge must accommodate modular decking, which the State DOT salvaged from another bridge. Decking units may not be modified.

Access to the construction site is limited by narrow, winding roads. This imposes restrictions on the size of components, and on the movements of construction equipment. Soil conditions restrict the weight that may be lifted by cranes.

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

## **SAFETY**

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

## **SCORING**

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

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

### **Lightness**

The bridge with the least total weight will win in the lightness category. Total weight is the weight of the bridge plus weight penalties prescribed in "Material and Components" and "Dimensions and Support." Decking and temporary shoring are not included in total weight.

### **Construction Speed**

The bridge with the lowest construction time will win in this category. Construction time is the product of the size of the construction team and the duration of construction plus time penalties prescribed in "Construction: Accidents." The construction team includes everyone who handles the bridge or any of its components during timed construction.

### **Stiffness**

The bridge with the lowest incremental vertical deflection will win in the stiffness category. Incremental vertical deflection is determined from load test 3.

### **Efficiency**

The bridge with the smallest sum of normalized total weight and deflection (SNWD) will win in the efficiency category. The sum of normalized weight and deflection is computed as

$$\text{SNWD} = \text{Total weight (lb)} + (300 \times \text{Incremental vertical deflection (in)})$$

## **Economy**

The bridge with the lowest cost (C) will win in the economy category. Cost is computed as

$$\begin{aligned} C = & \text{ Total weight (lb) } \times 1000 \text{ (\$/lb)} \\ & + \text{ Construction time (person-min) } \times 5000 \text{ (\$/person-minute)} \\ & + \text{ Number of temporary shoring units } \times 30,000 \text{ (\$/unit)} \end{aligned}$$

## **Aesthetics**

The full name of the college or university must appear on the bridge, or on a banner or placard attached to the bridge, in letters at least 2 inches high. If used, the banner or placard must be installed before the end of timed construction and is included in total weight.

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

## **Overall Performance**

The overall performance rating of a bridge is determined by adding the ranks of the bridge in the construction speed, stiffness, efficiency and economy categories. Note that the lightness rank is not included in the sum because lightness affects both efficiency and economy, which do appear in the sum. The bridge with the lowest score will win the overall competition. In the case of a tie, judges will use aesthetics as the tie breaker.

## DIMENSIONS AND SUPPORT

### Safety

If any of the following regulations is violated, the bridge must be disqualified. The figures titled "Side Elevation" and "Clearance and Deck Support" illustrate some of the requirements.

1. The bridge must provide rigid support for the decking along both of the edges that run in the longitudinal direction of the bridge. The support must be continuous for the central 6 feet of the bridge on which the load will be placed. Also see item 1 of the next section.

2. The bridge must span the abutments, which are fixed in place so that the clear distance between faces is 17 feet. Permanent shoring is not permitted.

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

4. Bearing areas at the four corners of the bridge must each extend behind the face of the abutment so that the bridge will remain supported by the abutments in the event that it is displaced either way in the direction of span. Also see item 4 of the next section.

5. No part of the bridge may extend so high that it cannot be constructed on the abutments in the building in which the contest is conducted. Also see item 5 of the next section.

6. No part of the bridge may be so low that it touches the river surface or bank with the bridge on the abutments. Also see item 6 of the next section.

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

8. The bridge may not be attached nor anchored to the abutments, and it may bear only on the top surface of the abutments.

9. The bridge may not be anchored, tied or braced to the ground.

## Usability

Violation of each of the following rules will result in a weight penalty of 50 pounds being added to the weight of the bridge. A penalty will be assessed for each violation. The figures titled "Side Elevation" and "Clearance and Deck Support" illustrate some of these rules. Dimensions will be checked without load on the bridge.

1. The bridge must provide support for the decking along both of the edges that run in the longitudinal direction of the bridge. The support must be continuous for the overall length of the bridge. This is easily verified by sliding a piece of decking along the full overall length of the bridge. Also see item 1 of the preceding section.

2. Although decking is nominally 42 inches wide and 1 inch thick, the bridge must accommodate widths ranging from 41.75 to 42.25 inches and thickness up to 1.25 inches.

3. Decking must be supported without gaps, overlaps or abrupt elevation differences between decking units. However, small elevation differences caused by decking resting on bolt heads are acceptable.

4. Each of the four bearing areas at the corners of the bridge must extend at least 6 inches behind the face of the abutment, be at least 2 inches wide and be fabricated of flat stock (e.g. plate, bar, strip, sheet) that is at least 1/8 inch thick. The prescribed bearing area must be solid (i.e. no holes) and the bottom surface that bears on the abutment must be flat and horizontal. Also see item 4 of the preceding section.

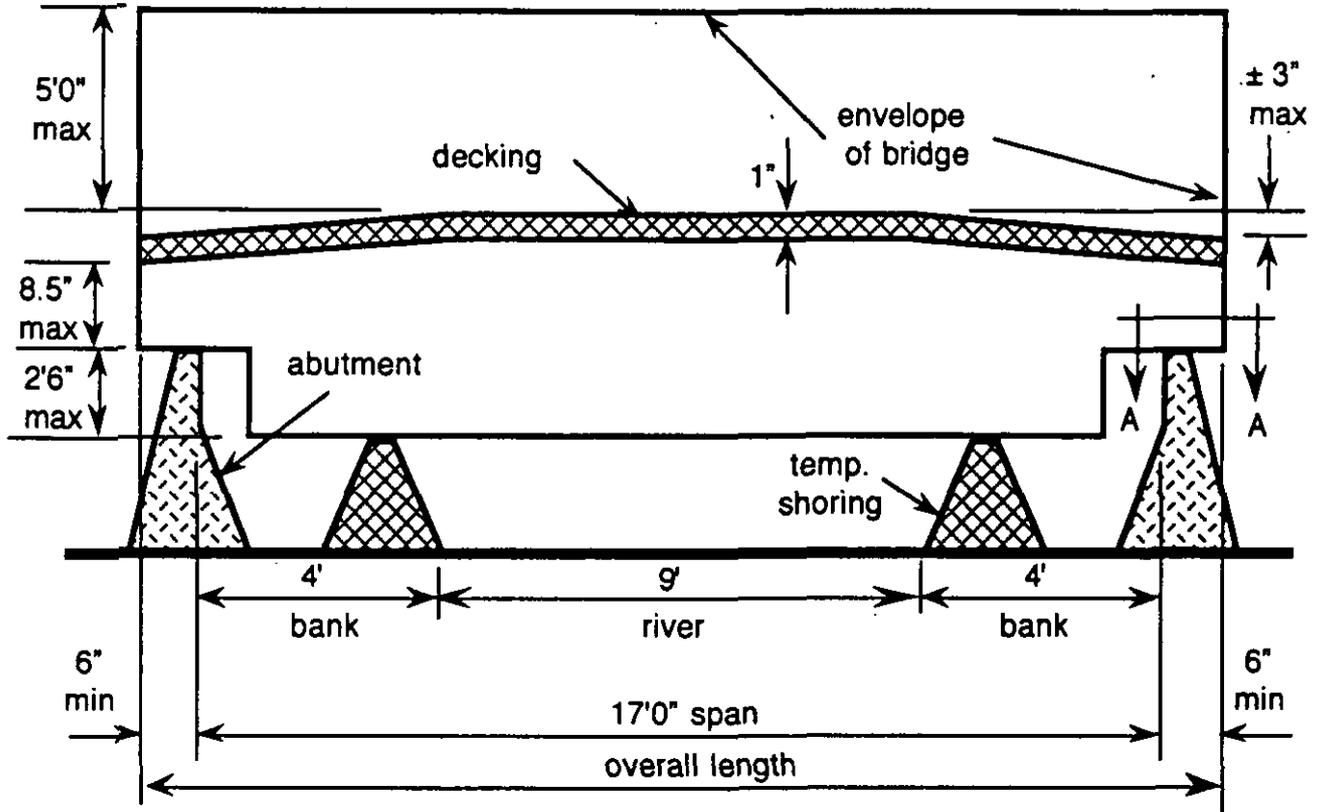
5. No part of the bridge may extend more than 5'0" feet above the top of the decking at any point on the span. Also see item 5 of the preceding section.

6. No part of the bridge may extend more than 2'6" below the top of the abutments at any point on the span. Also see item 6 of the preceding section.

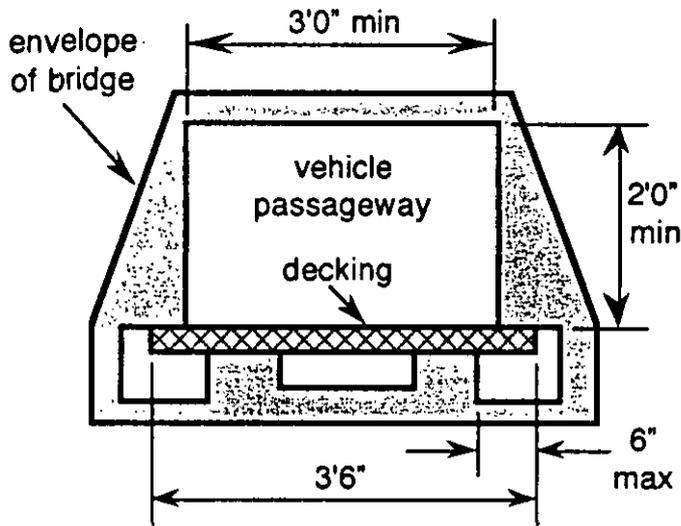
7. The surface of the decking support must be no more than 8.5" above the top of the abutments, measured at the abutments.

8. The absolute value of camber must not exceed 3 inches.

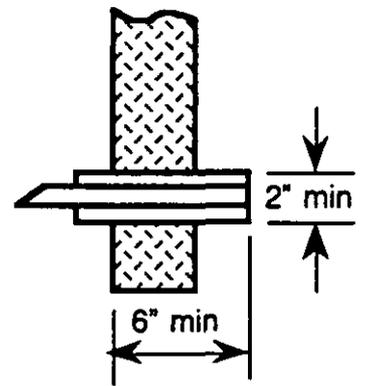
9. A 3'0" wide by 2'0" high rectangular vehicle passageway must be provided along the overall length of the bridge.



Side Elevation



Clearance and Deck Support



Section A-A  
Typical 4 places

## MATERIAL AND COMPONENTS

### Safety

If the following regulation is violated, the bridge must be disqualified.

1. A member may not weigh more than 40 pounds. See the next section for definition of "member."

### Durability and Constructibility

Violation of each of the following rules will result in a weight penalty being added to the weight of the bridge. The penalty for each violation is 10 pounds plus 5 times the weight of the non-conforming members, fasteners, assemblies and other parts.

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

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

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

b. Fasteners are steel machine bolts and nuts. Bolts must be straight, threaded and have hexagonal, square or round heads that will accept a wrench or screwdriver. Eye bolts are not permitted. Nuts must be threaded internally.

c. An assembly is no more than 3 members plus any number of fasteners that are joined together in the staging yards during timed construction.

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



Hollow circular and oval tube and other curvilinear closed shapes



Fabricated sections including closed curvilinear components

### Example Unacceptable Member Cross-Sections

4. A member may not exceed overall dimensions of 5'6" x 7.5" x 7.5." That is, it must fit in a prismatic box of those dimensions.

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

6. A member may consist of several parts rigidly joined together before timed construction begins. Those parts must remain rigidly joined throughout the construction process and in the completed bridge. For example, if a member incorporates a turnbuckle, that turnbuckle may not be turned after the start of timed construction. However, a turnbuckle itself may be identified as a separate member, in which case builders must join it to other members during timed construction and may turn and adjust it during timed construction.

7. Fasteners must be threaded and may not exceed 3 inches in length. Bolts must have hexagonal, square or round heads that will accept a wrench or screwdriver. Eye bolts are not permitted.

8. Every bolt must be secured by screwing it into a nut or threaded hole.

9. Members and assemblies may be joined without the use of fasteners.

10. The members of an assembly must remain joined (not necessarily rigidly).

# CONSTRUCTION

## Safety

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

1. Each unit of temporary shoring may not weigh more than 40 pounds. Temporary shoring is defined below.

2. Temporary shoring must not break or collapse during construction.

3. Only hand-held tools are permitted. Tools must be powered manually or by internal batteries. Field welding and tools requiring external power connections are prohibited. Ropes are permitted but gin poles, jacks, winches, come-alongs, counterweights and other hoisting devices are prohibited. Stools, ladders and similar objects for elevating builders are prohibited.

4. All builders must wear hardhats during timed construction.

5. A builder may not use the bridge, an abutment or temporary shoring to support the builder's body weight. For example, standing, sitting or kneeling on those objects is prohibited. However, a builder may lean on the bridge, abutment or shoring if both feet remain on the river bank.

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

7. A builder may lift or carry only one member or one unit of temporary shoring at a time. See "Material and Components" for definition of member.

8. An assembly may not be lifted or carried by one builder alone. See "Material and Components" for definition of assembly.

9. Two or more builders may lift or carry only one assembly at a time.

10. A constructed portion of the bridge (i.e. not conforming to the definitions of member or assembly) may not be lifted or carried.

11. A constructed portion of the bridge must be supported fully at all times by some combination of temporary shoring and abutments. That is, builders may not support either or both ends or sides of a constructed portion. Temporary shoring must be removed without lifting either or both ends or sides of a constructed portion of the bridge.

12. A constructed portion of the bridge may not be slid horizontally unless it is supported by both abutments, or by temporary shoring on both banks, or by one abutment and one unit of temporary shoring.

## **Team**

The construction team, also referred to as builders, consists of everyone who handles the bridge or any of its components during timed construction. Participation is limited to students. Only builders are permitted in the construction site during timed construction.

## **Tools**

Competitors provide their own tools. See item 3 of the preceding section. Hardhats are considered to be tools.

## **Construction Site**

See the figure titled "Site Plan" for layout of river, banks, and other features that affect construction.

## **Temporary Shoring**

Shoring is support on one or both river banks, and is provided by the competitors. Temporary shoring may be any material but must provide sufficient strength and stability to support the bridge. Temporary shoring must be removable without lifting the bridge.

## **Start**

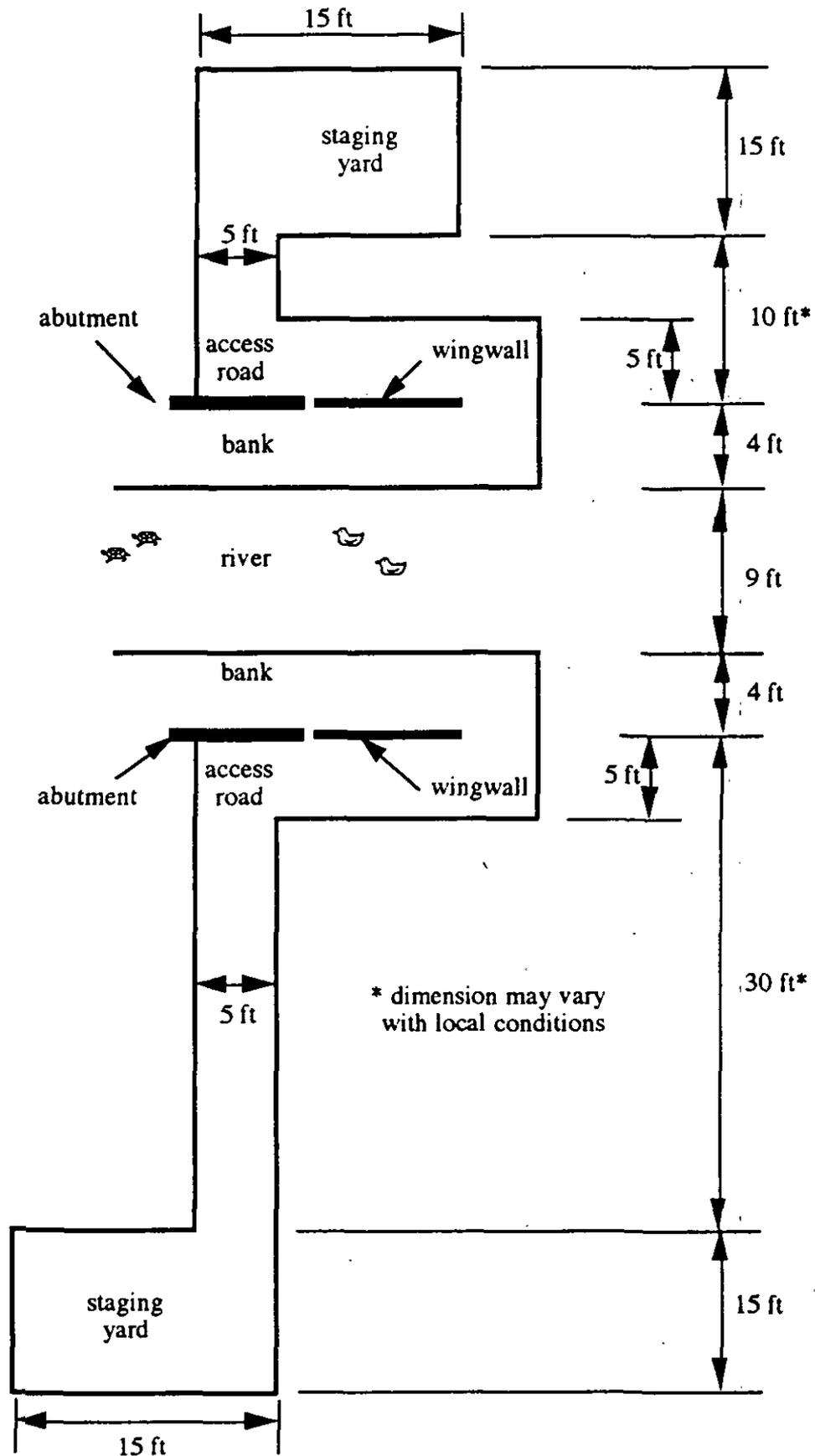
Before construction begins, all members, fasteners, units of temporary shoring, tools and builders are in the staging yards. Timing and construction begin when the builders signify that they are ready and the judge declares the start.

## **Time**

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

1. if a builder or judge sees a condition that could cause injury, or
2. when a safety regulation has been violated.

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



Site Plan

## Time Limit

The clock time for constructing a bridge is limited to 30 minutes. If construction exceeds that time limit, a penalty of \$5000 per clock minute over the limit will be added to the score in the economy category.

## Finish

Construction ends when the bridge is complete, and all tools, temporary shoring and builders are in the staging yards, and the builders signify that they are finished. Installation of decking is not included in timed construction.

## Accidents

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

1. A builder touches the river. Penalty is 3 person-minutes per incident. Exception: Builders may step in the river without penalty to retrieve a dropped member, assembly, tool or fastener.
2. A builder throws something. Penalty is 3 person-minutes per incident.
3. A builder crosses a wingwall or an abutment. Penalty is 2 person-minutes per incident.
4. Temporary shoring touches the river or an access road, or extends over the river. Penalty is 2 person-minutes per incident.
5. A member, assembly, or the bridge touches the river, a bank, or an access road. Penalty is 2 person-minutes per incident.
6. A member or assembly is placed on or leaned against the bridge, a wingwall, an abutment or a unit of temporary shoring without being joined to the bridge or held by a builder. Penalty is 2 person-minutes per incident.
7. A fastener or tool is placed on or leaned against an abutment, a wingwall, or a unit of temporary shoring. Penalty is 1 person-minute per incident.
8. A tool or fastener touches the river, a bank, or an access road. Penalty is 1 person-minute per incident.
9. A builder steps beyond the limits of an access road, staging yard or river bank. Penalty is 1 person-minute per incident.

## LOAD TESTS

### Safety Precautions

A bridge could collapse or sway suddenly during load tests. Therefore, minimize the number of people near the bridge while it is being tested.

If abutments are adjustable, set them so that the bottom of the bridge is 3 to 6 inches above ground.

During testing, safety supports must be in place 3 to 6 inches below the bottom of the decking.

Do not exceed 400 psf uniform load or 500 pounds concentrated load on the decking. Do not load on a cantilevered portion of the decking.

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

### Repairs

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

1. Damage occurring after construction will be repaired without penalty.
2. Minor construction errors will be repaired without penalty. For example, a nut may be adjusted to correct a slight misalignment of a primary component with no penalty.
3. Errors due to negligent construction will be repaired but a time penalty will be assessed in an amount, to be determined by the judge, that will exceed the incremental time required for careful initial construction. For example, a team that forgets to install bracing or makes no attempt to adjust nuts during timed construction will be penalized.
4. Deliberate exploitation of these repair provisions constitutes negligent construction and will be penalized heavily.

**General Procedures and Definitions**

Load tests are conducted without temporary shoring. Load test 1 is conducted without decking; load tests 2 and 3 are conducted with two decking units installed to accommodate the load.

Given weights of load are in addition to decking.

The figure titled "Location of Targets" illustrates some of the following procedures.

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

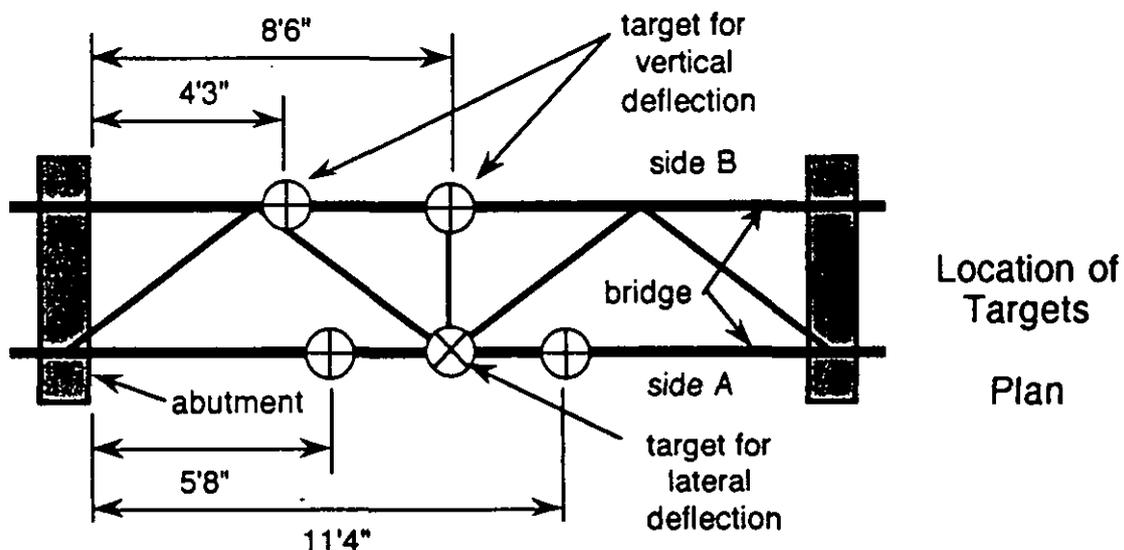
The judge marks a target at midspan on the A side, close to the level of the decking. All lateral deflection measurements are made to that target.

The judge marks targets on the A side at the third points of the span (i.e. 5 feet 8 inches and 11 feet 4 inches from the faces of the abutments). Then the judge also marks targets on the B side at the one quarter point and at midspan (i.e. 4 feet 3 inches and 8 feet 6 inches from the face of an abutment). The targets should be close to the level of the decking. Vertical deflection measurements are made to all four targets; vertical deflection is the largest absolute value of the four measurements.

Total lateral deflection is the absolute value of the horizontal distance of the target from its position at the beginning of load test 2. Incremental vertical deflection is the largest absolute value of the vertical distances of the targets from their positions at the beginning of load test 3.

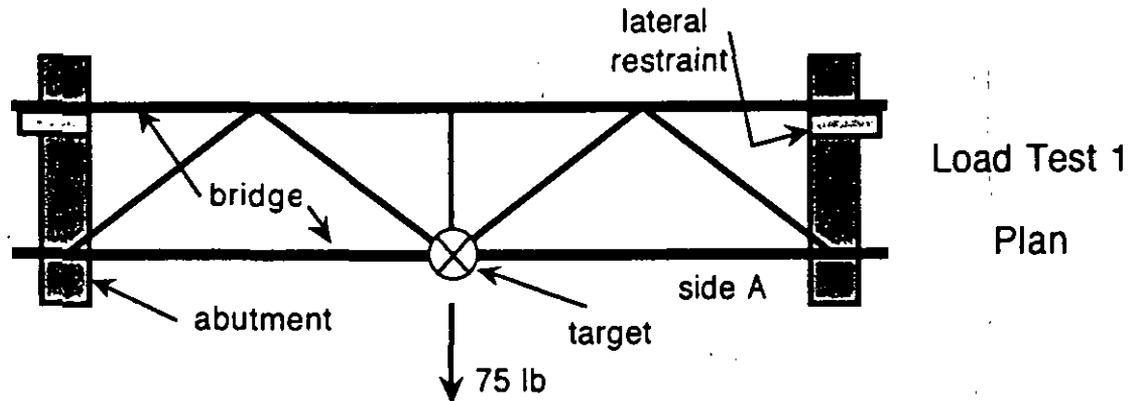
Load tests are conducted in numerical order.

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



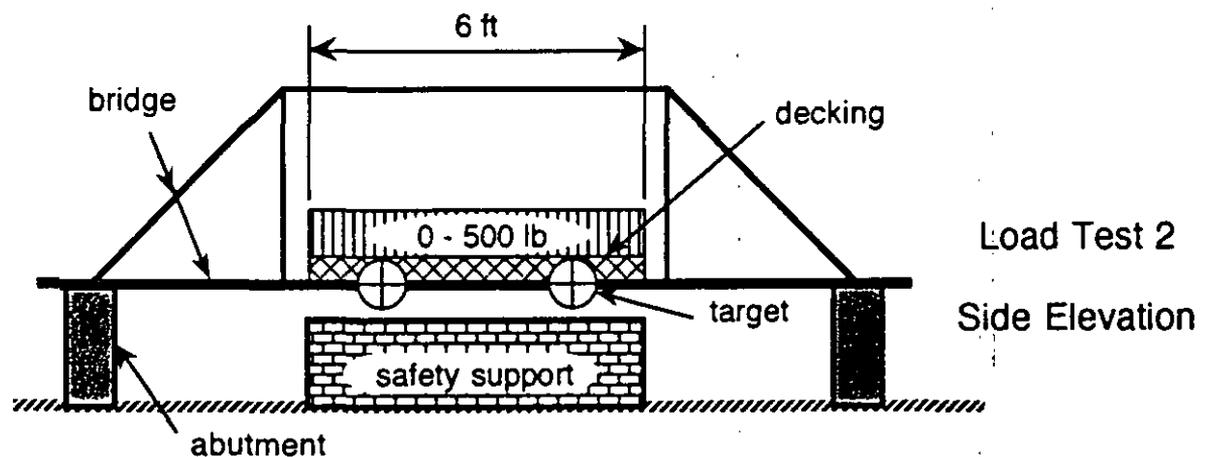
### Load Test 1 - Lateral

Load test 1 is conducted with lateral restraint installed on the abutments to prevent the ends of the bridge from sliding. On side A, as close as practical to midspan and to the level of the deck apply a 75 pound force in the lateral direction. To pass load test 1, the lateral deflection of the bridge must not exceed 1.0". If the bridge does not pass load test 1 it is disqualified; do not conduct any other load test. Remove the lateral load; it is not part of the remaining load tests.



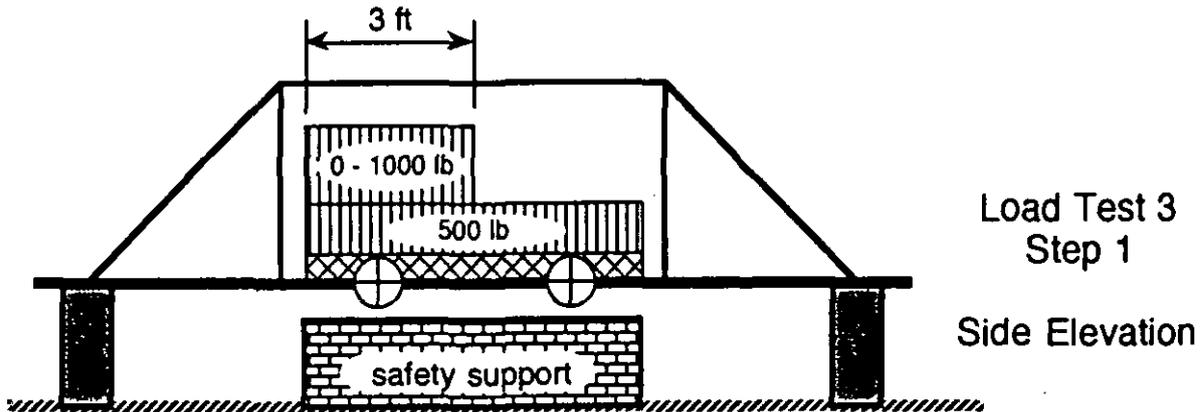
### Load Test 2 - Vertical, Preliminary

Uniformly distribute load over an area symmetric about the middle of the deck and extending 6 feet in the span direction, as shown in the figure. Terminate load test 2 when lateral deflection exceeds 1.0" or vertical deflection exceeds 2.0" or 500 pounds of load have been placed. A bridge passes load test 2 if 500 pounds of load was placed without a deflection limit being exceeded. If the bridge does not pass load test 2 it is disqualified; do not conduct any other load test.

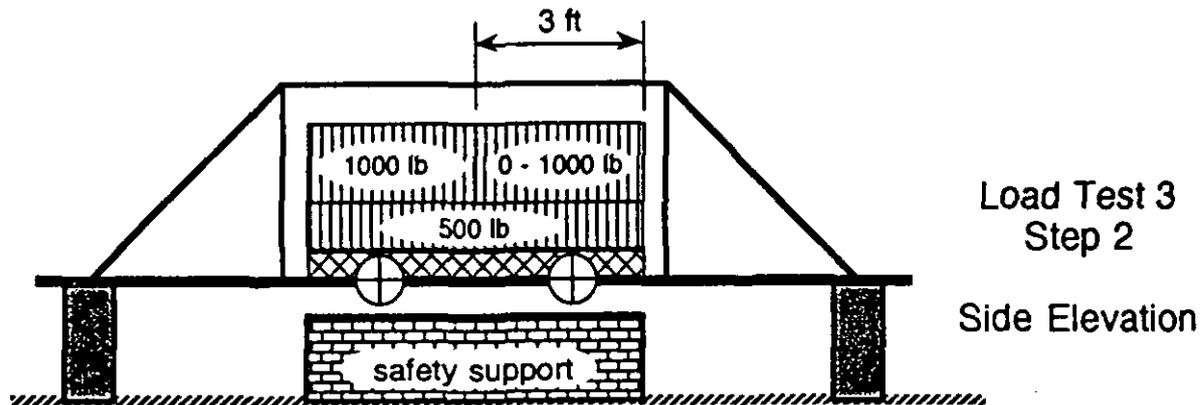


**Load Test 3 - Vertical, for Deflection Measurement**

**Step 1.** With the 500 pound load from test 2 remaining in place, record the vertical deflections of all targets (because they will be needed to compute the incremental vertical deflection). Then, uniformly distribute additional load over an area symmetric to the midline of the deck and extending 3.0 feet from midspan toward an end randomly selected and designated by the judge. That is, the load is longitudinally eccentric, as shown in the figure. Terminate step 1 when total lateral deflection exceeds 2.0" or incremental vertical deflection exceeds 2.0" or total load is 1500 pounds. Terminate load test 3 and disqualify the bridge if either deflection limit is exceeded.



**Step 2.** With previous loads remaining in place, uniformly distribute additional load over an area symmetric to the midline of the deck and extending 3.0 feet from midspan toward the end opposite to the one designated by the judge in step 1. That is, the load restores symmetry, as shown in the figure. Terminate step 2 when total lateral deflection exceeds 2.0" or incremental vertical deflection exceeds 2.0" or total load is 2500 pounds. Terminate load test 3 and disqualify the bridge if either deflection limit is exceeded. If the total load of 2500 pounds was placed without a deflection limit being exceeded, then the bridge passes load test 3. Record the incremental vertical deflection (that is, the largest absolute value of the vertical distances of the four targets from their positions at the start of test 3).



## EQUIPMENT PROVIDED BY HOST

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

### Lateral Load Device

Capable of applying 75 pound force in the horizontal direction.

### Measuring Instruments and Scales

#### Load

2500 pounds total. The load should be supplied in uniform pieces of size and weight that may be handled safely. When in place, the load should not provide significant stiffness in the longitudinal direction of the bridge. Sections of steel angle of uniform size and length are recommended for load. Sacks of material, containers of liquid, concrete blocks or jacking systems could be used. Decking is not included as part of the 2500 pound load.

#### Decking

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

#### Abutments

Construction. The top surface of each abutment should be at least 5 feet long, at least 3 inches wide, level, smooth, and approximately 3 feet above the ground.

Load Testing. A different set of abutments may be used during load testing. The top surface of each abutment should be at least 5 feet long, at least 3 inches wide, level and smooth. Height may be adjustable so that the bridge may be positioned close to the ground. Temporary lateral restraints are needed during load test 1.

#### Safety Support

The safety support must be used during load testing and is intended to limit the consequences of a bridge collapsing. The safety support should extend at least 6 feet along the length of the bridge. It should be adjustable in width and height, and should be centered under the bridge. The safety support must be placed before the beginning of load testing, with the top 3 to 6 inches below the bottom of the decking.

## JUDGING

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

## PROTESTS AND APPEALS

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

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

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

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

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

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

**After the National Contest** Appeals will not be accepted. However, AISC welcomes written suggestions for improving future competitions.

## TIPS FOR COMPETITORS

1. Strive for challenging but realistic goals for design and construction. The following statistics from the 1998 National Student Steel Bridge Competition suggest the levels of performance that are possible. However, when reviewing these statistics keep in mind that the rules and scoring for 1999 differ from those for 1998.

	Winning bridge in category	Winning bridge, overall
Weight (lb)	57	75
Construction time (person-minutes)	9.23	14.89
Incremental vertical deflection (inches)	0.165	0.165

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

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

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

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

6. Allow tolerances for spacing and levelness of abutments.

7. Allow tolerances for all limiting dimensions, in order to accommodate imprecise fabrication, thermal expansion, elastic and inelastic deformation, wear, etc.

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

9. Make sure that abutments, temporary shoring and safety support are strong enough (with a generous factor of safety) and will not tip during use, even if the bridge collapses.

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

11. Follow all safety regulations and guidelines during construction practice.

12. When load testing your bridge keep it as low to the ground as possible and place safety support a few inches below the decking under at least 6 feet of the span. This will reduce risk of injury and limit damage to the bridge if it collapses. Keep hands and feet out from under the bridge.

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

14. To expedite the competition have a preset plan for unloading and staging components of your bridge. Before the competition adjust your temporary shoring to conform to the height of the host's abutments.

## SCORE SHEET

### Time Penalties

See "Construction: Accidents"

items 1,2: violations \_\_\_\_\_ x 3 = \_\_\_\_\_ person-min

items 3-6: violations \_\_\_\_\_ x 2 = + \_\_\_\_\_ person-min

items 7-9: violations \_\_\_\_\_ x 1 = + \_\_\_\_\_ person-min

TIME PENALTIES (add) \_\_\_\_\_ person-min

### Weight Penalties

See "Dimensions and Support: Usability"

Number of violations \_\_\_\_\_ x 50 pounds = \_\_\_\_\_ pounds

See "Material and Components: Durability and Constructibility"

Number of violations \_\_\_\_\_ x 10 pounds = + \_\_\_\_\_ pounds

Wt. of parts in violation \_\_\_\_\_ pounds x 5 = + \_\_\_\_\_ pounds

WEIGHT PENALTIES (add) \_\_\_\_\_ pounds

### Construction Time

\_\_\_\_\_ builders x \_\_\_\_\_ min

+ time penalties = \_\_\_\_\_ = \_\_\_\_\_ person-min

### Total Weight

Bridge weight \_\_\_\_\_ pounds

+ weight penalties \_\_\_\_\_ = \_\_\_\_\_ pounds

### Aesthetics

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

Other items that may be considered:

General appearance	Finish
Balance and proportion	Elegance
Construction organization	Teamwork

AESTHETICS SCORE \_\_\_\_\_

**Deflection**

(incremental vertical, test 3) \_\_\_\_\_ inches

**Efficiency**

Total weight (lb) \_\_\_\_\_ = \_\_\_\_\_

Incremental vert. deflect. (in) \_\_\_\_\_ x 300 = + \_\_\_\_\_

SNWD (add) \_\_\_\_\_

**Cost**

Const. Time \_\_\_\_\_ x \$5000 = \$ \_\_\_\_\_

Total Weight \_\_\_\_\_ x \$1000 = +\$ \_\_\_\_\_

Units of Temporary Shoring \_\_\_\_\_ x \$30,000 = +\$ \_\_\_\_\_

TOTAL COST (add) \$ \_\_\_\_\_

**Ranks**

Disqualified bridges will not be ranked.

Lightness \_\_\_\_\_ Construction Speed \_\_\_\_\_

Aesthetics \_\_\_\_\_ Stiffness \_\_\_\_\_

Efficiency \_\_\_\_\_

Economy \_\_\_\_\_

**Overall Performance**

Sum of ranks, except lightness and aesthetics.

Construction speed + Stiffness + Efficiency + Economy = \_\_\_\_\_

Use aesthetics as tie breaker.

