Students Get Hands-On Experience At Steel Bridge Competition

Observers had their pick of bridges at this year's National Student Steel Bridge Competition in Anchorage.

In late May, 40 universities from around the U.S. gathered together at the University of Alaska-Anchorage to compete in the 8th annual AISC National Student Steel Bridge Competition. The competition—sponsored by AISC and co-sponsored by ASCE, AISI, NSBA, James F. Lincoln Arc Welding Foundation, TXI-Chaparral Steel Co. and the Nucor Corporationn—is a competition to determine which team of undergraduate engineering students can design and build the "best" steel bridge—or at least an 18' version.

Early last fall, AISC sent the 1999 competition rules to civil engineering schools all over the United States and Canada. Bridge teams came together, and the students began to apply the principals they have learned in classes such as Statistics, Mechanics of Materials, Structural Analysis and Steel Design. Teams competing at UAA had already competed at the regional level and have placed either 1st or 2nd in their respective regions to earn an invitation to the National Championship Competition. Fromy Rosenberg, assistant director of education at AISC, observed that "More and more students participate in the Student Steel Bridge Competition. In the academic year 1999, a total of 186 universities have competed in all of ASCE student chapter regions." The University of Nevada–Reno walked away with the first prize, followed by California State University–Chico and California Polytechnic State University–San Luis Obispo, respectively. A sportsmanship award was given to Howard University. Professor David Sanders, faculty advisor of the competition, remarked about the University of Nevada-Reno's victory: "I am very proud of this team. Last year's Nevada team finished third in the country, but this team was not satisfied, and worked very hard to improve. This is extraordinary when you consider that the team members were undergraduate students that were not just doing the competition, but also taking courses and working."

So how is the best bridge in the nation determined? As the competition goes on, each bridge is scored in six categories: Aesthetics, Construction Speed, Lightness, Stiffness, Economy, and Efficiency. Each team is given a "Problem Statement" which describes challenges encountered in a representative structural engineering project, allowing the students to create a scaled simulation of that project. The competition rules were changed for 1999 in order to improve the contest and to assure those competitors design and build new bridges. Teams are ranked in each category, and at the end of the day, the ranks of each team are added together.

Aesthetic ranking was judged by a team of architects and artists who considered the general appearance, balance and proportion of the design, elegance, finish, and construction organization of each bridge, but not the quality of fabrication because some bridges may be fabricated professionally while others are student work. Ideally, students should fabricate the entire bridge themselves, but 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. (The aesthetic ranking of the bridges could be used as a tiebreaker in the event of tie in the other rankings).

Less than three minutes

The Construction Speed score is the number of person minutes, plus penalties, that each team uses to construct their bridge in the erection area. Three identical erection areas are set up for the competition. Each erection area simulates an actual bridge construction site in a mountainous region. Bridge members must be brought to the "river" from the "staging areas" located away from the "river". Members and assemblies must be brought to the "river" along runways with corners because the mountainous approaches to the bridge site are torturous and fraught with obstacles. Time penalties are assessed if team members step outside the boundaries of the roads or in the river, or drop bridge parts or tools.

Additional penalties could be assessed if the strict safety rules of construction are not followed: at least two team members must handle a bridge "assembly" (an "assembly" is an assembled part of the bridge containing no more than three "members"). No team member can cross the river, or use the bridge or an abutment to fully support his or her body. Any constructed portion of the bridge consisting of more than 3 members has to be fully supported by the abutments or by temporary shoring at all times. Time of construction stopped when the bridge was constructed and all builders and tools were back in the staging areas. The final score is recorded in person minutes, as some teams are only made up of three or four students. Sanders stated that, "It is amazing to me how quickly these structures are assembled. The teams practiced many times in order to shave off just a few seconds. The entire competition emphasizes the need to work as a team."

The fastest team, California State University-Chico, erected their bridge with a three-person teamin just ***151.67 seconds***.

Easily Transportable

From the erection areas the assembled bridges are carried to the weighing area, where the Lightness score is determined. The lightness score of each bridge is the actual weight of each bridge, in pounds, plus any weight penalties assessed. Weight penalties are assessed if the bridge or any part of it does not meet the strict usability and material requirements of the rules. Bridges, save school banners or placards, must be built entirely of steel. Pipe and round or oval tubing can not be used to build the bridge. The assembled bridge must support the decking which will support the defection weights, and it must have adequately clearance so that a "truck" measuring 2' x 3' can drive over the bridge. The bridge could extend no more than 5' above the decking, nor more than 30" below the abutments. It must extend at least 6" beyond the abutments on each end. And all bridge members need to be rigid so competitors cannot use cable in their bridges. "In order to keep their bridge as light as possible, each component was closely evaluated. No matter how small the weight, a member was reduced or removed if not necessary," Sanders remarked.

The lightest bridge, from the University of Utah, weighed only 59.4 lbs.

From the weighing area the bridges are moved to one of the five loading stations where the Stiffness score is determined. Each of the bridges is subject to 4 different loads, and the deflection at five different locations on the bridge is measured under each load. First, a horizontal load of 75 pounds is applied to each bridge at mid-span. If the bridge deflects sideways more than 1", the bridge is disqualified from the competition. If it passes the lateral load test, the preliminary vertical load is applied. Team members put the decking on their bridge, and then place twenty 25-lb. billets (500 lbs.) onto the decking. Deflections are again checked and recorded – if the vertical deflection exceeds 2", the bridge is disqualified. If deflection is less than 2", an additional 40 billets (1000 lbs.) are placed on the bridge, this time off center. Again, deflection must be less than 2" for the bridge to qualify for the final load. For the final load test, 40 more billets are placed on the bridge, bringing the total load to 2,500 pounds. If the bridge holds the load without failing and does not deflect more than 2", it has qualified. Deflections are measured again, and the incremental deflection calculated. Incremental deflection is the maximum additional deflection that occurs as a result of the additional 2,000 lbs. placed on the bridge after the preliminary 500-lb. load. This incremental deflection is the stiffness score of the bridge.

Efficient Designs

Once construction speed, weight, and incremental deflection are measured, the Efficiency and Economy of each bridge was calculated. Efficiency is a value called the sum of normalized total weight and deflection (SNWD). The sum of normalized weight and deflection is = Total weight (lb) + 300 x Incremental vertical deflection (in). The bridge with the lowest value of SNWD will place first in the efficiency category. The economy or cost (C) of a bridge is computed as: C = Total weight (lb.) x 1000 $/lb.) + Construction time (person-min) x 5000 ($/person-minute) + Number of temporary shoring units x 30,000 ($/unit).

The bridge with the lowest cost wins the economy category.

The National Student Steel Bridge Competition creates a real-life scenario where the students' textbook learning can be put into practical engineering experience. "We're trying to get this thing where it's a real world situation," said head judge, John Parucki. "Specifications are important, dimensions are important. All these disqualifications or penalties we hope stick in the back of their minds somewhere . . . It's something you can't learn in a classroom."

In addition to experience, the competition teaches students teamwork, communication, and problem solving. One student frankly remarked, "You can't fight each other, or it won't work."

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

Economical Steel Design Seminar

The 1999 Lecture Series, "Essentials of Steel Design Economy," is designed to give engineers the tools they need to do their job within the time and budget constraints created by a project's owner.

The seminar will feature five lectures:

- Planning for Steel Design Economy
- Decision Making in System Selection and Layout
- Decision Making in Member Selection
- Economy in Connection Detail
- Project Review

These lectures will focus on giving a designer a better understanding of the economics of the steel fabrication/erection process and will focus on specific items the design engineer can use to reduce fabrication and erection costs, such as optimal bay sizes and layout and the use of repetitive member sizes. "The presenters have taken a step back to reveal the overall design perspective instead of drowning the audience in tedious technical calculations we all know how to use," explained one attendee at a presentation in January.

As part of the lectures, an example of a moment connection will be presented and then analyzed for economy in design, fabrication and erection. Also included in the lecture will be an assessment of the different roles and perspectives of members of the construction team.

"The seminar should help to improve communication and understanding between the design-detail-fabrication-erection team," explained Robert F. Lorenz, P.E., AISC's Director of Education. "We'll provide tips that will allow design professionals to anticipate detailed solutions to special conditions."

Seminar Schedule

Pittsburgh	Sept. 14
Charleston	Sept. 15
Washington, DC	Sept. 22
Richmond, VA	Sept. 23
Boston	Sept. 29
Portland, ME	Sept. 30
Philadelphia	Oct. 6
Edison, NJ	Oct. 7
Meriden, CT	Oct. 13
New York City	Oct. 14
Albany	Oct. 27
Rochester, NY	Oct. 28

Bracing Seminar Features Yura And Helwig

A new series of Bracing Short Courses, featuring Joseph A. Yura from the University of Texas at Austin and Todd Helwig from the University of Houston is about to get underway. The two-day, eight-hour course, including an 80-page handout, costs $200 ($175 for AISC/RCSC members). Covered are present principles, case studies and recommendations. The lectures include: column & frame bracing; lean-on systems; torsional bracing; beam buckling; lateral bracing of beams; and torsional bracing of beams.

Jointly sponsored by AISC and the Structural Stability Research Council, the seminar is a repeat of the standing-room only short course at the 1995 NSCC Conference. For more information, fax 312/670-5403 or register by calling 630/369-7784.

Bracing Course Schedule

1999

Sept. 23-24 ......Minneapolis

Dec. 6-7 ....Atlanta

2000

Jan. 11-12 ....Pittsburgh

Jan. 13-14 ....Denver

To receive more information on the Bracing Short Course, please fax 312/670-5403 or consult the AISC web site at **www.aisc.org**.

Steel Marketing Summit

For those who are looking to improve their competitiveness in the steel industry, AiC is offering their 5th Annual AISA STEEL SUMMIT from November 22nd through 23rd at the Royal Cliff Beach Resort in Pattaya, Thailand. The focus of the conference will be the commercial and marketing aspects of the steel industry. This event has been packaged with a number of site visit options available including Siam Strip Mill, Thainox stainless steel plant, TSSI Wire Rod Plant, and BHP's coating & painting facility.

If interested, contact Andrew Crooks by phone at 61-2-9210 5717, by fax: 61-2-9223-8216, or by e-mail: acrooks@rivernet.com.au.

Seismic Seminar: Braced and Special Moment Frames

August 18 marks the premier of a new steel design seminar, “Applying AISC Seismic Provisions for Braced Frames and Special Moment Frames.” The course is aimed at practicing professionals who need an immediate update on the 1997 Seismic Provisions and their application in LRFD for Braced and Special Moment Frames.

The seminar is divided into three parts:

- AISC 1997 Seismic Provisions/SAC Update (scope; seismic maps & design categories; load combinations; materials; SAC & NEHRP Update)
- Design/Detail: Braced Structures (Special Concentrically Braced Frame [SCBF]; Ordinary Concentrically Braced Frame [OCBF]; and Eccentrically Braced Frame [EBF])
- Connections for Special Moment Frames (Reduced Beam Section Connection; Tapered Welded Haunch Connection; Truss Analogy Connection; Proprietary Connection 1; Proprietary Connection 2; and others).

The 1997 Seismic Provisions are expected to become mandatory for seismic design in California as a replacement for the 1997 UBC, Chapter 22, Divisions IV and V. In addition, certain jurisdictions in California have requested the endorsement of SEAOC for the early adoption of the Provisions.

Developed by the AISC Committee on Specifications and Task Committee 113—Seismic Design with input from the Building Seismic Safety Council, the National Science Foundation, the SAC Joint Venture and the Structural Engineers Association of California, the Provisions are intended for the design and construction of structural steel members and connections in seismic force resisting systems in buildings for which the design forces resulting from earthquake motions have been determined on the basis of energy dissipation in the inelastic range of response. They currently are required for buildings that are classified by the Applicable Seismic Category D (or equivalent) and higher or when required by the Engineer of Record.

The course has a value of 5.5 PDH. The cost for the seminar is $185 ($135 for AISC members) with discounts for multiple attendees from the same firm. For more information, call 630/369-7784.

Seminar Schedule

Seattle	Sept. 8
Anchorage	Sept. 9
Sacramento	Oct. 12
San Francisco	Oct. 13
Salt Lake City	Oct. 27
Portland	Oct. 28

Joist Vibration Program

The Steel Joist Institute has introduced a new computer program to assist the qualified professional engineer in determining probable vibration characteristics of floor systems using open web steel joists. This program is designed for use in conjunction with The Steel Joist Institute's Technical Digest #5 "Vibration of Steel Joist-Concrete Slab Floors," a copy of which is included with the computer program.

The computer program allows the designer to quickly and easily calculate the frequency and amplitude resulting from transient vibration caused by human activity on a joist-concrete floor. The Modified Reiher-Meister graph can be displayed on the computer monitor visually displaying the intersection point of the system's Frequency and Amplitude and the resulting level of human perceptibility. The "what if" scenario - variations in slab thickness, concrete strength, joist size, joist spacing, floor decking, live and dead loads, span lengths - can be accomplished in seconds. Primary support systems consisting of joist girders or structural steel beams can also be analyzed as a part of the floor system.

The program is user friendly, can handle spans up to 100', and can accomplish calculations that previously required several hours in seconds. It's available on 3-1/2 inch disks and is IBM-PC compatible.

For more information or to order a copy, contact: Steel Joist Institute, 3127 10th Ave. North Ext., Myrtle Beach, SC 29577-6760 (web site: www.steeljoist.org).

AISC Information Technology Update

By Steven E. Hamburg, P. E.

35-Year Engineering Journal Archive CD-ROM

Are you getting tired of filling your bookshelf with all of those Engineering Journals? AISC has developed a new interactive CD-ROM containing all 35 years of its quarterly published *Engineering Journal* (*EJ*).

The CD-ROM allows you to search by subject, author, table of contents, keyword and year. You may also perform full-text searches throughout all EJ articles. For more information, see pages 30-31.

AISC Electronic Commerce (EDI) Initiative

• AISC's E-Commerce Initiative is attracting a lot of attention, including the presentation of a paper this month by RAM International at a London conference. To view a PDF version of this document, consult AISC's website www.aisc.org/releases/RAMpaper.pdf.

• The Intergraph Graphic Users Group also recently published a paper on AISC's E-Commerce Initiative (see www.aisc.org/releases/IGRAPHpaper.pdf). This paper is also posted in Intergraph's web site (www.intergraph.com).

• AISC will be establishing two email discussion lists later this month—one for the entire structural steel design and construction industry and the other specifically for software developers. These email discussion groups will allow the free exchange of information and opinions on the AISC E-Commerce Initiative. For more information see www.aisc.org/releases/edi.htm.

Version 3.0 - AISC Shapes Database - Available in November 1999

The third version of the AISC Shapes Database will be released in November 1999. Two versions (one containing all cross-sectional properties in U.S. customary units and the other in Metric units) and two editions ('Professional' and 'Software Developer') will be available.

The Professional Edition of Version 3.0 of the Shapes Database will contain cross-sectional properties of AISC shapes, including HSS, W, M, S, HP, C, MC, Angles, WT, Double Angles, MT, ST and Pipe.

The Software Developer Edition of Version 3.0 of the Shapes Database will contain the following:

- Cross-sectional properties of AISC shapes, including HSS, W, M, S, HP, C, MC, Angles, WT, Double Angles, MT, ST and Pipe
- AISC's official naming convention (i.e. the rules of the convention itself) for all shapes for which cross-sectional properties are provided.
- AISC's official naming convention (i.e. the rules for the convention itself) for flat, round and hex bars, plate, floor plate and sheet.
- Corresponding names (e.g. 'LLBB2x2x1/4' and not the actual rules for the convention itself) for each cross-section. This information will be provided in a separate data column.

AISC Web Site: Upgrade coming on October 4 (www.aisc.org)

AISC is performing extensive modifications to its ever-growing web site. Enhancements include:

- Increased speed
- Optional 'text-only' mode eliminating graphics
- On-line membership directories for all AISC members (i.e. Active Fabricator, Associate, NSBA Affiliate and Professional members)
- Sophisticated search engine for all contents within the site
- Extensive Frequently Asked Question section (FAQ).
- Expanded list of freely downloadable technical documents
- Free links for academic institutions offering courses involving structural steel and trade associations serving the structural steel design and construction industry

Steven E. Hamburg, P.E., is AISC's Director of Electronic Communication.