Bridges & Beyond

The 2003 National Student Steel Bridge Competition

Beth S. Pollak

The National Student Steel Bridge Competition gives young structural engineers a chance to put design, construction and project-management principles into practice.

"A century-old bridge that crosses an environmentally sensitive river must be replaced…no other river crossing is available for miles…the State DOT has specified steel as the material because of its durability and fast erection…your company's design/build proposal is among those 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 load tested…The contract will be awarded to the company that submits the best model."

This was the challenge faced by more than 1,100 students from 171 schools this year in North America; and after 20 regional competitions and a nail-biting national final in May, only one team could win. But many students returned home knowing that they had applied engineering and project management skills to create tangible steel structures—and they had a lot of fun in the process.

Third-place University of Florida team members in action as the judges observe their progress. The land-based team members remain on the bank of the "river" while one team member designated at the "barge" works from the water.

OVERVIEW

As all project managers know, coordinating the design, fabrication and erection of a steel bridge on schedule is no small task. But engineering students who participate in the AISC/ASCE National Student Steel Bridge Competition present an impressive display of agility, strategy and engineering skills as they create and assemble their steel bridges.

During the course of the year, the student teams design, fund, and fabricate the model bridges. Teams compete at one of 20 regional competitions, held in conjunction with ASCE regional conferences, to qualify for the national competition. The competition requires teams to erect their bridges in as short a time as possible. Rules give site conditions, member sizes, weight limitations, design loads, and erection and safety procedures. Penalties are given for stepping into the "water," dropping tools or equipment, and other violations. Once constructed, bridges have to meet limits for load-bearing capacities and deflection.

This year, the national finals were held at San Diego State University on May 23-24. The University of Michigan took the top overall award, followed closely by University of Wisconsin-Madison and University of Florida.

"The engineering students are doing more than just working on bridges," said Tom Cavallaro of Herrick Construction, who served as one of the judges at the national competition. "They learn to work as fabricators, project managers, engineers and detailers, and to see if their designs are constructable."

Team members from Columbia University work to erect their cable-stayed bridge, which won the aesthetics competition.

Prizes are awarded in seven areas: construction speed, lightness, aesthetics, stiffness, economy, efficiency and overall performance. This year the bridge competition was sponsored by AISC, and co-sponsored by ASCE, The American Iron and Steel Institute, The James F. Lincoln Arc Welding Foundation, the National Steel Bridge Alliance, Nucor Corporation and TXI Chaparral Steel.

TEAM BUILDING

University of Michigan took first overall in the finals, but captain Peter Haupt says his team had to work to rebuild itself during the course of the year. "Last year the team almost died out, with only two or three people," he said. "But we pulled together and did more publicity through our ASCE chapter. We tripled in size, and had more people to aid in the competition. We spent long hours constructing, problem solving, and fabricating, and it builds friendships."

Recruitment was also important for the University of British Columbia's team (UBC). "Year after year, [we publicize and recruit] through word of mouth," said Anu Saiki. "We get as many people involved as possible, and we put the bridge up for events on campus. People see the bridge and ask questions, and the curiosity draws them."

University of Florida's Bonnie Serina says the creation and construction of the team's bridge was a process of learning and working together. "We had a solid group of returning people and got a good start," she said. "There was total involvement, from freshmen to seniors. It was about training and teamwork—we started with nothing, and we have finished with skills and leadership."

TRUE DEDICATION

The design process for most teams began in the fall, shortly after the teams were formed. Some teams were formed

Rules of the Game

Each year, the rules of the steel bridge competition are reviewed and slightly modified to challenge the students—and ensure a fair competition. The list of rules includes regulations regarding bridge specifications, construction guidelines, safety limits, and the size and assembly requirements of cables, bolts and rigid members. What follows is a basic summary of what is required—and how to play.

At the time of publication of this article, the 2004 rules were finalized and will have been distributed to participating ASCE chapters.

Basic Competition Rules

- ✓ There can be no more than 10 builders on the construction team. All builders must wear hard hats and safety glasses during timed construction.
- ✓ Before construction begins all bridge members, tools, fasteners and builders EXCEPT for the barge must be in the staging yard. All bridge components and tools must lie flat on the ground. They cannot be connected or in contact with one another. Once time starts, no tools, builders or components can be brought to or removed from the construction site.
- ✓ Outside of the staging yard, a builder can lift, carry or support ONLY one cable with fittings and/or rigid assembly at a time. The number of builders moving an assembly must be at least equal to the number of rigid members and/or cables with fittings in that assembly.
- ✓ Outside of the staging yard, any portion of the bridge NOT in motion must be supported by itself, by the bridge structure, or by as many people as there are rigid members and/or cables with fittings.
- ✓ Builders can use only hand-held tools, and nothing can be thrown.
- ✓ No builder can cross or enter the river except the builder designated as the barge.
- ✓ Builders cannot use tools, team members, the bridge, or any portion of the bridge to support their body weight. However, they can lean on the bridge, provided that their feet or knees are on the ground.
- ✓ Time and construction can be stopped only if a builder or judge sees a condition that could cause injury, or when a safety violation or accident occurs.
- ✓ An accident includes: when a builder throws something; when a builder touches the river; when a builder steps outside of the boundaries of the construction site; when the barge touches or crosses the river bank, island or causeway; and if a bridge component or tool besides a bearing plate touches the ground outside the staging yard.
- ✓ Construction is over when all bridge members are connected and all tools and builders are back in the staging yards except the barge.

as part of academic curricula, and others were volunteer activities. Rules for this year's competition for the first time permitted the use of cables in the bridge design and construction. Many teams created innovative cable-stayed bridges, including the aesthetics competition winner, Columbia University. "We do a new bridge every year," said team member Ivan Vlahinich. "We start from scratch. The cable-stayed bridge was the highlight of the process, and made it interesting."

The design and fabrication of the steel bridges meant dedication: Many students spent vacations, nights and weekends welding and practicing, even during exam periods.

"We had weekly design meetings, and put in as much a possible," said University of Wisconsin-Madison's Jason Kutka. "We worked to optimize the design [to create] something that was as light as possible, and was as easy to assemble as possible."

Fabrication of the bridges began during or after the students' winter vacations. Some worked with fabrication shops and professional welders; others learned to do it themselves. "We built the bridge the second week of January, during winter break," Kutka said. "We had to wake up at 5:30 a.m. to be at the fabricator by 7 a.m. At the shop, they were really helpful. We had running design changes, for things like lateral deflection, and it went smoothly. We worked with them, cutting pieces and drilling holes."

UW-Madison's team also worked to perfect their construction technique. "We practiced every Saturday for a couple of hours, from 1 p.m. until 4 p.m.," said team member Drew Agosto. "We critiqued and critiqued to get everything perfect. We started with six people building, then eight, then nine. We were consistently [building the bridge] in under one minute."

The team's efforts paid off at the national finals—UW-Madison won the speed competition, with a final time of only 1 minute, 3 seconds, 19 seconds faster than the next-fastest team.

FUND RAISING

Individual teams were partially funded by academic departments and ASCE budgets, but many students had to make an extra effort to raise money for their bridges. "We sold pizzas, we cleaned yards, we mowed lawns, we painted, we scraped paint, we sold coupon books, and we had corporate donors," said Iowa State's Jake Bigelow.

Corporate donors helped bridge the gap for many teams. "Mostly companies sponsor us, and we work to make it close to the industry," said UBC's Saiki. "We get suggestions from our sponsors, and tricks for working with the competition rules."

Firms also served as important contacts for the soon-to-be graduating students. "The fact that they have to contact firms for fund-raising demonstrates interpersonal skills, as well as technical abilities and engineering knowledge," said competition judge Arief Koesoemawiria of Mactec Engineering and Consulting. "Developing industry contacts is important nowadays."

Jeff Deller, of Lawrence Tech, agreed that fund-raising was an important networking opportunity. "You talk to them about fund-raising, and they ask you for you resume!" he said.

REGIONAL COMPETITIONS

Regional competitions were held throughout the early spring, at different locations in North America. The top teams from each conference qualified for nationals.

Many teams started from scratch after the regional competitions: In order to be more competitive in the finals, they redesigned and re-fabricated their original bridges. "We re-fabricated the bridge after regionals, working full-time from April until now," said Brian Mashford, captain of the overall fifth-place team from Lakehead University. "It was steady work, with no help from ironworkers. We did our own welding and machining."

University of North Carolina-Charlotte also had a new bridge. "The regional bridge was not competitive," said team member Peter Foster. "We did the welding and bolting, and fabricated and tested it. We worked many man-hours on it, from 8 a.m. 'till midnight, even during finals, when we had papers to write, and theses to work on."

Practice time also intensified after regionals for the University of Alaska-Fairbanks. "We fine-tuned our procedures from regionals over and over again," said Mike Lund. "We wanted to be able to build our bridge consistently, and practiced taking extra tasks and members out."

After regionals, fund-raising efforts were easier for some schools. "It's tough to get funding every year, especially to travel from Alaska," Lund said. "But once we won regionals, fund-raising went well. The university was supportive and we had alumni sponsors."

Students from California State University-Sacramento had a similar experience. "We received $5000 in donations in the last three weeks," said Chris Ladeas. "Structural engineering groups gave more money, and the school also gave money."

Ladeas says his team also worked hard to improve the bridge for the final competition. "We had different schedules, but worked 20-25 hours per week, Saturdays and Sunday. We decreased the [bridge's] weight by removing the [original] top trusses—they were too much weight and required too much time to put together."

AESTHETICS COMPETITION

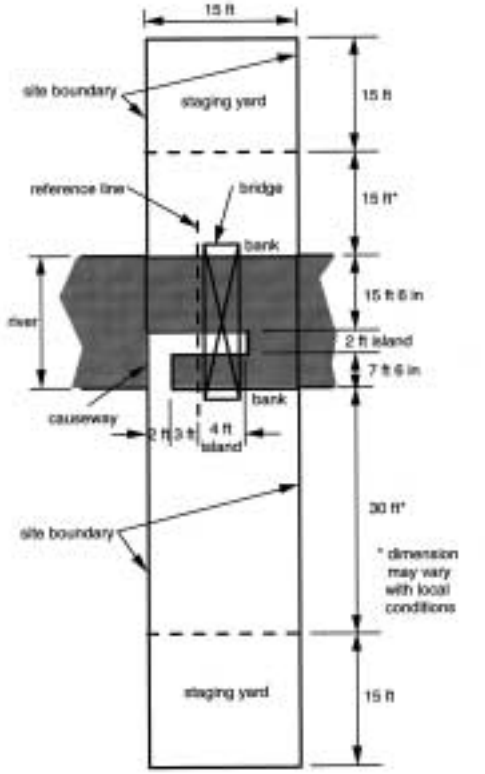
The National Competition began on the afternoon of May 23 with the aesthetics judging. Teams assembled their bridges to be judged based on general appearance, balance of the design, elegance and finish. Displays had to include a placard with the team's name, as well as an informative poster that described the bridge's design and fabrication process.

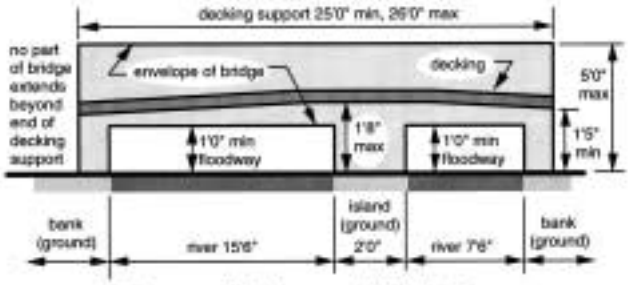
Many teams had designed their bridges with aesthetics in mind, including creative web and truss designs, as well as the incorporation of cables. Some teams coated their steel with their university colors. Displays were carefully and elaborately planned, with team helmets and mascots included. A few teams carved their team names into pieces of steel attached to their bridge.

California State University-Long Beach used expanded metal mesh to create the trusses for their bridge. "The mesh is lightweight and distributes sheer forces well," said Captain Angelka Grandov. "We fabricated test sections, and we were pleasantly surprised with it. I've never seen it used before."

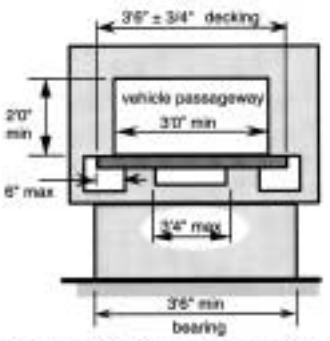
Southern Polytechnic University used purple layout dye to coat their trusses, which were designed with daz-

Site and Geometric Constraints for 2004 Competition





Spans and Clearance (Side View)



Decking Support, Roadway and Bearing (End View)

zling geometry. "The triangles are for structural stability," said team member Jason Steger. "The purple layout dye is lightweight and requires no primer."

FINALS

At 7 a.m. on May 24, the first bridge teams were gathered at San Diego State's Cox Arena to warm-up for the national final competition. Many teams had practiced assembling their bridges throughout the previous day and night, in parking lots, tennis courts and anywhere they could find extra space.

While the first teams began laying out their tools and bridge members in designated staging areas, the judges milled around, preparing for the day and reviewing the rules. Family members, friends, and other spectators gathered in the audience to support the students. By the time the competition kicked-off an hour later, excitement had risen throughout the stadium, and a cheer rose as the team from University of Missouri-Rolla took its mark to go.

The day moved quickly as students sprinted to construct their bridges, with pauses only after assembly, when judges circled to check for penalties and teams waited to proceed to the load and deflection tests.

By noon, it was clear that the teams' yearlong efforts had paid off—energy was high and competition was stiff—and the race stayed close as the day continued.

"This is one of the most competitive, tightest competitions we've seen in years," said AISC/ASCE rules committee member Don Sepulveda.

Team members from Southern Illinois University, which took 9th place overall, said they had a strong performance. "It was clean," said Ryan Phelps. "We had one step in the water, but we beat our regional time with half as many people."

Many teams had similar results—fast performances with only minor penalties. But a few had more severe errors: During the course of the day, three bridges collapsed during load testing, and three more were disqualified for other violations.

BRIDGES AND BEYOND

The competition was complete by the evening, and the teams gathered for an awards banquet later that night. About 620 students and faculty members attended the event.

Speakers from San Diego State University and ASCE joined AISC's Vice President of Engineering And Research Lou Geschwindner in congratulating the students on their efforts and encouraging them in their future engineering endeavors. Finally, Head National Judge John M. Parucki and AISC Director of University Relations Fromy Rosenberg announced the winners and presented them with plaques.

While the winners' exceptional performances stood out among their competition, they weren't the only ones who felt that the experience of participating was rewarding.

"It's our first time at nationals," said Lance Kraynek, of Youngstown State University. "The goal—well being here is the goal. Each year is a building year and each year, there's a learning curve and we get ideas from other schools."

Lakehead University's Mashford said the project was a chance to apply the material learned over the course of his university career. "We applied theory, and we made bookwork into bridges," he said.

Three bridges collapsed during the competition's load and deflection tests. The University of Central Florida bridge is shown here.

Competition co-founder and rules committee member Frank Hatfield, P.E. says that's the heart of the competition. "When you touch the product, and work with the steel, surprising things happen," he said. "The students learn they can bend the steel, and make any shape that they want. Teaching in the shop sinks in: It's real teaching that goes beyond theory." ★

Although most universities participate in this exciting competition, if your ASCE chapter does not, please contact Fromy Rosenberg at 312.670.5408 or rosenberg@aisc.org, who can help your chapter establish a team. For more information, visit: ***www.aisc.org/steelbridge.html****.*

2003 Winners

The top three teams were:
University of Michigan
University of Wisconsin-Madison
University of Florida

The top teams in each of 6 categories were:

Speed of Construction:
University of Wisconsin-Madison
Clemson University
University of Florida

Lightness:
Penn State University
University of Wisconsin-Madison
Lakehead University

Aesthetics:
Columbia University
University of Illinois-Urbana
University of Wisconsin-Madison

Stiffness:
Penn State University
SUNY-Canton
Southern Polytechnic University

Economy:
University of Michigan
University of Wisconsin-Madison
Clemson University

Efficiency:
University of Wisconsin-Madison
Lawrence Tech
Penn State University