Bridge **Builders**

The 2004 National Student Steel Bridge Competition

By Beth S. Pollak and Dan Swiatek

A record 44 teams participated in the 2004 National Student Steel Bridge Competition Finals (co-sponsored by AISC and ASCE) at the Colorado School of Mines in Golden, CO.

Members of North Dakota State University's student steel bridge competition team knew what it was like to have a prize-winning model bridge—the team won the ASCE/AISC national competition in 2002. After dropping to 12th place in the 2003 competition, the team was determined to win again at this year's finals, held May 28-29, 2004 at the Colorado School of Mines in Golden, CO. With careful planning and an innovative bridge design, NDSU's captain Mitch Okeson led his teammates to capture their second win in just two years.

"We really enjoy the competition, and we work really hard with it," said Okeson, who is completing his master's degree at NDSU. "The most rewarding part about it was knowing that we had something that was very competitive, and that we saw our ideas work out in a good economical design. For four of the members of the team, it was our last year, and we wanted to give it our best chance. Our team advisor also is leaving the university, and we wanted to win it for him too. We had a lot of motivation to do well and to go out with a bang."

A record 44 student teams participated in National Student Steel Bridge Competition finals, which are co-sponsored by ASCE and the American Institute of Steel Construction (AISC). During the competition, teams race the clock to

Team members from the Illinois Institute of Technology worked swiftly to assemble their bridge.

2004 National Winners

1. North Dakota State University
2. University of Michigan
3. Southern Polytechnic State University

2004 Category Winners

Construction Speed
1. Illinois Institute of Technology
2. Iowa State University
3. University of Wisconsin – Madison

Lightness
1. North Dakota State University
2. University of Michigan
3. University of Wisconsin – Madison

Aesthetics
1. North Dakota State University
2. University of Puerto Rico – Mayagüez
3. University of Wisconsin – Madison

Stiffness
1. North Dakota State University
2. Southern Polytechnic State University
3. University of Michigan

Economy
1. Illinois Institute of Technology
2. Iowa State University
3. University of Wisconsin – Madison

Efficiency
1. North Dakota State University
2. University of Michigan
3. Southern Polytechnic State University

Bridges were load-tested under the watchful eyes of competition judges.

erect their bridges as quickly as possible. Rules specify site conditions, member sizes, weight limitations, design loads, and erection and safety procedures. Penalties are assessed for stepping into the "water," dropping tools or equipment, and other violations. Once constructed, bridges must meet standards for load-bearing capacities and deflection.

"The competition brings together everything students have learned in the classroom," said competition organizer Fromy Rosenberg, AISC's director of university relations. "Students practice basic steel design and fabrication, project scheduling and management, and gain hands-on appreciation for the strength and versatility of structural steel."

This year, new deflection-measuring equipment helped the competition run smoothly. "There were lots of unique designs this year, and the Colorado School of Mines did a great job running the event," said Head National Judge John M. Parucki. "We also had more judges than ever before, and they did an excellent job."

Prizes were awarded for overall performance as well as in six specific categories: lightness, aesthetics, stiffness, economy, efficiency, and construction speed. North Dakota State University took first place overall, followed by the University of Michigan-Ann Arbor and Southern Polytechnic State University.

NDSU's bridge, which also won the aesthetics competition, was composed entirely of square and round steel hollow structural sections (HSS), which Okeson says gave it an elegant look. "It looked like it had a fourth dimension," he said. "It was a continuous joist from end to end, and over the long span, there was a 2'-6" straight truss. In our design analysis, we determined that uplift on the long span would be necessary. So we created a big point load on the end of a cantilever over that continuous span, which helped give uplift deflection on the short span."

NDSU's team of about 15 active members began design work for their bridge at the beginning of the academic year in August 2003. "Everyone reads the rules, and then we sit down and analyze structural efficiency and construction economy to consider what works and what doesn't," Okeson said. "After we determine the basics that we think will give us a score that will be competitive, we move on to the actual structural design. We try all our ideas, and by process of elimination, we come up with what we hope is the best one."

Team members did all of the fabrication for the bridge on their own. "We do all the cutting, all the welding and all the machine shopping. We're self-taught. I grew up on a farm, I learned it from home, and I took welding classes in high school."

Okeson, who plans to work for the Minnesota Department of Transportation when he completes his studies, says this year's win marks the end of an era for him. "It's been a part of my life. The bridge competition has provided a lot of fun times and has been a good experience. I'll miss working in the metal shop, brainstorming in a bar at night, and the camaraderie of a great group of people."

Tough Competition

Enthusiasm and competition was high this year, and teams like New Mexico State practiced the night before the competition in the hotel parking lot. "Steel Bridge gives you a real-world experience," said team member Max Lopez. "You learn that planning is important to get everything done on time."

Bridge designs also were creative: Students from the University of Missouri – Rolla used structural-design software program SAP 2000 to model and create a bridge with a circular curved arch supporting a long span. "We began brainstorming in October, and after considering more than 20 different designs, we began fabricating," said team member Jared Brewd.

"The curved steel arches for their long span had to be sent out to a professional fabricator to bend the steel," said teammate Bryan Madson. "The first time it was sent out, UPS lost one of the 15' arches!"

Many students spent vacations, nights and weekends designing, welding and practicing the bridge assembly, even during exam periods. Team members from Illinois Institute of Technology (IIT), who took first place for speed and economy, constructed their bridge during their spring break. "The bridge was finished just two weeks before the regional competition," said Captain Jorge Cobo. "We didn't know if we would make it to nationals."

At the national competition, the team assembled their bridge in just 1 minute, 48 seconds, but two penalties brought their final time up to 2 minutes, 9 seconds.

Cobo said that practicing to build the bridge quickly was a process of trial and error. "Every time you practice assembling the bridge, you find something new that you can improve. Once you find the best way to do something, you repeat it. We tried to coordinate the construction activities to make sure that all team mem-

bers were working and that there was no idle time."

Iowa State, whose bridge failed at the 2003 competition, came back strong this year, finishing in eighth place overall, and second place in both economy and speed. The team, clad in gray coveralls, assembled their bridge in just 2.383 minutes. "This year we built a beefier bridge and used a much higher factor of safety," said team member Chris Bauer.

Steel fabrication shops helped many teams fabricate and construct their bridges, and corporate sponsors lent financial support for tools, equipment and travel. Firms also are important connections for the soon-to-be graduating students. "I would hire any of these guys on the spot!" said University of Michigan professor Nikolaos D. Katopodes.

Iowa State's team co-chair Julie Maher said that the team worked hard at its fundraising efforts in addition to its bridge design. "Company sponsors helped provide money and supplies. A local fabricator donated the steel, helped with laser cutting, and custombent channel sections that otherwise would not have been available to the team. We also sold pizza every Wednesday to raise extra funds for the team." She said the bridge competition is a great way to put engineering lessons into practice. "[Steel Bridge] really intermingles the students [of different ages] and helps them see the class work and how to apply it."

Penn State also did a good job with fundraising: The team's letter-writing efforts earned about 25 sponsors. With the sponsors' support, as well as supplies and mechanical resources available at the university, the team was able to devote their full attention to the competition. "Work is never over, and there is always something to do to improve the bridge," said team member Nick Remington.

Rutgers University's bridge team started from scratch this year—and their bridge still made it to the national competition. "The entire bridge team for the last few years had been the same age, and they graduated together, leaving no one with experience behind," said Captain Douglas Eichenbluff.

The Rutgers team had not constructed their bridge with its name attached, so competition judges ruled that the team would have to place the name on their bridge and add the additional placement time to the total construction time. The team made a sign, fitted it with double-sided scotch tape, and chose their fastest runner to place it. As his teammates cheered him on, runner Michael Solar sprinted from the staging area to place the sign, adding just 3.87 seconds to Rutgers' total.

Returning Champs

University of Michigan (2003 Champion and this year's second-place winner) tried to incorporate aspects of last year's bridge into their 2004 model. "Some of the connections used were the same," said Captain Cordelle Thomasma. "But we also developed new connections specifically for this year's bridge."

Michigan's team made an impressive mark on the competition, taking second in both the lightness and efficiency competitions, third in the stiffness competition, and eighth in speed. To design this year's bridge, team members split up into "mini-groups" and competed against each other to design the best bridge. The team used ideas from each group's designs to construct their final competition bridge.

About half of Michigan's team from last year returned to compete again, and recruiting new members was easier after last year's big win. "The department threw a huge party at the beginning of first semester for the championship team," Thomasma said. "Lots of people came out to the party and got involved that way. It also was easier to get sponsors after winning."

Michigan's civil engineering department helps with money and other aspects of the competition, such as equipment and facilities. "The University also has the Wilson Student Team Project Center, which is shared by many teams on campus that need special tools and machines," Thomasma said. "The center contains all kinds of tools and machines, including mills, welders, saws, and grinders."

Some University of Michigan professors attended the competition to show their support. "The enthusiasm [for the Steel Bridge Team] stems from the leadership of the ASCE student chapter," said professor Radoslaw Michalowski. "But what you see is absolutely their work. We can give broad suggestions, but the students do all the specific design work on their own."

A Super Tool

The University of Wisconsin-Madison's "super tool" helped the team stay at the top of the competition. The tool is an irregular-shaped red steel plate with different notches, grooves, and holes to perform different tasks aiding in the construction of the bridge. It can be used as a counterweight and to hold up half of a truss while it is being constructed.

"We used statistics from previous classes to determine how long the tool had to be to properly act as a counterweight for the bridge legs," said team co-chairman Drew Agosto. "After some quick calculations to find the center of gravity and the moment, we came up with the proper size. It worked on the first try!"

UW-Madison's team took fourth overall, third in construction speed, lightness, aesthetics and economy, and fifth in efficiency. Agosto said the team's three co-chairs tried hard this year to recruit new members and generate enthusiasm for the team.

"At the first ASCE general meeting, the three of us presented information on the bridge competition while wearing big boots and hard hats," he said. "We did one-armed push ups and other stunts. It created a lot of buzz around the team."

Many students enjoyed the setting of the Colorado School of Mines just outside of Denver, where they had the chance to do some hiking in the mountains and take tours of the nearby Coors Brewery. Some students from schools whose bridges failed at regional competitions made the trip to Colorado to gain insight for their own teams.

In addition to ASCE and the AISC, other sponsors included the American Iron and Steel Institute; the James F. Lincoln Arc Welding Foundation; the National Steel Bridge Alliance; and Nucor Corporation of Charlotte, North Carolina.

Next year's competition will be held at the University of Central Florida (Orlando), May 27-28, 2005. For more information about the competition, visit **www.aisc.org/steelbridge.html**. ★

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