

PREDICTING THE STRENGTH OF COLD- FORMED STEEL

Cheng Yu is a man of steel.

The associate professor and coordinator of construction engineering technology at the University of North Texas is an expert on cold-formed steel, a thin type of steel structure that is less expensive and more environmentally friendly than other materials — and behaves differently.

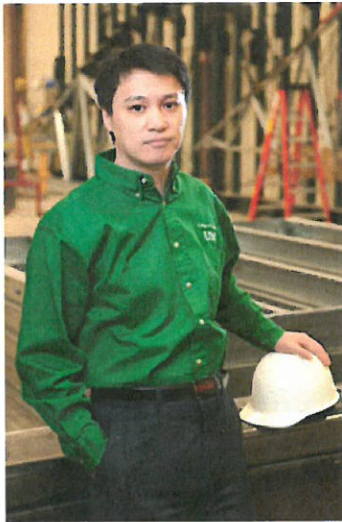
Yu has received more than \$1.7 million in grants to study structures made of cold-formed steel and is researching ways to predict the material's

behavior through a prestigious five-year CAREER award he received from the National Science Foundation in 2010. The work can be time-consuming and challenging, but the rewards are beneficial. Yu's previous results have been adopted in industry design standards developed by the American Iron and Steel Institute.

"That's why we work so hard — to try to help the industry," he says. "With the results adopted as national standards, many more engineers will benefit from my research."

Many insiders believe cold-formed steel has the potential to be the primary building material for homes, office buildings and other structures. Jay Larson, managing director for the American Iron and Steel Institute's construction technical program, says Yu's work could help make cold-formed steel the material of choice in the construction of sustainable buildings, especially mid-rise structures of four stories or more.

"Cold-formed steel is an excellent solution, and Dr. Yu is helping us develop many of the design provisions that are needed," he says.



The award-winning research of **Cheng Yu** has contributed to industry standards for cold-formed steel and could make it the material of choice in the construction of sustainable buildings.

Photo by: Jonathan Reynolds

By Jessica DeLeón

A UNIQUE MATERIAL

Yu earned his bachelor's degree at China's Tsinghua University, which boasts an international reputation for its civil engineering program. He came to the United States in 2000 to study at Johns Hopkins University, where he earned his master's and doctoral degrees, and joined UNT as a specialist in cold-formed steel structures in 2005.

"I believe steel structures are the perfect way to construct buildings," Yu says, citing the Eiffel Tower in Paris as one of his favorites.

Cold-formed steel is built from the same matter as heavy structural steel, but it has a thickness similar to that of a credit

Student research and design

Students are gaining design and research experience through the work of Cheng Yu. His research team includes two undergraduates and four graduate students who help develop and test his cold-formed steel models.

"The students help my research tremendously," Yu says. "Without them, I wouldn't have been able to accomplish what I have accomplished at UNT."

Roger Rovira, who earned his bachelor's degree in engineering technology in

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card. It weighs and costs less than other traditional construction materials, it's easier to transport and requires less labor, especially compared to wood and concrete.

The material is environmentally friendly because it doesn't produce much waste and is made up of about 75 percent or more recycled material, Yu says.

But because cold-formed steel uses unique cross section shapes and connection techniques, methods to predict its capacity strength must be developed.

Yu is attempting to create two numerical models to predict strength in the material so engineers can have an efficient and reliable way of using cold-formed steel.

The first model would predict the behavior of a cold-formed steel framed shear wall, sheathed by steel sheets. The other would simulate the performance of a cold-formed steel shear wall when rigid panels, such as plywood boards, are installed.

Yu identified distinct behaviors of those two types of construction materials in his preliminary research and now wants to develop scientific approaches to accurately predict them, particularly for extreme hazardous events such as hurricanes, tornados and earthquakes.

December, studied cold-formed steel in class and then went to work with Yu in his lab. Rovira was one of 10 finalists in the cold-formed steel design competition that Yu spearheaded, co-sponsored by the American Iron and Steel Institute along with the National Science Foundation.

Participants from universities in the United States, Canada, China, Turkey and Australia designed a cold-formed steel cross-section shape to hold up under certain conditions.

Rovira, who likes the mental work involved in the research, says he also likes working on cold-formed steel for another important reason.

"I think that will be the future of residential construction," he says.

INCREASED CAPABILITIES

The research requires hard work and long hours. Yu not only has to be a master in civil engineering, but he also has to know about electrical and mechanical engineering to build specialized testing equipment.

His lab team — including students and a visiting scholar — has helped him develop and test innovative building materials and prototypes. In his lab at Discovery Park, UNT's 300-acre research park, he has a hydraulic testing system and two structural reaction frames. He uses one frame, a 13-by-12-foot multi-functional reaction frame, to test shear walls, beams and columns. The other, a 60-by-22-foot frame, is used to test trusses.

UNT also is building a new facility at Discovery Park to give Yu and other professors more capabilities for their research. The new lab will feature a 4-foot-deep strong floor that will significantly increase testing capacity.

"I enjoy working with industry to get involved in solving real problems and developing innovative building structures," Yu says.

And the results could have big payoffs.

THE FUTURE OF STEEL

For example, cold-formed steel could be used more frequently. The material is most often used in interior partition walls, floor decking and the roofing and siding of buildings, Larson says. It's used less frequently in framing to support buildings in mid-rise construction, which Yu is trying to help develop.

"So far, the material is used structurally in perhaps 2 percent of the one- or two-family residential market and probably even less in mid-rise structures," Larson says. "There is a huge growth opportunity."

In addition to his research, Yu is promoting the material in other ways. He plans to write a textbook about cold-formed technology within the next five years. He also initiated an international cold-formed steel student design competition in 2011, which attracted 78 students from universities in five countries. Yu plans to continue to host future student competitions.

His efforts will benefit UNT in its goal of becoming a tier-one research university. Because of his research, the university is establishing relationships with iron and steel officials in the United States and China, says Richard Reidy, materials science professor and interim chair of the Department of Engineering Technology.

"He has done a really good job learning about the issues the industry faces," Reidy says. "We're dealing with a very high-level researcher here."
