Computer modeling to build better mud bricks

June 29 2010

Rammed earth and stabilized mud block or brick are cheap, easy to make, usually durable materials widely used for building homes and low-level structures, especially in developing countries. Despite their widespread use and long history, the structural properties of these materials are not well understood, so how they could be manufactured to better withstand destructive natural forces, such as earthquakes and weathering, remains a goal.

Craig Foster, assistant professor of civil and materials engineering at the University of Illinois at Chicago, hopes a specially tailored set of computer models he is developing may provide the necessary answers. He has just won a three-year, $243,000 National Science Foundation grant to conduct the work.

Foster will use what is called the finite element method of computer modeling to focus on the shear behavior of these materials in response to wind and earthquakes.

"We want to look at strength and ductility under varying conditions," he said. "The ultimate goal is to design safer and more efficient structures."

The computer models Foster is developing will help predict fracture patterns that run through the brick and mortar of these structures, leading to better insights into the structural behavior that may suggest ways to make them better.

Foster said the ultimate goal is a set of building codes for earth-based materials that will be simple to follow, and that will insure the materials are safe to use and economical to make.

Adam Tennant, one of Foster's Ph.D. students, initiated the idea for the project as part of a Fulbright grant he received to do research in India. Tennant worked with B.V. Venkatarama Reddy at the India Institute of Sciences in Bangalore, who has tested the strength of different mud-block samples under various conditions.

Foster has special interests in sustainability and the needs of developing nations. He saw how his expertise in numerical modeling could help advance the state of knowledge about these materials -- to the mutual benefit of both interests.

David Weed, another of Foster's Ph.D. students, will help develop and test the numerical models.

Working with Reddy's research team in India, Foster and his UIC students will take test data gathered in Bangalore and apply it to his computer models to see if it simulates what they see in the Indian laboratory experiments.

"Hopefully, that will give us more insights into the structural behavior," Foster said. "You see certain things in lab experiments, but when you run a model you can get a better sense of what's going on in a lot of ways," such as analyzing where are the greatest stress points and where dangerous cracks are likely to form.

While developing countries are the target beneficiaries of new insights into building better stabilized mud blocks and rammed earth structures, the sustainable nature of the materials has boosted their attractiveness in developed countries as well, especially in warm, arid regions such as the

American Southwest.

Mud block and rammed earth walls require little energy to create, unlike material such as steel, which is very energy-intensive to produce. Bricks, blocks and walls can be cured outdoors in dry regions with a lot of sunlight. Energy production costs are essentially free.

There are other environmentally friendly advantages as well, Foster said.

"It has good thermal properties to help regulate inside temperatures over the course of a day. And it's made from mostly locally available materials, on site or from nearby. Soil is everywhere."

Provided by University of Illinois at Chicago