Defending Against the Wolf

The University of Western Ontario is destroying a full-scale model home in order to improve construction practices and prevent future hurricane and storm damage to residential buildings

By F. Michael Bartlett, Department of Civil and Environmental Engineering, University of Western Ontario, London

According to a recent Swiss Re report, "2005 has been the costliest year ever for property insurers." The report notes that claims to property insurers as a result of natural disasters totalled US$78 billion last year, and more strong hurricanes are on the horizon. So everyone complains about the weather. But what is anyone doing about it?

A multi-disciplinary research team centred at the University of Western Ontario is creating a 'Big Bad Wolf' that will subject full-scale houses and house components to realistic, extreme wind loads. Seed funding, in the form of a $170,000 grant from the Institute for Catastrophic Loss Reduction, has germinated a CDN$6.8-million, world-class facility that is now under construction in London.

The overall objective is to address the safety, durability and economy of houses and light-frame buildings in the developed and developing world, by replacing conventional, "rules-of-thumb" design with rational, research-based, scientific and engineering principles.

"We do get hurricanes in Canada, and we want to see when typical Canadian construction starts to break under wind loads," according to Dr. Greg Kopp, who holds a Tier II Canada Research Chair in Wind Engineering at Western and is co-principal investigator on the project.

The Canada Foundation for Innovation, the Ontario Innovation Trust, and other non-governmental organizations are providing funding to construct the facility. To date, significant cash and in-kind donations have been received from St. Mary's Cement (St. Mary's), Gerdau-Amersteel (Cambridge), Dietrich Steel (London), steel service centre and fabricator members of the Ontario Region of the Canadian Institute for Steel Construction, the Ontario District Council of the International Association of Iron Workers, and others.

Realistic histories of dynamic pressures caused by turbulent winds will be obtained from tests of scale models at Western's internationally recognized Boundary Layer Wind Tunnel Laboratory. These data will feed 'The Wolf,' a system of pneumatic actuators that will apply the pressures to the surfaces of full-scale specimen. An array of video cameras will capture the failure; sensors mounted throughout the specimen will record data to validate computer predictions of the response.

Dave Henderson, manager of the Cyclone Testing Station at James Cook University in Townsville, Australia, is spending five months in London to help with the design and implementation of the pneumatic loading actuators. "I'm taking the team to lunch if the first test doesn't simply tear the roof trusses right off the tops of the second-storey walls," Henderson says. "But after that connection is strengthened, it will be very interesting to see where the next weak link in the system is."

Hanping Hong, the reliability expert on the team, says "the camera system can record construction as well as destruction of the house. We hope to classify the kinds of errors that typically occur in light-frame construction, and correlate these to the actual performance when subjected to extreme loads. We will be able to make educational videos for tradespeople using the information we record."

In addition, the facility will offer the opportunity to do building science research – for example, taking a read of moisture penetration through walls that may have been damaged by simulated

extreme wind loads. The team will also be researching the development and growth of mould.

"Test huts exposed to natural conditions exist elsewhere to study building envelope performance," the team's building envelope expert, Diana Inculet, observes. "But what will be new here will be the ability to stress and crack the envelope of the full-scale house under simulated realistic conditions, while exposing it to rain and moisture. That's completely new."

Eric Savory is collaborating with James Scott from the University of Toronto on the mould research. "We are currently working on a sensor that will detect mould growth in a wall cavity and use wireless technology to transmit that information to a central data acquisition system," Savory says.

The primary structure, which houses the full-scale, house test specimen, is approximately 20-by-20 metres in plan and 20 metres tall. As shown in Figure 1 below, it has a huge bi-fold door at one end and is mounted on rails: between periods of structural testing, it can be rolled to the east to expose the instrumented house test specimen to westerly winds.

Main building covering the first house test specimen, under construction

A prototype of the load actuator system is scheduled to arrive in the early summer of 2006, with the first tests on the full-scale structure to follow in 2007. The final test to destruction of the first test specimen is scheduled for 2008, at which time a new test specimen – perhaps a mobile home or some other form of manufactured housing – will be constructed.

In the process, a new generation of inquiring students will research and experience the scientific, evidence-based response to disasters and disaster-mitigation issues. CU

Collaboration with Fanshawe College Students

A novel memorandum of understanding involves students from the building technology program at Fanshawe College constructing the first 1,900-square-foot, three-bedroom test specimen as part of their education. "This is a wonderful learning opportunity," Martin Askes, building technology professor at Fanshawe, says. "I can talk about things like tolerances in class without the message sinking in, but when the students see how an accumulation of small errors causes a problem in the field, they get it."

The memorandum encourages collaboration between researchers at Western and Fanshawe. "When the data comes out on this house, my colleagues and I will be quite excited to see what's been found."

Fanshawe College students framing floor of first full-scale test specimen