DEVASTATING WEATHER EVENTS SUCH AS HURRICANE KATRINA HAVE DRAMATICALLY RAISED OUR AWARENESS OF HOW VULNERABLE BUILDINGS CAN BE TO THE POWER OF WIND. THEY HAVE ALSO INJECTED NEW URGENCY INTO THE NEED TO DEVELOP BUILDING DESIGNS AND MATERIALS BETTER ABLE TO MINIMIZE THE DAMAGE THAT CAN BE CAUSED BY DESTRUCTIVE WINDS.

Withstanding the Wind

— BETTER DESIGNS FOR HURRICANE-RESISTANT BUILDINGS

Rima Taher with models created by students in her NJIT courses

NJIT's Rima Taher is among those at the forefront of this effort. A civil engineer and special lecturer at New Jersey School of Architecture (NJSOA), Taher has spent several years evaluating the findings of research centers that have studied the effects of wind forces on buildings and structures. She has also analyzed the observations and conclusions of engineering investigations conducted in the aftermath of hurricanes and tornadoes. The ultimate purpose was to study and suggest structural solutions for the design of a hurricane-resistant home based on a concept proposed by researchers from the Center for Building Science and Technology (CSTB) in France, who cooperated with NJIT in this work.

"Although I'd like to say that there is a simple and economical solution for housing that won't fail or collapse in the perfect storm, such information does not yet exist," says Taher. "However, thanks to the work of many fine engineers and researchers, changes to home design and construction can make buildings safer for people, while saving government and industry billions of dollars annually."

"Design of Low-Rise Buildings for Extreme Wind Events" by Taher, published in the March 2007 *Journal of Architectural Engineering*, highlights recent findings in this area. As Taher reports, CSTB investigators performed extensive research and tested scale-model homes at their sophisticated wind-tunnel facility.

Testing wind effects on structures using wind tunnels originated in the early 1960s, with the Boundary Layer Wind Tunnel Laboratory at the University of Western Ontario, Canada, being a pioneer in such research.

Taher worked with the CSTB researchers to develop a prototype of a "cyclonic" or hurricane-resistant dwelling. The proposed design is an elevated structure on an open foundation, characteristics that reduce the risk of damage from flooding and storm-driven water. To protect against wind damage, the home has a hip roof and aerodynamic features that the CSTB wind-tunnel tests show can be especially effective.

Based on this work, as well as on other studies, Taher cites a variety of design recommendations for homes in high-wind regions, especially areas that routinely experience hurricanes:

- A square floor plan — or even better, a hexagonal or octagonal plan — with a roof that has four or more panels (hip roof).
- A hip roof with four slopes performs better under wind forces than a gable roof with two slopes. Gable roofs are generally more common because they are cheaper to construct. For best results, a roof slope of 30 degrees is recommended.
- Wind forces on a roof tend to be uplift forces, which is why roofs are often blown off during an extreme wind event. Therefore it is important to strongly connect the roof to the walls.
- Special attention should be given to all connections, not just those between roof and walls. Connections between the structure and its foundation as well as between walls must be strong. Complete structural failure is often a progressive process, with the failure of one structural element triggering the failure of another, and leading to a total collapse. Vulnerable connections can be inexpensively strengthened.
- Certain areas on a building — such as the roof ridge, corners and eaves — are typically subject to higher wind pressures. The home design developed by CSTB researchers incorporates aerodynamic features to alleviate wind pressures on the roof and other local pressures. For example, a central shaft connecting the structure's internal space and the roof ridge, which is the point of highest depression, can significantly reduce wind pressures on the roof by balancing internal and external pressures.
- Roof overhangs are also subject to wind uplift forces that could trigger a roof failure. In the CSTB design of a hurricane-resistant home, the projecting width of these overhangs is limited to about 20 inches.
- The CSTB's design also includes several simple, relatively inexpensive features that can reduce wind stresses at the roof's lower edges, such as a notched frieze or grid installed around the perimeter of the home at the level of the roof gutters.

Taher's journal paper, referenced above, discusses structural guidelines and recommendations for the design and construction of a hurricane-resistant home based on the proposed model in greater detail. Related research reports are also available at the NJSOA library.

Other agencies and institutions Taher cites for important efforts in this field include the Federal Emergency Management Agency (FEMA), especially for its engineering investigations in the aftermath of tornadoes and hurricanes. Also notable is the work of the Wind Engineering Research Center at Texas Tech University, and the Wind Engineering Research Center at Tokyo Polytechnic University, which Taher has visited. Additional U.S. institutions are the Wind Engineering and Fluid Laboratory at Colorado State University, the Natural Hazards Modeling Laboratory at the University of Notre Dame, and the Wind Simulation and Testing Laboratory at Iowa State University. ■

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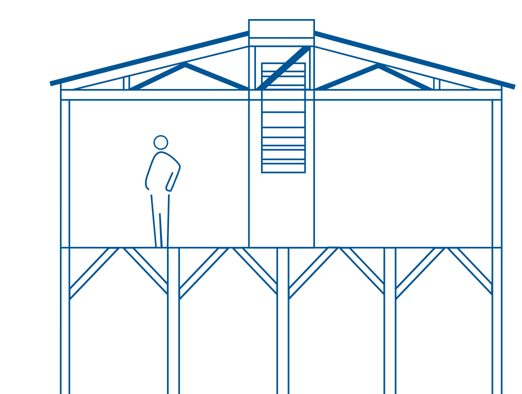

Hurricane-resistant home features advocated by researchers include an elevated structure on an open foundation and a central shaft at the roof ridge to help balance internal and external pressures.

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