Professor says certain home shapes and roofs hold up best in hurricane

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Certain home shapes and roof types can better resist high winds and hurricanes, according to a researcher at New Jersey Institute of Technology (NJIT).

Civil engineer Rima Taher, PhD, special lecturer in the New Jersey School of Architecture at NJIT, spent two years examining the findings of research centers that have studied the best designs and construction materials and methods needed to withstand extreme wind events and hurricanes.

“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,” said Taher. “However, it is obvious that thanks to the work of wind engineers and researchers that 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” (Journal of Architectural Engineering, March, 2007) by Taher highlighted such research findings. Wind researchers at the Center for Building Science and Technology (CSTB) in France, researched and tested reduced-scale home models at its wind tunnel facilities, and developed a prototype of a “cyclonic” or hurricane-resistant dwelling. Taher cooperated with the CSTB wind researchers, working on the structural aspect of the home’s design.

That design eventually became an elevated structure of a square plan form on an open foundation. The home had a hip roof and was equipped with a central shaft with aerodynamic features designed to reduce wind forces during an extreme wind event. Wind tunnel tests at CSTB showed that such a home would be far more efficient under high winds and hurricane conditions than a typical structure. CSTB is working with a builder to construct a prototype of such a home on Réunion in the West Indian Ocean.

From this work and other studies Taher recommends the following construction considerations for homeowners in hurricane-prone regions:

-- A home with a square floor plan (or better a hexagonal or octagonal plan) with a multiple-panel roof (4 or more panels) was found to have reduced wind loads.

-- Roofs with multiple slopes such as a hip roof (4 slopes) perform better under wind forces than gable roofs (2 slopes). Gable roofs are generally more common because they are cheaper to build. A 30-degree roof slope has the best results.

-- Wind forces on a roof tend to be uplift forces. This explains why roofs are often blown off during an extreme wind event. Connecting roofs to walls matters. Stapled roofs were banned following Hurricane Andrew in Florida in 1993.

-- Strong connections between the structure and its foundation and connections between walls are good. Structural failure is often progressive where the failure of one structural element triggers the failure of another, leading to a total collapse. Connections are generally vulnerable but can be inexpensively strengthened.

-- Certain areas of a building such as the ridge of a roof, corners and

eaves are normally subject to higher wind pressures. In the cyclonic home design, CSTB researchers proposed some aerodynamic features to alleviate these local pressures such as introducing a central shaft which would function by creating a connection between the internal space and the roof ridge considered to be the location of the largest depression. This connection helps balance pressures leading to a significant reduction in the roof's wind loads.

-- Roof overhangs are subject to wind uplift forces which could trigger a roof failure. In the design of the hurricane-resistant home, the length of these overhangs should be limited to 20 inches.

-- The design of the cyclonic home includes simple systems to reduce the local wind stresses at the roof's lower edges such as a notched frieze or a horizontal grid to be installed at the level of the gutters along the perimeter of the home.

-- An elevated structure on an open foundation reduces the risk of damage from flooding and storm-driven water.

Source: New Jersey Institute of Technology