Residential Roofing and Hurricanes[1]

Wind acts on structures in the following ways:

- Windward walls and steep-sloped roofs are acted on by inward-acting or positive pressures.
- Leeward walls and steep- and low-sloped roofs are acted on by outward-acting or negative pressures.
- The pressure changes at sharp edges and at points where the building geometry changes.
- Localized suction or negative pressures at eaves, ridges, and the corners of roofs and walls are caused by turbulence and pressure changes. These pressures affect load on components and cladding.

The Roofing Industry Committee on Wind (later changed to *Weather*) Issues (RICOWI) was established October 11, 1990. In response to insurance industry concerns as to excessive property loss from windstorms, RICOWI and the Department of Energy/Oak Ridge National Laboratory entered into a Cooperative Research Development Agreement for the Wind Investigation Program (WIP). This program includes all of the major roofing trade associations in North America.

Through WIP investigations, RICOWI conducted two of the most comprehensive roofing investigations immediately following Hurricane Charley (August 13, 2004) and Hurricane Ivan (September 16, 2004).

To understand the findings, it is important to appreciate that wind uplift (vertical), suctional, and torsional (twisting) forces cause most damage. The wind uplift pressures on a structure vary depending on roof/building height, roof slope, location (oceanfront or inland), and roof style.

There has been discussion as to what style or type of roof is best, hip or gable. Although hip roofs have been reported to have fewer problems, roof damage still occurs. Hip roofs are believed to be less prone to damage than gable roofs for several reasons: they slope in four directions; the sloping faces enhance the performance of the roofing material; they generate less uplift and are structurally better braced; they laterally brace the primary roof trusses, or rafters, and support the top of the end walls of the home against lateral wind forces; and they eliminate the hinge formed between a gable end and a gable-end wall.

It is generally agreed that wood-frame gable ends of roofs can be failure-prone, except when properly braced. In many instances gable-end failure seems primarily attributable to poor or non-existent bracing between gable-ends and the rest of the structure. The use of structural outlookers rather than ladder-type framing can help. These generally cantilevered 2×4s, oriented edge-wise at roof sheathing joints, extend outward from the first interior trusses or rafters over "dropped" gable-end wall framing. Secondary bracing installed between trusses can also increase lateral support.

Some preliminary results of the WIP investigations include:

- Wind-borne projectiles are a major factor in home damage and destruction during a hurricane. The penetration of the building envelope (through the loss of doors—primarily garage and glass—and windows) can allow the buildup of internal air pressure that acts to lift the roof and push out the sidewalls. Wind-borne debris (especially from roofing materials) can contribute to a significant portion of this damage.
- Soffit panels were easily blown away. More attention to soffit design and installation is warranted.
- Observed (and/or possible) modes of failure for steep-slope residential roofs included:
  - Age and maintenance
  - Force of winds exceeded design
  - Improper selection of materials
  - Insufficient attachments
  - Structural failure
  - Workmanship

References and Resources:

APA—The Engineered Wood Association—has a number of publications including:

Retrofitting a Roof for High Wind Uplift
www.gp.com/BUILD/DocumentViewer.aspx?repository=BP&elementid=3195

Roof Sheathing Fastening Schedules for Wind Uplift
www.gp.com/BUILD/DocumentViewer.aspx?repository=BP&elementid=3210

Asphalt Roofing Manufacturers Association (ARMA) (www.asphaltroofing.org)

Blue Sky Strengthening Homes Project

Improving the Wind Resistance of Roof Systems: Asphalt Shingle Roofs
www.113calhoun.org/pdfs/asphshingleroofs.pdf

Building Officials Association of Florida (www.boaf.net)

Clemson University Department of Civil Engineering

Holding on to Your Roof: A Guide to Retrofitting Your Roof Sheathing Using Adhesives
http://www.scseagrant.org/pdf_files/hotyr.pdf

Department of Financial Services Office of Insurance Regulation (www.fldfs.com/deductible)

Federal Alliance for Safe Homes (FLASH) (www.flash.org). Includes several animated short videos related to roofing

Federal Emergency Management Agency (FEMA) (www.fema.gov)

FEMA Hurricane Recovery Advisories – Hurricane Charley in Florida – Mitigation Assessment Team Report (www.dca.state.fl.us/fbc/Hurricane%20Research%20Advisory%20Committee/FEMA%20Charley%20Report/FEMA488_ch8.pdf)

Specific FEMA advisories on the following topics: *Roof Underlayment for Asphalt Shingle Roofs – Recovery Advisory No. 1* – September 2004; *Asphalt Shingle Roofing for High-Wind Regions – Recovery Advisory No. 2* – September 2004; *Tile Roofing for Hurricane-Prone Areas – Recovery Advisory No. 3* – September 2004 can be found at (www.dca.state.fl.us/fbc/Hurricane%20Research%20Advisory%20Committee/FEMA%20Charley%20Report/FEMA488_ApndxD.pdf)

Florida Building Code Information (includes product approval system) (www.floridabuilding.org)

Florida Roofing, Sheet Metal and Air Conditioning Contractors Association (www.floridaroof.com)

Florida Wind Insurance Incentives Web Site (www.floridawindincentives.org)

Institute for Building & Home Safety (www.ibhs.org). Includes several short videos related to roofing and wind damage.

Also includes preliminary damage observations hurricanes Charley, Frances & Ivan 2004 (www.flains.org/public/PreliminaryDamageCharley1019.pdf)

Miami-Dade product approval (www.miamidade.gov/buildingcode/pc_home.asp)

National Roofing Contractors Association (www.nrca.net)

Roofing Industry Committee on Weather Issues (RICOWI) (www.ricowi.com) - Information on how to obtain the final report—which aims to be a factual resource of the performance of roof systems in high winds, including a summary report of Hurricanes Charley and Ivan best-verifiable wind speeds—will be available on this site.

Texas Tech University: Wind Science and Engineering Research Center

(http://www.wind.ttu.edu/Shelters/protect%20your%20family.htm)

Tile Roofing Institute (www.tileroofing.org)

Note: A joint sub-committee consisting of members from the FRSA (Florida Roofing, Sheet Metal and Air Conditioning Contractors Association, Inc.) and the TRI (Tile Roofing Institute) formulated recommendations based on surveying damage from the 2004 hurricanes and with input from the code and roofing and tile manufacturing community. These recommendations are designed to further clarify the current installation procedures as they pertain to the specific roof tile systems (mechanically fastened, adhesive-set, mortar-set). Supplemental instructions for hip and ridge attachment sections of the FRSA/RTI "Concrete and Clay Roof Tile Installation Manual" – 3rd Edition dated April 2005 are available for use by authorities having jurisdiction and can be found on the Web at

www.dca.state.fl.us/fbc/Hurricane%20Research%20Advisory%20Committee/FRSA_TRI%20Roof%20Tile%20Report/Hip_and_Ridge_Installation_Final-Rev_4-06-05.pdf

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Don't know where to go for an answer to a specific question?

Contact: Building A Safer Florida, Inc. 1-850-222-2772 or www.buildingasaferflorida.org

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