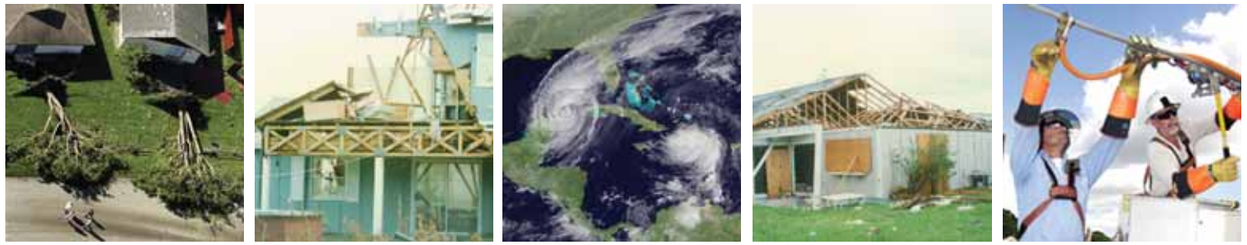
hurricane lessons learned & re-learned



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by Charles C. Hoover, P.E.

History has a way of repeating itself. What can be learned from past deadly storms?

My personal experience with hurricanes originates with Hazel in October 1954. Although I was five and lived on a farm in southeastern Pennsylvania, I clearly recall the howling winds, and the scene with most of the roof covering swept away by Hazel's winds. My life is still being touched by these devastating storms, having experienced two of three hurricanes as they swept through the highlands of central Florida. I was out of the country while my family dealt with Charley.

Perhaps one of the earliest lessons learned was that hurricanes are scary, noisy, generate work for carpenters and make living inconvenient.

It is almost 14 years (August 1992) since Hurricane Andrew swept through south Florida and south central Louisiana, and 17 years (September 1989) since Hugo swept ashore in Charleston, SC, and traveled inland to Charlotte, NC. These are the first events where I was involved with damage assessment teams, directly observing building performance in these high velocity wind events. These were great learning experiences.

Certain buildings performed well, while others did not. This might be summed up by an article in a Charleston newspaper at the time. The headline featured a Clemson civil engineering professor and wind engineering expert stating, "What went through here was not a bad storm, but rather a bad builder."

This lesson is that not all craftsmen are equally skilled in assembling buildings to adequately resist the forces of nature.

In my experience observing hurricane damage, it is extremely rare to observe a member failure. Failures typically are substantially undersized connections, or simply a lack of connections. This lesson may alternately be titled as "connections, connections, connections"; it's what holds the structure together.

Buildings as far inland as Charlotte had substantial damage from Hugo. The lesson relearned was that hurricanes cause damage deep inland. They are not just coastal events.

During our storm investigations, we talked with individuals who were without electric power for two weeks. They relied on wells for water, and were not "living the dream." I learned that a generator is a necessity. The lesson is to have a plan for when the power goes out for days or weeks.

The state of Florida had to recognize it was creating a disastrous situation. Florida turnpike toll collectors were collecting turnpike tolls from hundreds of thousands of evacuees fleeing Hurricane Andrew. Traffic was backed up for miles. Fortunately, then, Governor Chiles intervened to stop the collection of tolls. Today, toll collection is halted for evacuation and there are plans for one way traffic in all lanes. Here is another lesson that had to be learned.

at a glance

- Charlie Hoover has observed the hurricane damage of many storms: Hazel, Hugo, Andrew, Charley, Katrina and Wilma.
- In his experience, Hoover notes it is rare to observe a member failure. Instead, failures are typically caused by undersized connections or the absence of connections.
- The U.S. has transitioned from three major regional codes to the single International Building Code (IBC), reducing the number of different codified wind design methodologies.
- By adopting the latest editions of the ASCE-7, the codes have implemented the latest research into the design of structures.
- Damage to roof coverings is still a widespread occurrence due to water intrusion into buildings.

In the late 1980s, there was a developing awareness that building performance needed to be improved. To provide guidance, Florida's Department of Community Affairs along with the Southern Building Code began developing prescriptive standards to better guide professionals building residential structures. It could be said that Andrew and Hugo were "final warning shots" accelerating the development and dissemination of information to improve the performance of structures resisting high velocity winds.

The U.S. has transitioned from three major regional codes—the State Building Code (SBC), the Uniform Building Code (UBC), and the Building Officials and Code Administrators (BOCA)—to a single code perhaps optimistically titled International Building Code (IBC). Several states, in particular Florida, have promulgated their own state codes, but the IBC is the basis for the single state-wide code. A single code reduces the number of different codified wind design methodologies. The lesson was to reduce the variation by reducing the number of codes.

The American Society of Civil Engineers (ASCE) publishes a design standard for loads titled ASCE-7. This standard was updated every two to three years during the past two decades. Titled ASCE-7 93, 95, 98, 02, 05, the standards included numerous changes to improve how engineers load structures for wind. By adopting the latest editions of the ASCE-7, the codes have implemented the latest research into the design of structures. The lesson here is to keep up with the design standard—methods change.

The investigation of some building damage from Andrew indicated that large unprotected doors or windows were breached by flying debris. This was mentioned in my article on Andrew. That article was read by the chairman of the Wind Load committee for the SBC, and although I had retired myself from the committee, he asked me to rejoin.

This committee developed the wind borne debris test standards that are now part of the IBC. These tests were applied to elements closing the openings in the structure. This substantially raised the level of protection of the building by protecting the openings from failing. Openings can now be protected by products that didn't exist ten years ago. The lesson learned is to protect openings with shutters or products that meet the wind borne debris standard.

Hurricane Katrina blew away the record book. Approximately 275,000 houses were destroyed. Some swept away by storm surge, some by wind and a majority by flood waters after protective levees were breached. A new lesson that is still being evaluated is the wisdom of building in a coastal community

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that is below sea level and is protected by miles of man made levees. It is apparent these gulf coast areas will be focused on rebuilding to the guidelines of the newest wind design standards.

The most recent lesson relearned was from Hurricane Wilma. Wilma's wind speeds were at or below the design wind speeds for the region. However, many of the eastern Florida communities (three million Florida Power and Light customers) were without electrical power for as long as three weeks. Original estimates were for as long as five weeks for full recovery. Most residents never thought of being without power for more than a few days.

Several recent articles have stated that loose bolts on the cross bracing of extra-high-voltage transmission towers may have caused the structural collapse of 30 of these large towers. This is a possible new lesson of connections. As a matter of interest, FPL had to replace approximately 16,000 power poles.

Residents would prefer that utilities, such as sewage, water, and electricity are operational in a matter of hours rather than weeks. Hopefully utilities and government planners have learned the lesson, and are reviewing improvements that will return utilities quickly.

Hurricane Charley shifted track to the Northeast, came ashore at Punta Gorda, passed through Orlando and exited around Daytona Beach. Thousands had evacuated to central Florida, and were surprised to discover they were now directly in Charley's path. This caused everyone to reassess how they read the graphical advisories from the National Oceanic and Atmospheric Administration's (NOAA) National Hurricane Center (NHC). The hurricane could track anywhere inside the cone, not just the depicted center path. We all relearned the lesson of reading these figures from the NHC.

The three hurricanes that passed through central Florida in 2004 had significant emotional impact on residents. Familiar landscapes, trees, tree canopies were gone

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emotionally and physically stretched during these times and to practice patience and tolerance.

Damage to roof coverings is still a widespread occurrence. The resulting water intrusion into buildings ruins the interior contents, can create mold and mildew problems and is a huge inconvenience to the occupants. The performance of newer coverings seems to be better. The lesson learned is that building owners need to carefully and wisely choose the roofing product and research the skill and knowledge of the roofing contractor.

There continue to be new discoveries. Researchers have identified extra-high-velocity wind streams embedded in the major wind currents. These are narrow bands with wind speeds substantially higher than the surrounding wind field. This lesson indicates we have more to learn about the intricacies of hurricanes, because there may be extra high velocity wind streams embedded within the storm.

With so many lessons learned and relearned, coastal dwellers are more prepared, as forecasters improve the accuracy of their prognosis. Building codes are more stringent and comprehensive in scope; design standards are more accurate and more complex. Residential construction is more complex and more jurisdictions are requiring the structure be designed by a professional engineer. Building inspectors are held to a higher education standard and craftspeople work to a higher standard.

These lessons have been learned. There is substantial evidence that structural elements designed and constructed to standards post Andrew and Hugo have performed as expected. Coastal dwellers are now hurricane veterans, and are better prepared.

So, now, 52 years after my introduction to hurricanes, they are still, scary, noisy, generate lots of work for all craftspeople, and make living primitive. SBC

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or lying on the ground. Most buildings had some level of storm damage, and blue tarped roofs were common. This generated an atmosphere of unfamiliarity. Everything looked different and everywhere looked devastated. This milieu contributed to a sense of helplessness in many residents. It was apparent that workers' minds were also on matters at their homes. It was a time for tolerance and understanding of how deeply many people were impacted by loss of property, and the inability to get assistance. In some ways it resembled combat shock. The lesson learned is to realize individuals are

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