A Resource for the State of Florida

HURRICANE LOSS REDUCTION

FOR

HOUSING IN FLORIDA:

ROOF SHEATHING FASTENER STUDY

A Research Project Funded by

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PREPARED BY
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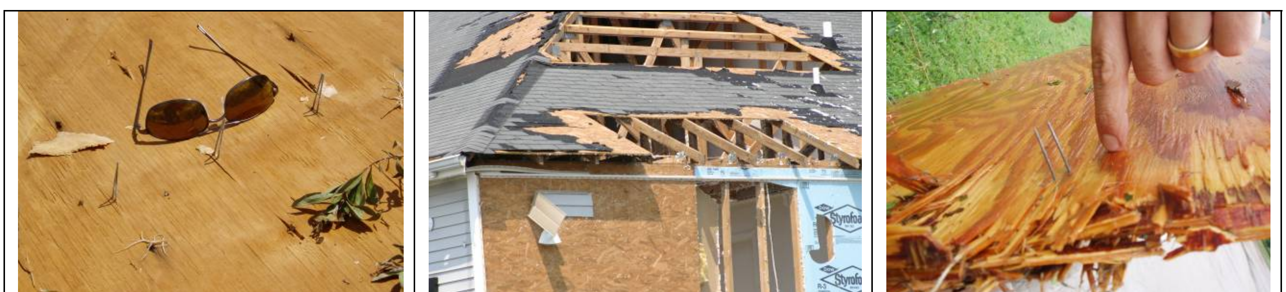
Background

One of the most common failures experienced by residential structures subjected to hurricanes is the loss of roof sheathing. As plywood and other structural products were introduced to the marketplace, focus on attachment methods was based on concerns about warping and shear capacity instead of uplift capacity, which would ultimately determine whether or not a roof survived powerful hurricane wind conditions. As a result, fasteners and fastening schedules in Miami, Florida were the same as those in Minneapolis, Minnesota, two states with completely different dominating climate events.

The Florida Building Code has responded to this issue through ongoing research to determine the most effective method to secure roof sheathing to roof structural members. Based on its findings, the Florida Building Commission has made several amendments to the building code since Hurricane Andrew in 1992 regarding this specific issue to ensure that homes in Florida can survive extreme wind events. One such addition now is the use of 8D ring shank nails for roof sheathing attachment (Florida Building Code, 2004, 2322.2.4) as opposed to the 8D common nail prescribed in the previous 2002 building code. The change in the building code was the result of research carried out by the IHRC in 2003 and 2004.

Although the Florida Building Code has improved the consistency and quality of sheathing fasteners, fastening schedules still differ greatly statewide in homes built prior to the introduction to the code. These differences became particularly evident after Hurricane Charley struck the southwest coast of Florida in 2004. Damage assessments conducted by the IHRC found many homes constructed using staples to fasten sheathing to roof structural members. Outside of Florida, staples are still considered acceptable for building in other hurricane-prone regions. Texas, for example, who employs both the International Residential Code and the International Building Code with amendments to address location specific design issues, allows for staples to be used in roof construction (Texas Building Code, 2000, section 211.4.1). Photos from Charley (2004), Katrina (2005) and Rita (2005) below illustrate the inadequacy of stapled sheathing.



(a) Hurricane Charley	(b) Hurricane Katrina	(c) Hurricane Rita

Purpose and Scope of Research

The extent of staple fasteners observed during recent damage assessments prompted the IHRC to perform panel uplift tests using staples in order to expand on testing undertaken in the 2003-2004 research year. Maximum uplift capacities were determined for sheathing secured by staples and compared to uplift capacities of 8d bright common nails tested in previous experiments and proscribed in building codes prior to the 1995 updates.

Concurrently, a new Stanley Bostitch hybrid fastener was tested. The Sheather Plus, or the smart nail, claims to be a revolutionary nail that is both cost effective and provides a safety factor unmatched by any other product. According to laboratory testing, the Sheather Plus resists both shear and uplift forces of up to 271 psi, depending on shank diameter and nailing pattern. The Sheather Plus consists of a "50/50" shank, half smooth and half threaded, which promises an ultimate shear loading of 9,348 lbs, about 20% higher than other sheather nails. Made of carbon steel alloy, this nail exceeds a bend capacity of 100,000 psi, can be used in a nail gun, and costs only $15 dollars more than current roof sheathing fastener.

Testing Protocol

Testing for this research was carried out using the Laboratory for Wind Engineering's vacuum chamber, which is capable of testing full roof sheathing panels 4' x 8' in size. The vacuum chamber simulates uplift pressure that would be applied to a roof sheathing panel given wind flow over a single family detached dwelling. The uplift pressure required to dislodge the sheathing from its structural member is directly correlated to the strength of the sheathing connection as well as the wind speed. A fastener requiring more pressure to be uplifted from the roofing structure would potentially perform better in stronger hurricane conditions.

Test specimens consisted of nominal 5/8" thick and ½" thick CDX plywood fastened to structural members consisting of nominal 2" x 4" lumber at 2' on center. Eighty specimens were tested: 15 full roof sheathing panels of 5/8" thick plywood secured by 2" staple legs, 15 full roof sheathing panels of 5/8" thick plywood secured by 1.5" staple legs and 50 full roof sheathing panels of ½" thick plywood secured by the Sheather Plus nail. Sheather Plus nails were driven with a nail gun at 12" on center for the interior and 6" on center around the edges, as prescribed in the current Florida Building Code. Staples were applied using staple gun using the fastener schedule as for Sheather Plus nails. Each panel was tested in the vacuum chamber allowing the IHRC to determine the pullout capacity of each fastener.

The following steps were taken for each panel test:

1. Fabrication of the test specimen
2. Inspection specimen to detect overdriven nails
3. Marking cross-members A through E from left to right
4. Mounting the test specimen on the vacuum chamber
5. Sealing panels on the chamber using 6mm vinyl sheets and adhesive tape to ensure the assembly is air tight
6. Measuring of moisture content in each cross-member (2"x 4") using a digital electronic moisture meter. Moisture content was then recorded on a work sheet and also marked on the cross-member itself
7. Activation of the vacuum pump until failure of the test specimen resulting in the vacuum seal being broken
8. Reading and recording pressure (psi) at the time if failure.

9. Identifying and recording the type of failure for each fastener, i.e. partial pullout, total pullout, head pull-through, etc.

Data Analysis and Conclusions

After testing was completed, statistical analysis was performed using the results to determine relationships between pullout pressures and fastener types. Histograms and PDF fits are shown in Figure 1. Both staple types had only about half of the pullout capacity of the Sheather Plus nail. The 1.5" staple leg staple had a mean pullout capacity of 67 psi while the 2" staple leg staple performed slightly better with a mean pullout capacity of 79 psi. The Sheather Plus nail performed exceptionally well with a mean pullout capacity of 140 psi, as compared to 106 psi measured with common bright 8d nails.

Figure 1.