Insurance Institute for Business & Home Safety

Where building safety research leads to real-world solutions.

2011 Hurricane Demonstration Testing Summary:

Insights on Wind-Driven Water Entry

Interior water damage resulting from wind-driven rain is a significant loss driver affecting coastal and inland properties during hurricanes, severe thunderstorms and other high-wind events accompanied by rain. Recent Insurance Institute for Business & Home Safety (IBHS) research and testing illustrates how such losses can be substantially reduced through relatively simple, inexpensive changes to residential roofing systems, such as sealing the roof deck (which costs about $500 for an average-sized home).

In August 2011, IBHS conducted a first-of-its-kind full house examination of how wind-driven water penetrates common types of openings in residential roof systems. The study was modeled on real-world, post-event damage assessments in areas where winds were strong enough to blow off roof cover, but not strong enough to tear off roof sheathing or decking. Water entry was captured in high-definition still photos and video that clearly show the consequences of water intrusion through cracks between roof sheathing elements and nail holes left as roof cover came off, as well as through attic ventilation elements (e.g., gable end vents, ridge vents, and soffits).

Objectives for IBHS' first wind-driven water research project included:

- quantifying the relative volume of water penetration through different roof openings;
- cataloguing types of water penetration damage to different parts of a house;
- demonstrating effective individual damage mitigation techniques, such as sealing the roof deck; and,
- illustrating why sealed roof decks are core components of the IBHS FORTIFIED for Existing Homes™ and FORTIFIED for Safer Living® program requirements for hurricane prone regions.

About the Testing

A full-scale, 1,300 sq. ft. duplex was designed and constructed for the demonstration and quantitative testing. Sheathing joints on one half of the roof deck were sealed, while joints on the other half were not sealed. Both halves of the roof were then covered with simple felt paper underlayment prior to installing asphalt shingles. The roof system included gable ends fitted with vents and one-foot wide soffits at the eaves. The roof sheathing stopped short of the peak along the primary ridge, so it was possible to install a ridge vent during one set of tests. A series of quantitative tests was conducted before the scheduled hurricane demonstration.

Highlights of Quantitative Test Results

- **Open and covered soffit tests simulating events when soffit material is: 1) lost; and 2) remains in place.**

At 50 mph, water entered the attic at a rate of about 1.3 inches per hour per square foot of open soffit area (simulating loss of soffit material). Most water was deposited within the first 10 feet of the attic space adjacent to the open soffit. By comparison, only 6 percent of the water quantity entering in the open soffit test accumulated

during a test conducted at the same wind speed when the soffit was covered with typical perforated soffit vent covering (simulating soffit material remaining in place).

At 70 mph, water entered the attic at a rate of about 2.9 inches per hour per square foot of open soffit area. By comparison, only 25 percent of water entering in the open soffit test accumulated during the same test when the soffit was covered. With the soffit cover in place, the 70 mph wind produced about 9 times more water accumulation in the attic than the 50 mph test for the same conditions.

- **Exposed Roof Sheathing Tests**

Engineers stopped the comparative test between the sealed and unsealed sides of the roof deck 16 minutes into the test because the 3-gallon containers collecting water on the unsealed side were overflowing. The sealed roof deck side (where roof sheathing joints were covered with a self–adhesive, modified bitumen tape) experienced about one-third of the water entry experienced by the side without tape. Some water entry on the sealed roof deck side was due to cuts in the tape that occurred when roof cover was removed. Even holes left by nails that were pulled out when roof cover was removed led to steady drips of water into the attic. Use of ring shank nails to fasten shingles and underlayment would likely help reduce these leaks, because they are less likely to pull out, even if roof cover is blown off. There was no sign of leakage through the Florida Building Code High Velocity Hurricane Zone approved ridge vent.

Hurricane Demonstration

Upon completion of quantitative testing, water collection devices were removed from the duplex, drainage holes in the ceiling were patched, and furniture was installed to model actual living spaces. The finished structure was then subjected to a series of wind-driven rain events modeled after Hurricane Dolly. Following this testing, an experienced property insurance claims adjuster estimated the amount of damage in the kitchen, dining area and living room on each side of the duplex. Losses were estimated to be three times greater for the unsealed roof deck side than losses on the sealed roof deck side ($16,935 versus $5,408). Of particular note: all furniture on the unsealed side of the duplex required replacement, while furnishings on the sealed side only required cleaning.

Conclusions and Recommendations

The type of natural catastrophe recreated in this test program routinely causes widespread, significant property damage, and can displace homeowners for several weeks or months. That is why a sealed roof deck is required as part of the IBHS FORTIFIED for Existing Homes™ Bronze Hurricane Designation. The designation incorporates current best practices in a systems based approach to reducing water entry related losses in high wind events. These recommendations are also incorporated in the IBHS "Roofing the Right Way" guide.

IBHS' water intrusion tests confirmed that sealed roof deck guidance is a very effective way to reduce water entry during hurricane or thunderstorm conditions. Importantly, roof installers should be careful to make sure that seams are securely sealed and that the drip edge is attached using typical high-wind requirements for fasteners. It is likely that the Florida Building Code High Velocity Hurricane Zone requirements for applying roofing cement around edges of the roof would also help reduce water entry if the roof cover does suffer damage in a storm.

While initial results are impressive, much more detailed investigation is needed to quantify the amount of water entry that can be expected for normal construction; how much water penetration can be reduced with various prevention measures; and, how much water entry can be tolerated by various construction materials and systems before costs of water entry remediation increase significantly.