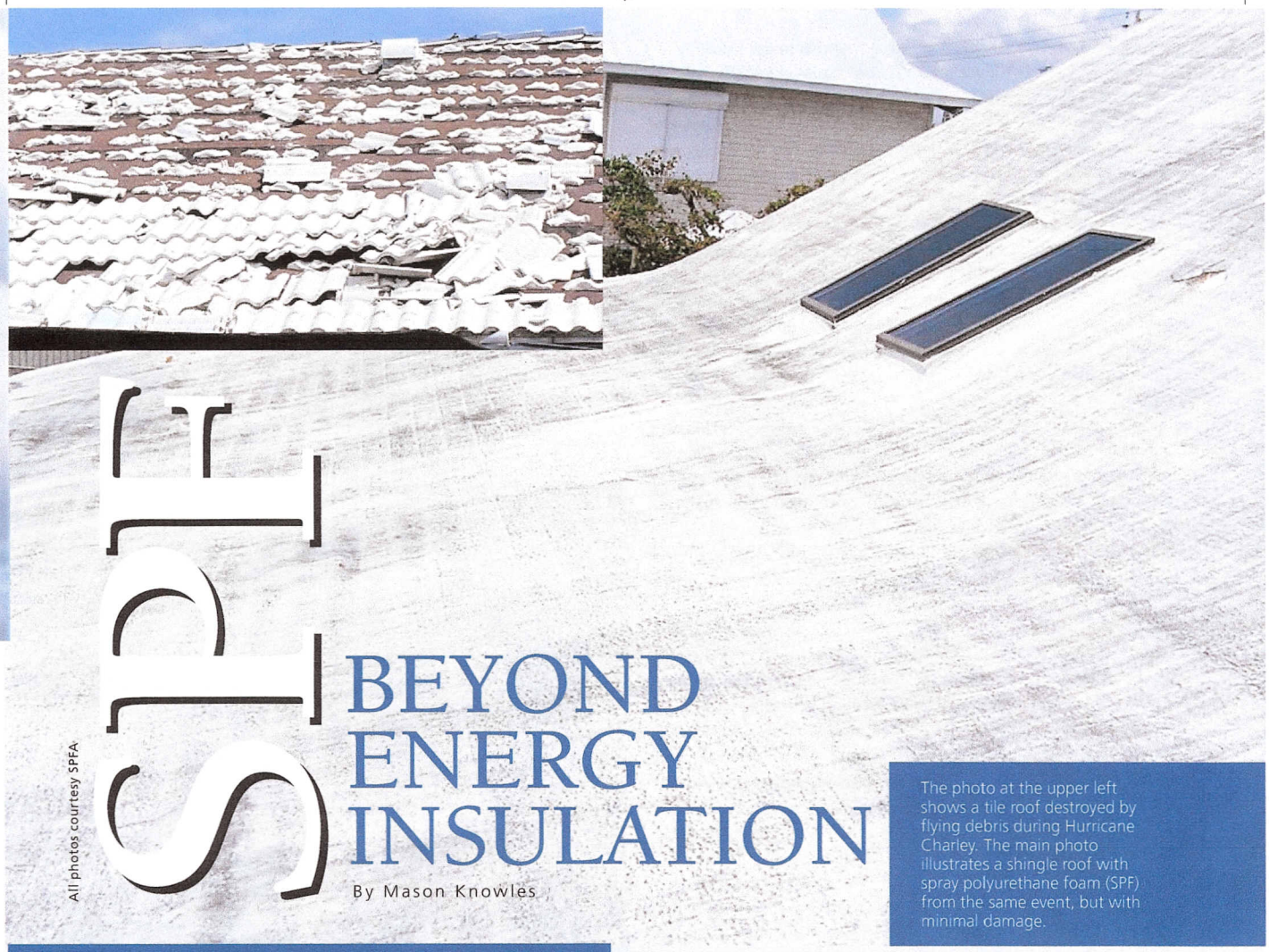


All photos courtesy SPFA

SPF BEYOND ENERGY INSULATION

By Mason Knowles

The photo at the upper left shows a tile roof destroyed by flying debris during Hurricane Charley. The main photo illustrates a shingle roof with spray polyurethane foam (SPF) from the same event, but with minimal damage.

Previous issues of *Modern Materials* have examined some of the myriad advantages to specifying spray polyurethane foam (SPF), especially its insulation value and air barrier qualities. This spray-applied, insulating foam plastic is installed as a liquid and then expands many times its original volume. These spray foam formulas can be tweaked to have many different physical properties depending on their desired use. For example, the same basic raw materials can make an insulation foam that is semi-rigid and soft to the touch, but can also create a high-density roofing foam resistant to foot traffic and water.[1]

As building insulation, SPF can provide high levels of R-value, while serving as an air barrier and offering assistance in moisture control.[2] In roofing, it insulates and helps eliminate thermal bridging (*e.g.* through fasteners or gaps in decking), while helping to provide a long-lasting roofing assembly.

Whether by prolonging a roof's service life or by improving the thermal performance of a building, spray polyurethane foam can enhance a building's energy efficiency. However, one added bonus is the material's ability to help improve structural integrity—a particularly salient advantage in areas facing the potential of high-wind events.

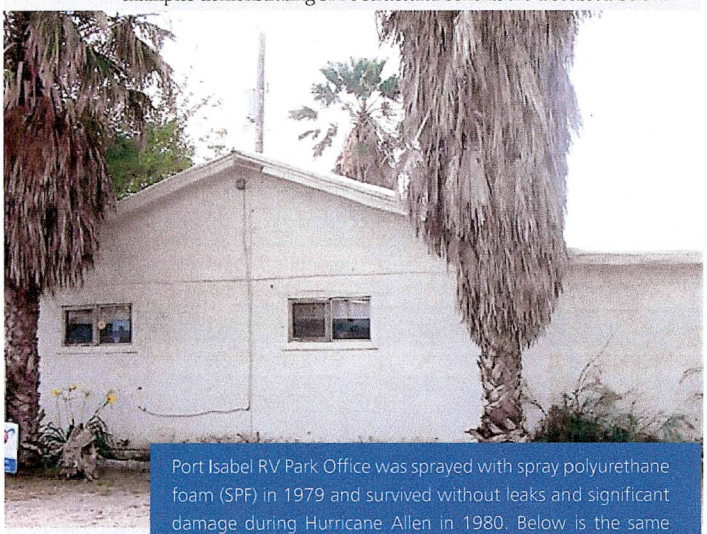
Riding out the storm

Marelene Hillen of Port Lucie, Florida, initially faced skepticism in getting her homeowners' association to approve the installation of an SPF room over her existing shingle roof. However, her persistence in educating those about the possibilities of plastic products paid off.

"In my neighborhood, more than 40 of my neighbors lost their roofs and most of their belongings last season from three hurricanes hitting us in six months," she says. "My roof that was sprayed with SPF didn't leak a drop."

Tales from Texas

This author insulated more than 100 buildings on Texas' South Padre Island from 1976 to 1980. When Hurricane Allen blew into town in 1980, packing more than 193-km/h (120-mph) winds, most buildings on South Padre (and in the nearby mainland town of Port Isabel) sustained significant damage. However, of the more than 100 buildings treated with spray polyurethane foam (SPF), only two leaked. (Both were easily repaired within two days.) Two other examples demonstrating SPF's structural benefits are discussed below.



Port Isabel RV Park Office was sprayed with spray polyurethane foam (SPF) in 1979 and survived without leaks and significant damage during Hurricane Allen in 1980. Below is the same building in 2006—no reported leaks in 26 years.

Port Isabel RV Park

In 1979, John Denney constructed a wood-framed office building at his mobile home park in Port Isabel, but driving rain during frequent tropical storms regularly leaked through the walls. The owner decided to spray the entire outside envelope with SPF. Soon after, Hurricane Allen hit and the building weathered the storm with only superficial damage (easily corrected with a little sealant) and, more importantly, no leaks or structural damage. As shown in this photo taken May 2006, the building still looks the same as the day it was sprayed—it has not leaked since the SPF was installed.

White's Lumber

A small section—15.2 x 15.2 m (50 x 50 ft)—of the lumberyard's post frame building (wood trusses and corrugated metal walls and roof) was being insulated with SPF just before a tropical storm hit. Afterward, the sections with SPF were the only ones still intact. Due to the foam's performance, the owners installed the material to the underside of the metal roof and walls and have not reported any leaks since.

A related example can be found in David Gautier's Pascagoula Ice and Freezer Plant in Mississippi. The ice plant is a 4180-m^2 (45,000-sf) complex consisting of the original turn-of-the-century building with additional sections added every 20 years or so. The original construction comprised brick walls with wood tongue-and-groove decking.

With its Category 4 winds—200 to 233 km/h (125 to 145 mph)—and an accompanying 7.6 to 9-m (25 to 30-ft) storm surge, Hurricane Katrina destroyed a vast area of the Mississippi Gulf Coast. However, the Pascagoula Ice and Freezer Co. sustained no damage in the SPF-insulated sections. (In places that lacked SPF, pressurization from the high winds blew out portions of the roof deck.)

"These building have not only survived Hurricane Katrina, but also three other major storms—Frederick, Elena, and George," explains Gautier. "The spray foam definitely helped keep the buildings together."

Structural integrity

Building owners who request SPF be installed for thermal efficiency reasons could also benefit when more building officials recognize the material's advantages in terms of structural integrity. By examining the characteristics of SPF, a better understanding can be gained of how this plastic product helps hold materials together, while also assisting in making the building more energy-efficient.

Tenacious adhesion

SPF is sprayed on as a liquid and then expands to form a rigid foam plastic with great adhesive characteristics. Since it bonds so tightly to a substrate, it is very hard to pull off in high winds. When installed over concrete panels, SPF resisted up to 47.4 kPa (990 psf) of pressure in Factory Mutual's (FM's) wind uplift pull test. It glues the whole structure together, increasing the structure's rigidity with around 172.4 kPa (25 psi) of tensile strength. However, it still has some flexibility to allow building movement without cracking.

Monolithic water barrier

SPF is installed as a liquid and then rises and expands to fill in cracks and crevices. Closed-cell SPF has been approved by the U.S. Coast Guard and Army as a water-resistant flotation material and is accepted as a roofing system. The Federal Emergency Management Agency (FEMA) has added SPF as a recommended building product to reduce flood damage in buildings.[3]

Adds structural strength

The National Association of Home Builders (NAHB) Research Center tested SPF and determined spray foam-insulated wall panels increased the racking strength of both wood and metal stud walls 70 to 200 percent, depending on the type of sheathing used. The NAHB report concluded, "in a racking event such as a hurricane, there would be less permanent deformation of the SPF-insulated walls." (See "NAHB Racking Research.")

Versatile

When installed to the outside of buildings, SPF reduces the profile and minimizes building movement so high winds are less likely to catch a corner or tear the substrate. When added to the inside of a structure, spray foam 'glues' the whole building together, enhancing overall wind and pressurization resistance.

Natural shock-absorber

NAHB Racking Research

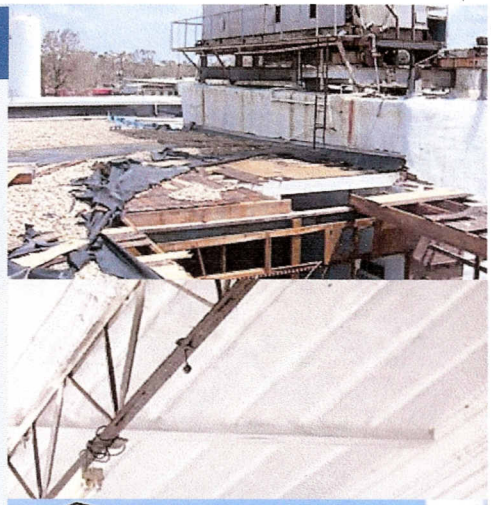
Average Maximum Racking Load Supported by Each Panel Configuration
Table 1

Stud spacing	Spray polyurethane foam (SPF) panels with vinyl sheathing	SPF panels (5/8-in.) with plywood	Non-SPF panels with vinyl	Non-SPF panels (5.8-in.) with plywood
406 mm (16 in.)	2800 lb	5300 lb	913 lb	2890 lb
610 mm (24 in.)	2420 lb	6387 lb		
813 mm (32 in.)	2588 lb			
1219 mm (48 in.)	2298 lb			
16 in. braced			3853 lb	5262 lb

Table 2

Specimen	Maximum racking load	Maximum racking deflection	Maximum racking set
oriented strandboard (OSB) with R-19	4800 lb	1.045 in.	0.516 in.
OSB with SPF	6000 lb	0.767 in.	0.142 in.
drywall with R-19	2400 lb	0.856 in.	0.413 in.
drywall with SPF	5380 lb	0.945 in.	0.407 in.

The information within this article comes from two tests conducted by the National Association of Home Builders (NAHB). Table 1 draws on information from the group's 1992 wall performance testing of 2x4 wood stud panels, while Table 2 references the association's 1996 racking performance study of metal wall panels.



At the Pascagoula Ice Plant in Mississippi, the deck was destroyed by pressurization in areas where no SPF was installed. However, spray foam installed to the interior kept the section of the building in one piece. The exterior also had SPF installed. It shows no damage.

SPF is a natural shock-absorber; even heavy wind-blown items such as tree limbs, metal panels, and concrete tiles usually only superficially damage spray foam substrates. When wind-driven debris damages the surface of the foam, it resists peel off and often continues to provide water resistance to the interior of the building.

Reduced pressurization

Some deck and roof membrane failure occurs when high air pressure forced into, or developed inside, the building literally blows up the roof deck or roof membrane. SPF eliminates air infiltration that can let high air pressure inside the building. By 'air sealing' the building, SPF minimizes the potential for interior pressurization and its ensuing damage.

Easily repaired

Typically, damaged SPF can be easily repaired with a compatible sealant or by cutting out the damaged portion and installing more foam.

Notes

[1] As spray foam formulations vary by manufacturers, design professionals should consult their suppliers' specification sheets to understand the chosen product's exact properties.

[2] As insulation formulation may vary from manufacturer to manufacturer, design professionals should consult the suppliers' specification sheets to understand the exact properties over time, including the actual R-values. Factors affecting the R-value include thickness of application (*i.e.* the thicker the foam, the better the aged R-value), the substrate, and the covering systems used (*i.e.* the lower the perm-rated covering and substrate, the higher the aged R-value).

[3] Visit www.hurricaneconstruction.net/files/FEMA%20Technical%20Bulliten%202-93.pdf

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FM Wind Uplift Results

FM Global conducted Class 1 roof coverings tests in January 2005. For the 3.6 x 7.3-m (12 x 24-ft) Wind Uplift Pressurization Test, the sample met 10.1 kPa (210 psf) for minimum approval for FM I-210, *Windstorm Classification.* The construction failed six seconds into the 10.8 kPa (225 psf) 'round,' due to fastener pullout from the supports.

In the 1.2 x 1.2-m (4 x 4-ft) Wind Uplift Pull Test, the sample over concrete met the minimum of 47.4 kPa (990 psf) for approval requirements of FM I-990, Wind Uplift Classification. (In this case, 990 psf was the capacity of the equipment.)