



Performance Under Pressure: Structural Insulated Panel (SIP) Walls



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The path of Hurricane Charley traverses the state with Port Charlotte in its eye.

(Source: FEMA, MSNBC)

In the Eye of the Storm...

The 2004 Atlantic hurricane season kept Floridians busy as four storms crossed the state within a six week period. The first storm to hit was also one of the most dangerous. Hurricane Charley made landfall on Friday, August 13, 2004 near Port Charlotte, Florida bringing 145 mph winds and a storm surge up to 20 feet high. Ultimately, Hurricane Charley forced evacuation of 2.7 million Floridians and knocked out power to 1.2 million households.

The Insurance Information Institute has estimated that Hurricane Charley was the second most costly hurricane in U.S. history behind 1992's Hurricane Andrew. In all, the big four hurricanes of 2004 (Charley, Frances, Ivan, and Jeanne) now stand as four of the top six most costly storms on U.S. record. As a result, homebuilders, homeowners, and insurance agencies are all searching for ways to increase the storm resilience of Florida's communities.

Building a More Durable Home

One way of ensuring a new home's safety is to build it using durable, hurricane-resistant construction systems. A great example is the structural insulated panel (SIP) wall system. SIPs are an engineered prefabricated sandwich of structural sheathing such as oriented strand board, cement fiber board, or various types of metal surrounding a solid foam insulating core. Though SIPs have been around since 1935 when the U.S. Forest Service's Forest Products Laboratory first developed them, they have only become more widely used within the last decade.

SIPs can be used in walls, ceilings, floors, and roofs. SIPs provide a high R-value with the benefits of a high strength-to-weight ratio. Our case study home built by Home Front, Inc. in Sarasota County, Florida used a SIP system with wall panels made of a low-density foam core sandwiched between fiber cement board sheathing braced by an interior steel ridge beam. Home Front, Inc. also uses aluminum-skinned SIPs for their roofs.



A Home Front, Inc. residence can be dried-in after about 3 days with a shell cost of approximately \$25 per square foot.

(Source: Home Front, Inc.)

Universal Model (1-Story)

Location | Sarasota County, FL

Builder | Home Front, Inc.

Living Space | 3/2 @ 1,370 ft²

Total Under Roof | 2,000 ft²

Price | \$150,000 (est.)

HERS Rating | 94

Wall | Hardie® Board SIP

FL Approval | # FL1048

Roof | Elite Aluminum SIP

FL Approval | # FL1049

Tie-Down | Proprietary

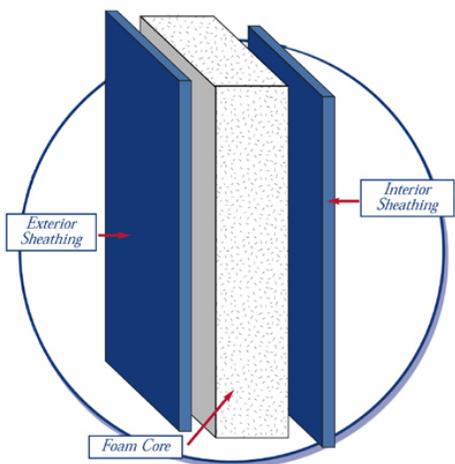
Performance Under Pressure

Sure, structural insulated panel (SIP) walls sound like a durable building system, but how do they perform in the high wind load conditions of hurricanes and tornados? In our case study example, the Home Front, Inc. wall panels are compliant with Dade County, Florida codes, the most stringent wind-borne debris requirements in the country. Wind tunnel testing proved both the wall and roof SIPs used by Home Front, Inc. could withstand 9,000 wind cycles up to 200 mph with no damage. Additionally, these wall panels meet the static wind loading test (ASTM E 330) and the Southern Building Code Congress International’s (SBCCI) standard for large missile impacts (SSTD 12-99).

During testing, the Home Front, Inc. SIP wall system, consisting of 5/16” thick Hardie® cement board sandwiched around a 4” thick core of polystyrene foam, deflected less than 1/8” under an approximately 1,000 lb/ft load. The wall’s breaking strength has tested to be approximately 7,000 pounds.

Another high performance feature of the Home Front, Inc. system is an internal steel moment frame that stabilizes the SIP structure and adds additional wind resistance capacity. Further innovations in the Home Front, Inc. system include a proprietary roofing SIP made by the Elite Aluminum Corporation of Ft. Lauderdale, FL.

Beyond the wind-borne debris requirements, SIP walls have proven to provide safe haven from other damaging forces resulting from high wind conditions. **NOTE, this data is for demonstration only and not to be used for design purposes.**



Typically, SIPs have a foam core surrounded by structural sheathing. (Source: www.iowacoolers.com)

Home Front’s SIP Wall vs. 2” x 4” Wood Studs with ½” Sheathing
Test Conditions: 28.9 psf wind load (~125 mph storm)

	SIP Wall	Wood Stud Wall
<i>Axial Compression</i>	500 lbs/ft	400 lbs/ft
<i>Bending Moment</i>	1,180 ft-lbs/ft	350 ft-lbs/ft
<i>Shear</i>	636 lbs/ft	< 400 lbs/ft

(Source: Home Front, Inc.)



The Home Front, Inc. SIP houses have vaulted ceilings and ductwork inside the conditioned space. (Source: Home Front, Inc.)



Home Front, Inc. uses a steel moment frame to improve wind resistance and steel studs to increase termite resistance. (Source: Home Front, Inc.)

Variables Affecting Performance

The performance of any structural insulated panel (SIP) wall depends on its component materials and installation process. There are a few important variables to take into consideration when building with SIP systems.

1. Panel fabrication (proper panel gluing, pressing, and curing is critical to prevent delamination)
2. Panels must be flat, plumb, and have well designed connections to ensure tightness of construction
3. Though SIPs offer ease of construction, installers may need training for the system
4. Fire-rating of SIP materials and air-tightness of SIP installation affect the system's fire safety
5. Potential insect and rodent mitigation issues depending on SIP materials and construction

To discover more about SIPs and view a sampling of producers/suppliers or a list of the systems approved for use in Florida, visit the following websites:

- Florida Department of Community Affairs Building Code Information System - Product Approval Search Page
 - http://www.floridabuilding.org/pr/pr_srch.asp
- Structural Insulated Panel Association (SIPA)
 - <http://www.sips.org>
- City of Austin: Sustainable Building Sourcebook - Materials: Structural Insulated Panels
 - http://www.ci.austin.tx.us/greenbuilder/srcbk_6-20.htm



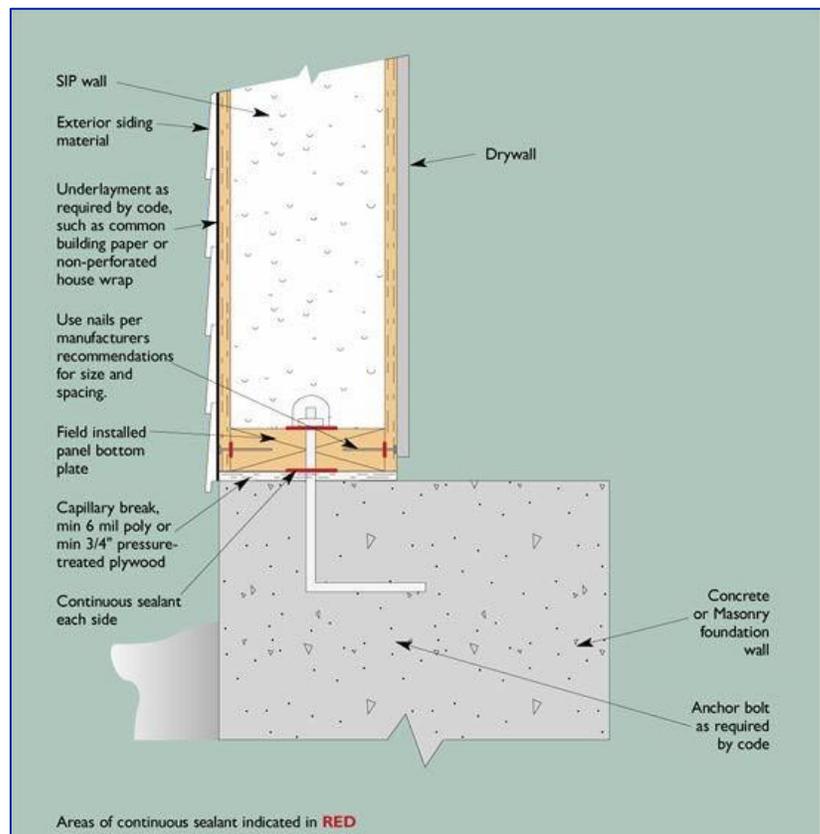
A four man crew can quickly and easily install the Home Front, Inc. SIP walls.

(Source: Home Front, Inc.)



SIPs can also be installed as roofing or flooring systems.

(Source: Home Front, Inc.)



Cross section detail of a typical SIP and the wall to foundation connection.

(Source: www.sips.org)

Other Benefits of SIP Walls and the Home Front, Inc. System

Energy Efficiency and Comfort

- SIP walls typically have R-values around R-20 while the SIP roofs have R-30, though these values vary depending on the specifications of the SIP and the width of the insulating core. Home Front, Inc.'s "Florida Modern" model home exceeded the local energy code by 38%.
- SIP systems can help homeowners pursue Energy Star® ratings and energy-efficient mortgages.

Noise Suppression

- SIP systems reduce noise transmission over traditional stud framing with fiberglass insulation due to the SIP's inner core of solid-foam.

Improved Indoor Air Quality

- Due to the tightness in construction of SIP systems and the lack of thermal bridging as is common in wood framing, SIP homes have less air leakage, are more easily controlled, and feel less drafty leading to improved occupant comfort.

Ease of Construction

- Once the floor slab is completed, Home Front's system can "dry-in" a house within approximately three days using a small crew of about four people. Some SIPs arrive on site with wiring and plumbing chases pre-installed from the factory.

Environmental Performance

- SIP systems often produce less waste than traditional stud-framed building envelopes due to the factory precision of the panel production.
- SIP systems such as the one utilized by Home Front, Inc. can reduce the need for roof shingles as the metal sheathing of the roof panels can also function as the finished roof.
- SIPs made from non-wood materials, like the system used by Home Front, Inc., can mitigate environmental disturbance from termites and the mold and mildew problems that can arise from the absorption of moisture in traditional wood construction.

Sources

Home Energy Magazine Online (March/April 1998) - SIPs Face the Skeptics

- <http://homeenergy.org/archive/hem.dis.anl.gov/eehem/98/980308.html>

Home Front, Inc.

- <http://www.homefronthomes.com/>

Insurance Information Institute - Hurricane Charley Information Center

- <http://www.iii.org/media/hottopics/additional/florida/>

Partnership for Advancing Technology in Housing (PATH) - PATH Technology Inventory: Results from the Field: Home Front Inc

- http://www.toolbase.org/tertiary_printT.asp?TrackID=&CategoryID=1507&DocumentID=3562

Partnership for Advancing Technology in Housing (PATH) - Structural Insulated Panels

- <http://www.toolbase.org/tertiaryT.asp?TrackID=&CategoryID=1402&DocumentID=2047>

South Florida Sun-Sentinel - Hurricane Headquarters

- <http://www.sun-sentinel.com/news/weather/hurricane/>

U.S. DOE: Energy Efficiency and Renewable Energy - Structural Insulated Panels

- <http://www.eere.energy.gov/consumerinfo/factsheets/bd1.html>

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