

# **SIPs Face the Skeptics**

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**by Polly Sprenger**

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**Structural insulated panels are one of several experimental building materials being pushed to combat the volatile lumber market. The panel houses are energy-efficient and easy to build, but resistance from the building trades and some technical glitches are holding back mass acceptance.**



On a balmy Saturday morning last August in Sedro-Wooley, Washington, a group of volunteers and construction professionals set out to build a house, and finish before game time on Sunday. They would use structural insulated panels (SIPs), a 45-year-old method and material that most builders still view with skepticism. SIPs consist of an insulating interior--usually expanded polystyrene, extruded polystyrene, Styrofoam, or polyurethane-- sandwiched between two pieces of rigid backing--plywood, waferboard, sheet metal, gypsum board, or, most commonly, oriented strand board (OSB).

The Sedro-Wooley project was sponsored by the Engineered Wood Association, the U.S. Department of Energy (DOE), Habitat for Humanity, and the Structural Insulated Panel Association (SIPA). All of these groups are trying to promote the use of SIPs for new home construction because panel houses can be remarkably energy-efficient, built with less labor, and produce less waste than traditional wood frame construction.

Since the first SIP house was built in 1952, the technology has improved and spread in small pockets around the country. Even so, in 1996, SIP houses accounted for less than 1% of new housing starts (about 8,000 homes). Subcontractors like electricians and plumbers don't know how to approach the panels, and small builders are unwilling to risk their businesses on a new technology.

The market for SIPs has increased significantly in the last decade; according to a study commissioned by SIPA, annual production of the panels has increased 100% since 1991. The more than 100 U.S. panel manufacturers now produce in excess of 32 million ft<sup>2</sup> of panels every year. Will Zachmann of

**Table 1. Characteristics of SIP House and Wood Frame House**

	Wood Frame House	Structural Insulated Panel House
Home Energy Rating System (HERS) score	87-35% better than the Model Energy Code (MEC) compliant <i>Reference Home</i>	89%-45% better than the MEC compliant <i>Reference Home</i>
Foundation	Block stem wall and slab R-10 to 2-ft depth	Block stem wall and slab R-10 to 2-ft depth
Walls	2 x 4 frame walls R-13 fiberglass batts + 1/2-in rigid insulation	4-in SIPs 3 5/8-in, R-14 EPS core
Ceiling/Roof	2 x 4 truss roof R-30 blown-in cellulose	Flat ceiling of 8-in SIPs 7 3/8-in, R-29 EPS core Frame roof above
Windows	Double-pane aluminum-clad wood frames U-value = 0.49	Double-pane aluminum-clad wood frames U-value = 0.49
Measured Envelope Leakage	ACH <sub>50</sub> = 3.9	ACH <sub>50</sub> = 2.4
Measured Duct Leakage	To outside = 0 CFM	To outside = 0 CFM

Source-Florida Solar Energy Center/U.S. Department of Energy report. *Field Research: Energy Use of Wood Frame and Structural Insulated Panel Homes*. October 1997.

**Table 2. Energy Savings in SIP House\***

	Wood Frame House	SIP House
ACH <sub>50</sub>	3.9	2.4
Measured Duct Leakage	To outside = 0 CFM	To outside = 0 CFM

	Wood Frame House	SIP House	SIP Savings
Predicted heating energy use (HERS)	7,342 kWh	5,961 kWh	19%
Predicted heating, cooling, and water-heating energy use (HERS)	14,992 kWh 41.1 kWh/day	13,611 kWh 37.3 kWh/day	9%
Calculated UA (preconstruction)	271 Btu/h°F	265 Btu/h°F	2%
Measured UA electric heating test	276 Btu/h°F	242 Btu/h°F	12%
Predicted electric heating use (DOE2)	46.8 kWh/day	39.3 kWh/day	16%
Measured electric heating use	37 kWh/day	31.4 kWh/day	15%

\*Figures are for a two-story 1,200 ft<sup>2</sup> house.

Source: Florida Solar Energy Center/U.S. Department of Energy report. *Field Research: Energy Use of Wood Frame and Structural Insulated Panel Homes*. October 1997.

SIPA reports that if current industry projections hold true, these figures could jump to between 50 and 112 million ft<sup>2</sup> annually by 2000. Through projects like the Sedro-Wooley house and other ventures, the organization hopes to increase builders' exposure to the technology, and dispel some myths that may be causing them to hesitate.

One of the more obvious benefits of SIPs is that they offer ready-made walls and ceiling complete with insulation. In 1993, the Florida Solar Energy Center (FSEC) and DOE did a side-by-side comparison of a wood frame house and a SIP house. The foam core of the panels--3 5/8 inches to 5 5/8 inches thick for walls and 5 5/8 inches to 7 3/8 inches for ceilings--had R-values of R-14 and R-29 respectively.

These insulation values, the study found, were especially effective because the SIP house was more airtight. The panels require fewer seams, since they can be ordered as whole walls directly from the manufacturer (see "[Wall R-Values That Tell It Like It Is](#)," *HE* Mar/Apr '97, p. 15).



**SIPs are easier to assemble than wood-framed walls. But building crews are not accustomed to the material, and training takes time.**



**Figure 1. There are three common methods of joining panels: a dual plywood spline joint (top), a solid 2x blocking**

This prevents air leakage along the many joints created by wood frame construction. The measured air leakage in the stick house was around 3.9 ACH<sub>50</sub>, compared to 2.4 ACH<sub>50</sub> in the SIP house. Armin Rudd, task leader of the study for FSEC, says that number should be looked at critically, since the stick house in the study is considerably tighter than the national average for airtightness in the existing U.S. housing stock (see [Table 1](#)). Rudd found that the energy required to heat the SIP house was about 15% less than that required to heat the frame house (see [Table 2](#)).

Without the placement of studs every 16 inches on center, SIPs also offer less opportunity for thermal bridging (see "[Fundamentals of Moisture in Houses](#)," *HE* Nov/Dec '95, p.11). Like an I-beam, SIPs get their structural strength from the length of their span, so studs within the wall aren't necessary. Allen Lee, a researcher at Pacific Northwest National Laboratory explains: "The panels utilize a stressed-skin principle where the overall strength of the panel is much greater than the strength of the components, thus reducing the need for structural framing members. Because the panels are structural, they withstand forces and loads imposed on the walls, floors, and roofs, which, combined with their superior insulating properties, makes them ideal building component materials."

### Cleaner Job Site

Theoretically, SIPs can make a builder's life easier in many ways. The building site becomes a much cleaner place when SIPs are used. At the Sedro-Wooley house, SIPA logged a total of 0% waste from all floor and ceiling panels and 1% waste from the



**An average-size SIP house requires 24-36 panels; a larger home like this one uses more. Installing roof panels may require a light crane, but walls can be constructed with on-site labor.**

**joint (middle), or a single top spline joint. All three joints work essentially the same way: two panels are placed side-by-side and the plywood or 2x is placed between them. Fasteners are screwed or nailed through the OSB on the panels, into the plywood or 2x.**

roof panels used in the one-story house. Most of the site waste came from OSB splines (29% waste from four 4 x 8 sheets) and from other site-cut lumber struts and supports. Overall, site waste for the house was less than 3% of the total materials, compared with a standard 15%-20% on most job sites.

Less waste and cheaper labor costs do allow SIPs to compete better with wood frame construction, although in material costs alone, SIPs are more expensive. In an article in the *Forest Products Journal*, economist Henry Spelter calculates that panel walls can be constructed at an average cost of \$513 per 100 ft<sup>2</sup> of wall. Spelter places the cost for building wood frame walls at about \$436-\$471 if studs are spaced every 2 ft. "Lower labor costs are offset by higher material costs to yield slightly higher in-place costs compared to wood frame," Spelter writes. For an average 2,000 ft<sup>2</sup> house, costs for using SIPs would be around \$625 more than costs for wood frame.



**Panels arrive on the site direct from the manufacturer. In many cases, they already have wiring and plumbing chases cut.**

Installation can be very simple. Although manufacturers use various methods to lock panels together, most are installed using three simple joints: a dual plywood spline joint, a solid 2x blocking joint, or a single top spline joint (see [Figure 1](#)). The spline joints are generally accompanied by a small trough, at least 3/8-in deep, cut in the foam. This trough is filled with an adhesive caulk or an expanding foam sealant that keeps the joint airtight. The dual plywood spline joint consists of a short groove cut in the foam end of the panel along its entire height on the front and back faces. Two plywood splines are fitted into the grooves of both adjoining panels, and fastened through the face. The single spline joint is the same joint only on the outside edge. The block joint follows the same concept, but has a groove wide enough to accommodate a 2 x 4 stud, with the OSB facing of each panel fastened to the stud.



**Builders and architects can specify pre-cut window and door openings from the panel manufacturer. The only job-site task is assembly.**



**A finished SIP house saves about 15% of the heating and cooling costs required for its stick-built counterpart.**

Corner details vary, depending on the structural demands of each corner, but most panel manufacturers offer comprehensive manuals for constructing with their specific products. Anywhere two panels meet, a chase can be cut in the foam, and the joint sealed with expanding foam sealant.

The panels are manufactured to varying stages of completion. Some arrive at the job site as 4 ft x 8 ft panels, while others arrive as 24 ft x 8 ft walls. In addition, panels can come with wiring chases already cut, easing the burden of the electrician who is hesitant to cut into a structural panel. Jim LeRoy, CEO of Panel Pros, a panel fabricator in Keene, New Hampshire, estimates that about 80% of all panels are delivered with wiring chases pre-cut.



## The Skeptics Speak



**Labor costs for building SIP houses are low--once a crew has been trained. The costs are higher with current labor skills, since trained SIP builders aren't available.**

In fact, SIP houses *are* still more expensive to build, around 3%5% higher than traditional frame construction. The demand is low, so production facilities for the panels aren't operating at full capacity. Because most builders don't have experience with the technology, labor costs are actually still quite high. Every task on a SIP house is a new job for these builders to learn.

Another builder in the Blacksburg, Virginia, area has voiced similar concerns about the technology. "Experimentation is risky," says Eric Sallee. "I can't say that strongly enough. We, as builders, can't afford to lose even one house. Look at other 'great' new products that have been introduced to the marketplace early with disastrous results--asbestos, fire-resistant plywood, and exterior insulation and finish systems. And at least in all of these cases, it was possible to fix the problem--not easy or inexpensive, but possible. If something goes wrong with SIPs, it's the structure you're talking about."

The SIP manufacturing industry is well aware of the obstacles it faces. The industry association, SIPA, is attempting to combat these fears with well-placed publicity about the volatility of lumber prices; the quality of lumber (SIPs arrive straight--more than you can say for most raw lumber); and the mostly undisputed efficiency of SIP houses compared with wood frame construction.

The new focus of SIPA is not only to continue this publicity, but to sponsor trainings and demonstrations for builders as well. Projects like the Sedro-Wooley house and other partnerships with Habitat for Humanity help with this goal, exposing builders and consumers to the technology. More SIPs in the public eye means more inquiries from the customer base.

Sallee suggests that one path to broader builder acceptance is through the use of SIPs in manufactured housing.

Sallee isn't the only one who has hit on this as a good strategy. At Pacific Northwest National Laboratory (PNNL), DOE has sponsored a study to investigate the viability of combining the manufacturing processes of mobile homes with the manufacturing processes of SIPs. Allen Lee, formerly of PNNL, and George James of DOE have suggested in their research that introducing SIPs to mobile homes would be valuable to both industries (see "Innovation in Manufactured Housing: Structural Insulated Panels," p. 16).

Lee and James write that "recent market and regulatory trends have created pressures on the [manufactured home] industry to seek innovations that can improve energy efficiency and construction quality without undermining its inherent production cost advantages. SIPs offer advantages that might help the manufactured housing industry address these issues."

The advantages for the SIP industry could be just as important. Mobile home construction is one of the fastest growing sectors of the U.S. housing market. An increased demand from this industry on the SIPs market would drive up production so that panels could come down in price, making them more accessible to builders and homeowners. Panelized mobile homes might also give builders the evidence they need that SIPs are a safe investment. Because manufacturers would be forced to comply with the standardized HUD code, builders would have more quality assurance.

And if this theory needs a historical precedent, wood-frame construction itself was born out of a need for low-cost housing. In 1833, Fort Dearborn, Illinois, had fewer than 100 inhabitants. Less than 60 years later, thanks to a much-ridiculed invention, it housed more than a million inhabitants and went by the name of Chicago. Most of these new inhabitants lived in frame houses, an idea proposed by Augustine Taylor in 1833 to replace timber-frame building. At the time, fellow builders thought the idea was so ludicrous that they gave it the nasty nickname "balloon frame," saying the buildings were so light they would just float away.

The building trade does change, but demand from the market will play a huge part in any success SIPs have. Stimulating that demand with help from HUD-manufactured housing may be the quickest route to popularizing this technology.

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