by Steve Carlson

Builders assemble a custom saltbox using panels provided by Branch River Foam Plastics. Panels are cut in the field according to shop drawings that Branch River supplies for each home.

STRESS-SKIN HOMES MOVE MAINSTREAM

With refined systems foam-panel manufacturers are penetrating more markets

On a wooded hillside in Keene, N. H., heavy machinery is at work building roads and laying sewer lines for a 54-house development.

The houses are far from identical, but share design features such as steep roofs and cathedral ceilings. Those that are closed in wear the badges of energy efficiency: tiny heating systems and air-to-air heat exchangers.

The development looks similar to many others in the upper-middle price range. But instead of studs, joists, or timber frames, the houses are all supported by sandwich panels.

Structural sandwich panels are not a new idea. Many individual builders have experimented with the concept. Just after World War II the U.S. Forest Products Laboratory began a research project that lasted 31 years, determining that structural panels compare favorably to conventional building methods.

But according to the relatively few manufacturers of structural sandwich panels, their products are just beginning to receive widespread acceptance. After years on the fringes of the building industry, they say demand is now mushrooming as rapidly as they can increase the supply.

There are many different kinds of structural panels. Some are limited to specific applications. The Arco Wall-frame System, for example, is for walls only. Others are for roofs only. Charles Harra, a contractor in Tahlequah, Okla., has for several years been using custom-built structural roof panels for his homes, but prefers conventional stud construction for walls.

But panels are available for just about every component of an insulated shell, including subfloors, flat ceilings, and even foundations. One of their attractions is versatility. They can be the principal structural component, or part of a hybrid. If a cathedral ceiling must span a long distance between supports, or if another post might get in the way of the ping-pong table, structural panels may be the answer.

The only thing all structural foam panels have in common is that they supply both structure and insulation. Most have exterior sheathing and a continuous interior nailing surface. Some have the drywall and siding already in place.

Types of Foam

As with other foam panels, there are two types of plastic used in structural panels: expanded polystyrene (EPS) and polyisocyanurate.

As long-time *NEB* readers are well aware, debate over the relative merits of these materials has raged for years.

Supporters of EPS note that it is considerably less expensive, and say that you get more "R" per dollar. There's no gas to escape from the foam, so the R-value remains constant over the years, and there's no damage to the Earth's ozone layer. They note that fire retardants are added to the EPS used in the panels, and say that it has an excellent fire rating if interior surfaces are covered with an appropriate thermal barrier such as 1/2-inch drywall.

Proponents of polyisocyanurate say their foam has a far better R-value to start with, that outgassing is minimal

once the foam is sealed into a wall, and that even under a worst-case scenario, the R-value will be better than EPS for many decades. They also emphasize that polyisocyanurate is far more fire-resistant.

We won't try to settle that controversy here.

Structure

Most structural panels are similar to standard stress-skin panels, but have waferboard (or oriented-strand board) on both sides of the sandwich.

Various mastics are used by manufacturers to form a tight bond. At least two manufacturers—Winter Panels and Cheney Building Systems (maker of Chase panels)—foam their polyisocyanurate panels in place rather than laminating. They claim that the foam itself provides a stronger bond than any mastic.

With a strong bond, the foam acts like the web of an I-beam, with strength in the range of 2.5 to 3.5 times that of standard stud construction.

An exception is Arco's Wallframe system, which is not technically a sandwich panel, but serves the same function. Arco's Wallframe panel was first developed by a small firm, RADVA (Radford, Va.), and the technology was brought up by the oil giant in 1984. The panels frame EPS in light-gauge galvanized steel. The framing acts like steel studs, but the foam provides a thermal break for energy efficiency.

Several panel makers offer alternatives to waferboard for specific applications. For example, some come faced with tongue-and-groove boards on the interior for cathedral ceilings. Delta Industries, whose full line includes foundation panels, uses pressure-treated plywood for below-grade applications.

Other than structural strength, the panels serve the same purpose as the foam panels used for timber-frame homes. They provide a tight, insulating envelope, similar to the packaging used by fast-food joints to keep burgers hot. In fact, most of the manufacturers started with non-structural panels (Branch River Foam Plastics and Winter Panel are prominent examples). Others, including Cheney and Arco, began with structural panels and have created non-structural variations in response to demand.

Tom Teubel, senior marketing director for Arco Wallframe, says a great many infill panels are now being made for commercial steel-frame buildings and timber-frame homes. Gene Marki, production manager for Cheney, says non-structural panels for timber-frame homes now account for about 25 percent of the firm's business.

Shimming is mandatory-if the panels are not perfectly plumb, you'll get a saw-tooth configuration at the top rather than a straight line.

Construction Methods

Depending on who you talk to, construction with structural panels is either simpler or more complicated than stick-building. But everybody agrees that it takes less time.

Each panel system has its own unique way of attaching panels to each other and to different building components.

Branch River's panels, for example, fit together with thin wooden splines, joined with construction adhesive and fastened with screws. The company will recess the foam on top and bottom to accommodate top and bottom plates, as most builders don't have the tools to do that easily. But it's up to the builder to cut panels to size if necessary (they come in 4x8-foot and 4x16-foot sizes), and to cut openings for doors and windows.

Winter Panels are joined by inserting a 2x4 halfway into each joining edge, then screwing the outside and nailing the inside. However, a newer version is being developed that will fit together with a modified tongue and groove–with sufficient surface contact to allow gluing the panels together. Windows are framed by letting-in 2x4s around the opening. The top panel and the attached 2x4 become, in essence, a box beam. According to Amos Winter, the joining systems are designed to assure that "there is only one way to put the panels together—the right way."

Arco's Wallframe panels sit on 2x4 bottom plates, and the metal frames overlap. They are connected with sheet metal screws. Corners are connected with steel strapping.

Chase Panels (made by Cheney) have a unique mechanical fastening system. Two cam locks are molded into one edge of each panel, near the top and bottom of the joint. Operated by a hex wrench, a hook swings out of each lock, is attached to a pin in the next panel, then is tightened. The company claims this makes field installations easier, assures a tight fit, and eliminates any need for studs and splines that can reduce R-value at the seams.

Building a panel home requires advance planning and precise measurements. The panels fit together like a jigsaw puzzle, and when it's time to add the last piece, earlier errors can make it difficult. Even if all the panels are square and true, foundations seldom are. Shimming is mandatory—if the panels are not perfectly plumb, you'll get a saw-tooth configuration at the top rather than a straight line. And no matter how carefully you measure and level every panel, you will need a sledge hammer for final adjustments.

Virtually all wall panels have electrical chases molded in to make wiring easy. You just cut holes for boxes along the chase, and glue them in. Air infiltration around boxes is eliminated.

Most manufacturers say that their panels can be used by any contractor or do-it-yourselfer who has mastered basic construction skills. "You need to know how to plumb up and square a wall," comments Wayne Clarke of Branch River. Several panel manufacturers say that if the last panel doesn't fit perfectly, it can be cut, or the empty space can be filled in. Anybody building a panel home is advised to have on hand a few cans of spray foam.

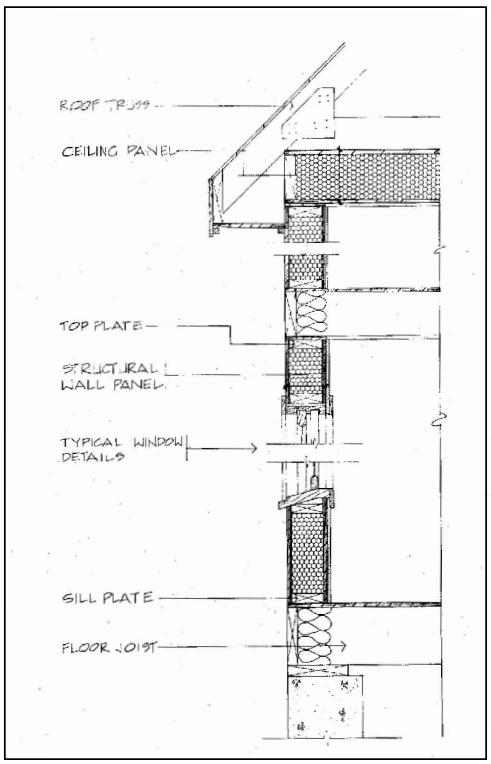
But at least one manufacturer, Winter Panel, insists on the strict quality control of every house built with its products. Using sophisticated CADD (computer-assisted drafting and design) programs, the company designs each house, and pre-cuts each panel. Training programs are offered for contractors who want to use the panels. The products are not sold to do-it-yourselfers.

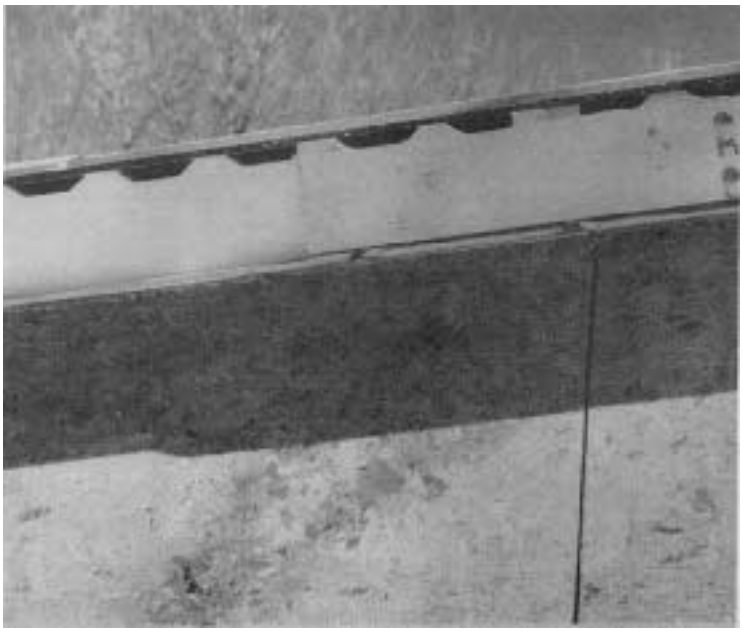
Tom Harrison, executive vice president of Winter Panels comments, "we're perfectionists. We want to be sure that when our products are used, they're used in the right way." In fact, a separate corporation—Amos Winter Homes—has been established to build homes with Winter Panels. It is the panel maker's biggest customer.

Cost

Early proponents of structural panels saw them as a way to build homes cheaply. The test house built by the U.S. Forest Service Laboratory would definitely not appeal to today's Yuppies. It was a trailer-shaped box with a flat roof, three doors, and one window. But in commercial applications, they never became cost-competitive with modular stud-wall construction.

The big news now is that structural panels have become cost-competitive with stick-built houses. Every panelmaker we talked with said it is now possible to come within 5 to 10 percent of the price for conventional construction of a similar house. And, they all





Branch River designed its structural wall system (left) to resemble standard platform framing—for easy use by tradesmen. Its Air-Flow panel (photo, right) has built-in ventilation channels, which have won it approval from some asphalt-shingle manufacturers.

A fresh polyurethane panel rolls off the machinery at Winter Panel Corp., in Brattleboro, Vt. (left). The machinery foams the insulation in-place between two long waferboard faces. By curing the panels in a curved mold, Winter can create the bowed panels used in his bow-cape design (right).

say, the panelized house has more design possibilities, and will be more energy efficient.

Not surprisingly, a structural panel house costs more for materials and less for labor than a comparable stick-built house. Robert Barr, General Manager of Amos Winter Homes, says that "while most houses are 40-percent materials and 60-percent labor, we reverse that. Our houses are 60-percent materials and 40-percent labor." Therefore, Barr says, "the closer you get to a major metropolitan area (where labor costs tend to be high), the better our prices look. "

Wayne Clarke of Branch River says there is a "learning curve" for builders using panels. The first house built may require some time to get used to new techniques and, in some cases, new tools. But labor savings will increase dramatically once you've built your second or third panelized house.

"You'll only need one lead carpenter," he says. "The rest of the crew can be laborers, because all you have to do is tilt the panels into place and screw them together."

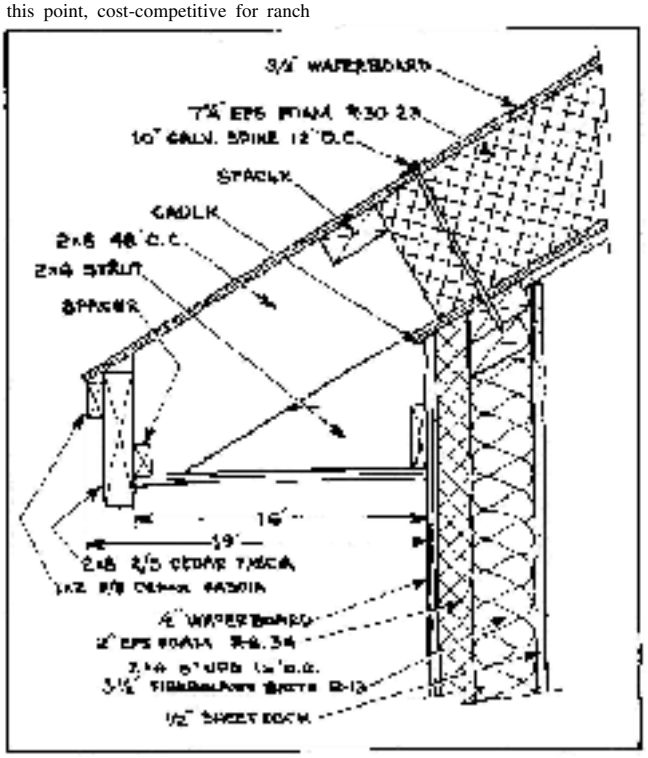
Gene Marki, the spokesman for Cheney Building Systems, says that an average 1,500 square-foot home built with his firm's panels will cost $2,000 more than a similar home built with 2x4s, and about the same as one built with 2x6s. The energy savings will pay back any difference in cost within five years, he says.

Delta, the only manufacturer we contacted that makes structural panels for foundations, claims that cost savings are particularly attractive when you go below grade. The company cites studies in Maryland that indicate that its "All-Weather Wood" foundation saves $280 in materials costs, and 58 man-hours in labor, in comparison to a concrete block foundation. According to Delta, energy savings and the ability to use the basement as comfortable living space are additional benefits.

Amos Winter says his firm is not, at this point, cost-competitive for ranch houses. "But the moment you add design features, any character, we're competitive. If you consider energy efficiency, and deviate at all from a box house, ours is a very cost-effective system."

Barr, who manages Winter's contracting firm, says "affordable housing" continues to be an important objective. "Our goal in 1988 is to produce a parallel-line house that we can deliver as a shell [at a price] in the high teens," he says.

Harra, the Oklahoma contractor who uses roof panels, says the panels increase the cost of his homes by about 2 percent compared to using a conven-



Oklahoma contractor Charles Harra stick-builds walls, but uses oversized 8x28-foot panels for the roof (left). Because the R-30 panels can span 14 feet, they yield open and flexible interior spaces, in addition to top energy performance. The eaves are trimmed out traditionally (right).

Any design, such as the classic colonial above, is possible for Cheney Building Systems, in New Berlin, Wis., which customizes panels for each home. Typical details include (clockwise from top right) chainsaw window cutouts; foamed-in-place windows; panels continuous to sill; and rafters sitting in notches. When trusses are used, they sit on a let-in 2x4 top plate.

The Wallframe system from Arco Chemical is not a stress-skin, but uses an EPS core set in a galvanized steel frame. The system was chosen for the second floor of this shopping center in order to meet a tight production deadline.

tional truss roof. But he says it's a good investment. In addition to energy-efficiency, the panels allow cathedral ceilings, which (a) add architectural interest, (b) increase air space in a small house, diluting cooking odors, etc., and (c) make it possible to install lofts, which increase the usable living space.

All of the manufacturers we interviewed cited "affordability" as a goal, but one which they say is becoming increasingly elusive due to steep rises in land prices. It makes little sense, they say, to try to build a $30,000 house if the only place to put it is a $50,000 lot.

Energy Efficiency and Other Advantages

Energy-efficiency is a major selling point for structural panels. If properly installed, they virtually eliminate infiltration and thermal bridging.

If EPS is used, a 3.5-inch wall panel provides about R-14, and an 11.5-inch roof panel provides about R-45. With polyisocyanurate, manufacturers claim that inch for inch, the R-value is nearly double those figures. In either case, panel makers emphasize, that because the panels reduce thermal bridging, they provide better insulation than a stud-wall house with the same nominal R-value.

But manufacturers list a wide range of other advantages as well. These include the following:

- Construction time is speeded up. An insulated shell can be completed in a matter of days. (In theory, a crew with a crane should be able to complete the shell in one day, but in practice, that seldom happens.)
- The strength and versatility of the panels facilitate design features such as vaulted spaces, cathedral ceilings, and lofts.
- There is a continuous nailing surface inside as well as out. This makes it easier to install cabinets or anything else that's nailed or screwed to the wall.
- Theft and vandalism at the building site are minimized. (The panels are large enough that they don't often "walk away.")
- It's a unique product. Some home buyers have a preference for anything that's new and different, as long as it's cost-competitive with more traditional construction.
- Several panel makers emphasize that their products are straighter and truer than ordinary lumber. (But like any other building materials, they should be inspected upon delivery. A panel that's not quite square can set back your schedule more than, say, a bowed 2x6!)

The Roof Ventilation Issue

Last year, the Asphalt Roofing Manufacturers' Association (ARMA) issued a technical bulletin advising against putting asphalt shingles directly over insulated decks.

That struck a sensitive chord among makers of stress-skin panels. All of the manufacturers we interviewed said they were seeking approval from ARMA for their roof deck products, and hope to receive it soon.

They said modifications may be made in roofing procedures in order to meet ARMA's concerns. One change reportedly under consideration is a recommendation that the traditional layer of felt be skipped, and that the shingles be nailed directly to the stress skin.

One manufacturer, Branch River, offers a roof panel in which the EPS is grooved underneath the upper skin to allow ventilation.

When we talked with Wayne Clarke of Branch River, he said their product—the"Air-Flo Panel"—had already received approval from several of ARMA's board members, and that his firm hopes for unanimous approval soon.

Durability

Stress-skin panels have, in general, been as thoroughly tested as any new building product on the market today.

The 31-year study by the U.S. Forest Service is the most comprehensive and thorough study of the issue. Unfortunately, many of their careful tests are meaningless today since the original panels had paper honeycomb cores, and facings made of hardboard, paperboard, and asbestos.

But as time went on, some of the panels were replaced with more modern materials, including polyurethane and polystyrene. The careful measurements continued, and the results, for the most part, were positive. The government reports conclude:

"Performance of sandwich panels in the experimental unit, for periods of 31 years, indicates that panels of nominal thickness can be satisfactorily used in housing construction."

In the area of energy performance, the government said:

"The panels with extruded polystyrene and polyurethane cores, which were installed in 1968, not only showed good structural performance but satisfy insulation requirements for most climates."

Private tests have been conducted as well. Chase Thermopanels were originally developed more than 20 years ago for construction of walk-in coolers. According to the firm's spokesman, Gene Marki, one of the original panels was recently dismantled and tested. He says the R-value of the urethane foam was reduced by only about 5 percent, and there was no structural deterioration. In short, structural sandwich panels are "new" only in the sense that they are newly popular for construction of homes. Compared with many other new technologies, they have a proven track record.

The Market

Manufacturers were reluctant to release sales figures, but all say the market is now expanding rapidly.

Structural panels are still only a small percentage of the business of Winter Panels, but the percentage is increasing fast: 17 completely panelized homes in 1986, 52 in 1987, and 112 scheduled for 1988.

Joe Williams, general manager of Delta, declined to provide numbers but said "business has shot up. We're getting bigger and bigger, now that our products are understood and accepted for residential as well as commercial applications." Gene Marki of Cheney echoed that, but said some of the biggest increase in demand has been for non-structural versions of the panels for timber-frame houses.

At Branch River, Wayne Clarke said sales of structural panels have increased by 40 percent this year over last year. Tom Teubel, the spokesman for Arco, said use of Wallframe panels is continuing at a steady pace, inhibited only by a need for more regional distributors.

They all agree that the technology is quickly entering the mainstream, and that within a few years, nobody will think it's unusual when a house is built without studs, joists, or timber frames. ■

Steve Carlson is a contributing editor to New England Builder.

Directory of Structural Stress-Skin Panel Manufacturers

Advance Foam Plastics, Inc.
5250 North Sherman St.
Denver, CO 80216
303/297-3844

Arco Building Systems, Inc.
1500 Market St.
Philadelphia, PA 19101
800/333-0081

Associated Foam Manufacturers
P.O. Box 246
Excelsior, MN 55331
612/474-0809
800/255/0176

Atlas Industries
6 Willows Rd.
Ayer, MA 01432
617/772-0000

Branch River Foam Plastics, Inc.
15 Thurbers Blvd.
Smithfield, RI 02917
401/232-0270

Cheney Building Systems, Inc.
2755 South 160
New Berlin, WI 53151
414/784-9634

Delta Industries, Inc.
1951 Galaxie St.
Columbus, OH 43207
614/445-9634

Enercept, Inc.
3100 9th Ave. S.E.
Watertown, SD 57201
605/882-2222

Foam Products Corp.
2525 Adie Rd.
St. Louis, MO 63043
314/739-8100

Homasote Company
P.O. Box 7240
West Trenton, NJ 08628
609/883-3300

Insulated Building Systems
100 Powers Court
Sterling, VA 22170
703/450-4886
(pending code approval)

Insulkor, Inc.
201 E. Simonton
Elkhart, IN 46514
800/521-1402

J-Deck Building Systems, Inc.
2587 Harrison Rd.
Columbus, OH 43204
614/274-7755

Low-Temp Engineering, Inc.
308 East Main St.
Route 123
Norton, MA 02766
617/285-9788

NRG Barriers, Inc.
15 Lund Rd.
Saco, ME 04072
207/283-8000

Pacemaker Plastics Co., Inc.
126 New Pace Rd.
Newcomerstown, OH 43832
614/498-4181

Thermal Foams, Inc.
2101 Kenmore Ave.
Buffalo, NY 14207
716/874-6474

W. H. Porter, Inc.
4240 N. 136th St
Holland, MI 49424
616/399-1963

Winter Panel Corp.
Box 168 B Glen Orne Dr.
Brattleboro, VT 05301
802/254-3435