# HIGH PERFORMANCE
# WALL SYSTEMS

*by Alex Wilson*

*Most builders surveyed now use some combination of 2x6s with: foam on the outside (left) or foam on the inside (right). One builder imports rigid fiberglass (above) from Canada.*

## Energy-minded builders strive to save Btus while keeping construction simple

A few years ago, during the height of energy awareness, every builder I knew used a different wall system. Builders were trying every option they could think of to minimize heat loss and produce a building shell tight enough for one of Jacques Cousteau's mini-subs.

Complexity was no concern. And as for cost, well... that was sometimes a problem. In fact, because so many extras were added in the interest of energy conservation, the builders sometimes found they couldn't charge for their own time if they wanted to come in under budget. Somehow the satisfaction of producing a zero-energy house made up for the poverty those builders often endured.

But times have changed since then, and *New England Builder* was interested in learning how much the practices of these builders have changed. What follows is an informal survey of a handful of builders who I believe have been on the leading edge of energy-efficient home building for the past decade. Their experiments with numerous energy-conserving techniques can teach us a great deal.

**The Findings**

Out of the eight builders I interviewed, there are some broad similarities in the wall systems used. Most employ some type of. rigid foam sheathing over fiberglass-insulated studs. All but one builder employs 2x6 framing. Most use air barriers, such as Tyvek. And, in general, the wall systems used today are far simpler, though slightly less efficient, than the ones they used five or six years ago.

Chuck Silver, of Solaplexus, in New Paltz, N.Y., and John Rahill of Black River Design, in Montpelier, Vt., are two designer-builders who have been through the gamut of superinsulated construction details over the last ten years. They have both settled on a 2x6 framing system, 24 inches on-center, with one inch of Koppers Rx on the interior, ½-inch CDX plywood on the exterior, and interior strapping to provide a wiring chase and a secure nail base for drywall.

Silver seals the rigid insulation joints with foil tape to provide an uninterrupted vapor barrier, and then uses full 2x4 horizontal strapping (see Figure 1). With 2x4 strapping, he has room for shallow electrical boxes (manufactured by Bell, a Division of Square D) and thereby avoids penetrating the vapor barrier. He justifies 2x4s over 2x2s or 2x3s because the cost difference is not that significant, the wood quality tends to be a lot better with 2x4s and it provides a wider margin of error with the drywalling.

Because of the bounciness when installing strapping over foam, Silver recommends pneumatic nailers or screw guns. By spacing the 2x4 strapping properly, horizontal sheets of drywall can be installed quickly. Protective steel plates are used wherever wiring passes through the strapping—to prevent damage to the wire or injury.

Silver uses no extra studding in exterior walls where interior partitions join. The plates are interlocked, but the last stud in the partition is left out. After insulation and strapping are installed in the exterior wall, the last partition stud is simply nailed to the horizontal strapping. At wall corners, he builds a stan-

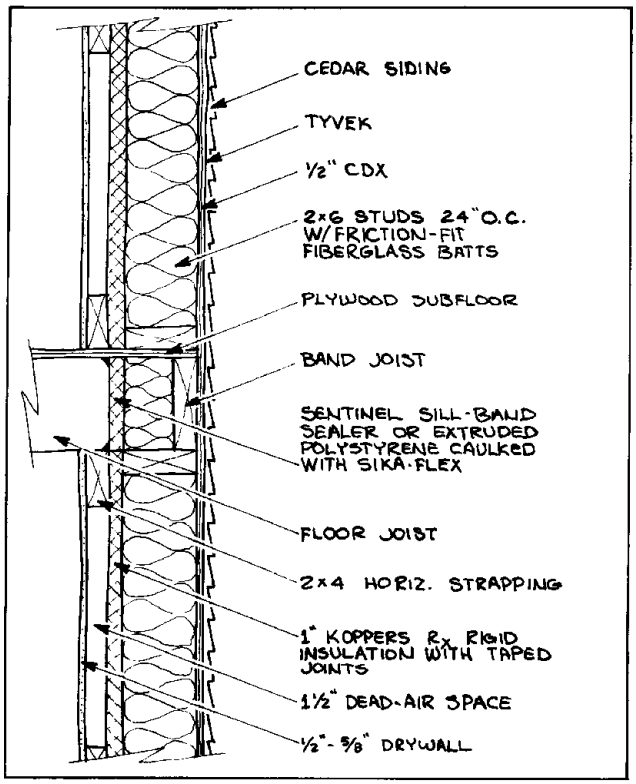
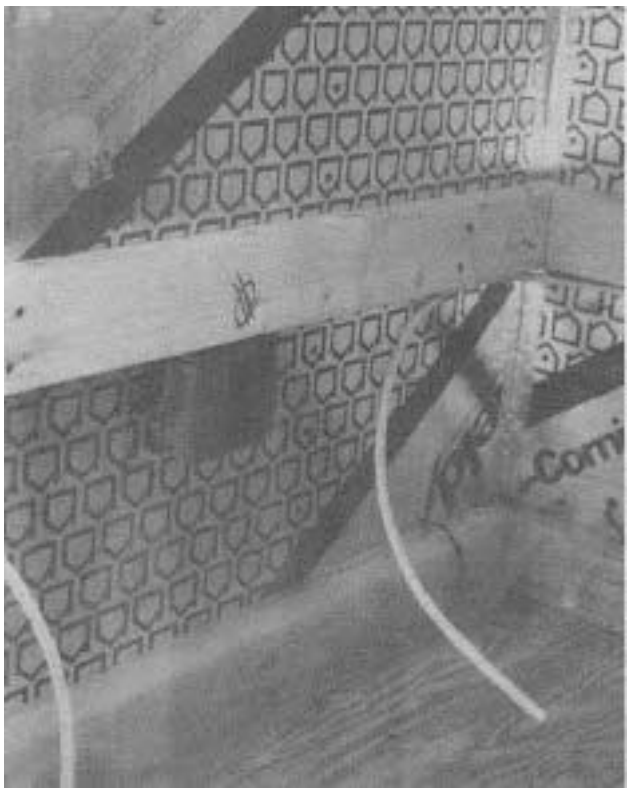



***Figure 1.*** *Chuck Silver, of New Paltz, N.Y., uses rigid insulation on the inside and seals it with foil tape. Between floors, Ethafoam blocks fit between joists. Wiring goes in the 2x4 strapping space. Interior strapping is run at the right height to support outlet boxes (see photo below).*



dard 3-stud corner, but adds an extra stud 8 inches in from the corner in both directions, to provide a secure nailing base for the horizontal strapping.

At the rim joist, Silver employs one of two methods. One is to install fiberglass batts, capping the batts at the line of the rigid insulation with Sentinel Sill Band Sealer (Sentinel Foam Products, Airport Rd., Plant 1, Hyannis, MA 02601; 617/775-5220), and caulking the Sill Band in place with Sikaflex Multi-Caulk to make up for potential shrinkage of the Sill Band. Sikaflex is a polyurethane caulk available from Sika Products (Construction Products Divison, Lyndhurst, NJ 07071; 201/933-8800). The other method is to use polystyrene blocks in place of the Sill Band sealer, also caulked in place with Sikaflex.

Silver lists a few advantages of his system as follows:

- All electrical/mechanical equipment is kept out of the insulation and not mixed with the vapor retarder.
- He gets over R-30 with a very conventional building system. Even the electricians like it (after the first one) since most of their runs are horizontal and there's less drilling.
- He gets to put the low-permeance material (the rigid foam) on the inside where it does him some good, and he avoids the need for poly by taping the seams in the Koppers—making it the vapor retarder.
- He gets some additional R-value from the foil he paid for (because of the air space).
- He gets plywood on the outside of the frame for bracing strength.
- Drywall can be glued to the strapping for a superior job. This can't be done with poly over the studs.

Rahill is not comfortable with the Koppers providing an entire vapor barrier. He prefers to add a layer of polyethylene, ideally Tu-Tuff which is a lot stronger than standard poly. Both Silver and Rahill achieve about an R-30 wall system.

Rick Schwolsky, of Grafton Builders in Grafton, Vt., employs the same system, but without the interior strapping (Figure 2). Schwolsky, who co-authored *The Builder's Guide to Solar Construction* a number of years ago, has settled on this system after using double-stud 2x4 construction (with 2x10 plates) and a 2x6 wall system with rigid insulation on the exterior. Using 2x6s, 24 inches on-center, he has encountered some waviness on the exterior wall surface. And he has switched back to 1/2-inch CDX from waferboard after swelling of the waferboard caused him problems with the window jamb extensions (they did not align with the inside wall surface).

Kate Mitchell, of Island Women Construction, Inc. on Nantucket Island, Mass., uses a very similar system, but with 2x4 studs rather than 2x6s, 16 inches on-center. She generally uses one-inch Thermax on the interior, though she sometimes goes with Dow Styrofoam on the exterior (when the rigid insulation is put on the exterior she prefers polystyrene because it breathes somewhat). Mitchell wraps the building with Tyvek.

Using inierior rigid insulation with drywall right over it, Mitchell occasionally gets complaints from the drywallers, though this tends to be much less of a problem with skim-coat plaster jobs. Interestingly, veneer plaster has replaced taping and jointing almost completely on the Island.

For insulation purposes, Mitchell treats each story of the house as an individual unit. Although she used to try to wrap the band joists with a vapor barrier, she's "let go" of that. She does, however, insulate the band joist area with individual pieces of insulation fit between the joists.

Ward Smyth and Doug George both use rigid insulation on the outside of fiberglass-filled 2x6 studs. Ward Smyth of Salmon Creek Builders in Salisbury, Conn., uses 2 inches of Koppers Rx (Figure 3). He adds ¾-inch furring strips on the Koppers as a nail base for the cedar siding, but admits that he has difficulties with the furring strips. They are attached with 4½-inch annular ring nails, which is time-consuming and not all that sturdy— the furring strips "rock" a bit on the foam. At corners, Smyth installs ½-inch plywood for strength and uses only 1½-inch Koppers to keep the outside surface even. He installs a poly vapor barrier on the interior, between the studs and drywall.

Doug George, of Conserve Associates in Dover, N.H., a firm which has won national recognition for excellence in superinsulated building design, employs a more complex version of the same wall system, but one in which moisture build-up in the stud cavities would be next to impossible.

As shown in Figure 4, George's wall system uses 2x6 studs, 24 inches on-center, with 1½-inch GlasClad (Tyvek-faced rigid fiberglass insulation board from Canada) on the exterior. He attaches 1x3 furring strips over the GlasClad (nailed vertically into the studs with 2½ galvanized roofing nails), and for siding typically uses special shiplapped ¾x6-inch cedar clapboards. However, when a client wants standard at 16 inches on-center.

For good nailing at the sill, George uses a 2x8 flush with the exterior. Similarly, he uses solid through-the-wall framing (ripped from 2x10s) around window openings. Otherwise the GlasClad would compress and throw the window out of alignment.

George uses let-in metal bracing instead of plywood to reinforce the studs, and fills the stud cavities with 5½ inches of Certainteed Insulsafe III "blown-in-

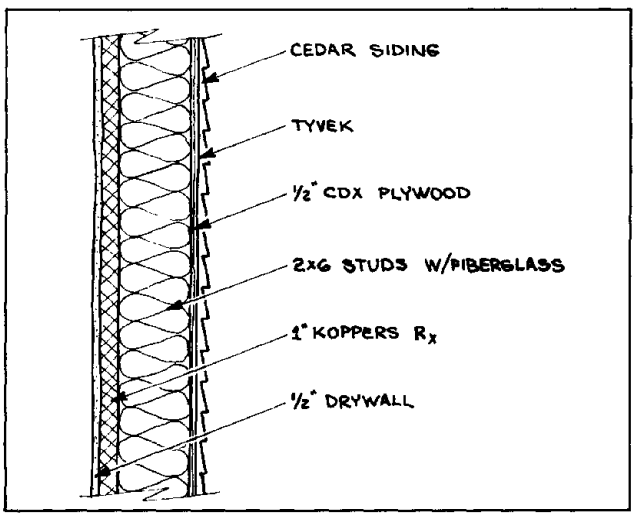



***Figure 2.*** *Rick Schwolsky, of Grafton, Conn., keeps it simple with plywood sheathing on the outside and one-inch foam on the inside.*

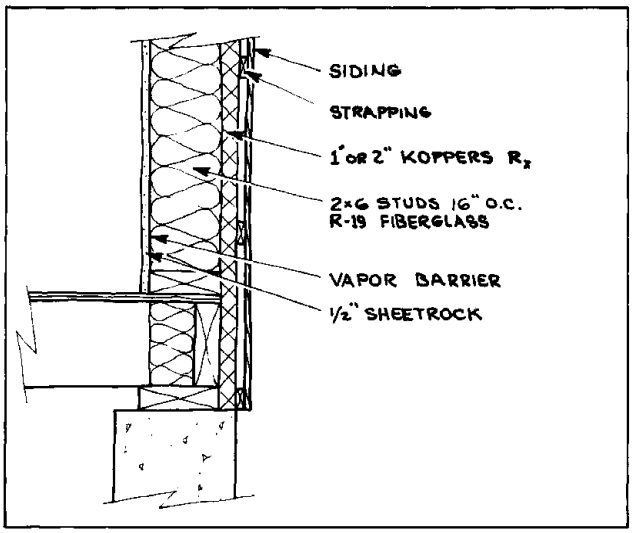



*Figure 3. Custom builder Ward Smyth used to wrap the vapor barrier around the outside of the band joist, but now keeps it simple. He relies on an Aldes venting system to remove excess humidity.*

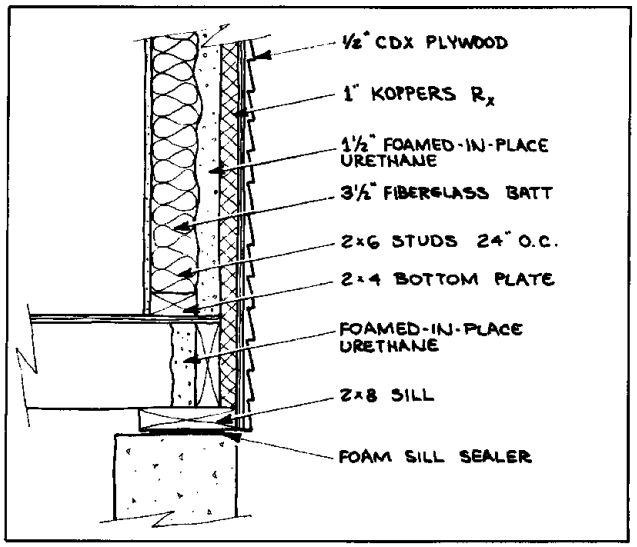



*Figure 5. Bill Brodhead, of Riegelsville, Pa., uses foam-in-place polyurethane and special framing details to create a one-step air barrier and insulation. No inside vapor barrier is used.*

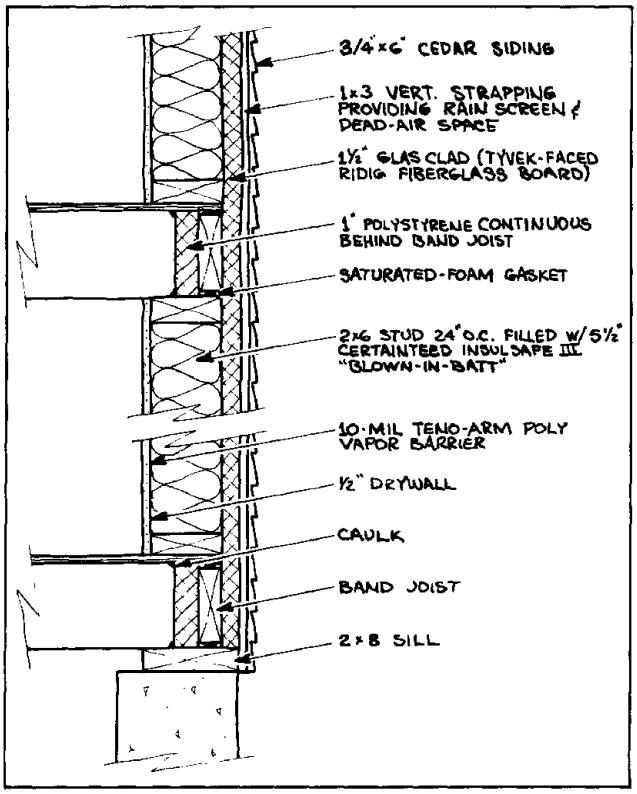



*Figure 4. Doug George, of Salisbury, Conn., solves the problem of between-floor transitions by running a continuous strip of rigid foam against the inside of the band joists. Floor joists are cut short by 1 inch, but still have 3 inches of bearing.*

batt" insulation at a controlled density to achieve R-22.55. Rather than standard poly vapor barrier, he uses 10-mil Teno-Arm poly (from Sweden) and seals all seams and edges with tape or Teno sealant. Half-inch drywall is attached right to the studs (he used to use horizontal strapping on the interior). He minimizes penetrations through the vapor barrier by using plastic receptacle boxes, sealed to the vapor barrier by cutting an undersized hole in the poly at each receptacle, and forcing the poly to stretch around the box.

To get a tight seal around the band joist area, George uses saturated foam gaskets (Denarco Sales, P.O. Box 793, Elkhart, IN 46515; 219/294-7605) between the framing members. Against the inside face of the band joist, George places a continuous band of l-inch-thick rigid foam and caulks it in place. The joists are cut one inch short to allow for the foam, but still have 3 inches of bearing. This eliminates the unpleasant and time-consuming job of insulating and sealing each joist space separately.

The cost for this wall system, excluding the drywall materials and labor, is about $6 per square foot. He achieves a wall insulation value of R-30 to -32. When tested with a blower door at 50 Pascals, his houses show less than one air change per hour.

Because of the high cost of GlasClad ($17/sheet), George is looking into using perforated extruded polystyrene on the exterior instead. This will require his crew to perforate the sheets, which he thinks is necessary to assure breathability. He would like to see a perforated polystyrene product brought onto the market for this application and is surprised that no one has offered it yet. At corners, he will use 1/2 -inch plywood for strength and thinner polystyrene, as Smyth does.

Jim Goodine, of Blue Heron Construction Corp. in Shaftsbury, Vt., uses the simplest wall system of any of the builders surveyed: 2x6s, 16 inches on-center. He achieves about an R-19 or R-20 with the system, about what Kate Mitchell obtains with 2x4 studs and an inch of rigid. Goodine is very conscientious about the vapor barrier on the interior and air barrier on the exterior. He tapes the Tyvek at seams and caulks it at windows.

Goodine's firm also builds timber-frame houses, which it insulates with 8 inches of fiberglass installed in wood trusses attached to the outside of the frame. He has used both "Larsen trusses" which his crew fabricated, and Trus-Joists, but would like to see economical wall trusses become available commercially.

One of Goodine's requirements for an acceptable wall system is that it does not damage the Earth's ozone layer, as most rigid-foam insulations are thought to do. He'd like to see a rigid insulation developed that insulates well, does not harm ozone, and is not toxic when burned.

The final wall system covered is also the most complicated. Bill Brodhead of Buffalo Homes in Riegelsville, Pa., frames his houses with 2x6 studs, but with 2x4 top and bottom plates, flush with the inside. He installs an inch of Koppers Rx foam on the outside of the studs, then foams-in-place 1½ inch of urethane insulation (Figure 5). Then he fills the rest of the stud cavity with 3 ½-inch fiberglass batts. By having the top and bottom plates set in 2 inches, he gets continuous urethane coverage all the way down to the plywood deck–thus preventing any infiltration under the bottom plates. Infiltration is also blocked by using two-stud corners and no studding on exterior walls where interior partitions join (similar to Silver).

With this system, Brodhead claims he doesn't need a vapor barrier. The foamed-in-place urethane provides an excellent seal. He always installs air-to-air heat exchangers in his houses, however, to keep humidity levels in check.

While this system sounds complicated, it is much simpler and faster than the double-stud wall system he used to use. In fact, at a customer's request, he recently built a double-wall house and he re-experienced all the hassles of double-wall framing, sealing the vapor barrier with Tremco acoustical sealant, and labor overruns. His newer system, which he has been using for about three years now, is a lot easier and comes in at a lower cost, he claims.

At R-30, his present system insulates about as well as the double wall, though it doesn't test out quite as tight in blower-door tests he has done. He gets 2 to 3 air changes per hour at 50 Pascals, as compared to 1 to 2 for the double-wall-and-poly system. He points out that the foaming must be carefully watched to ensure complete coverage.

**Conclusions**

As for what wall system is the best, that's up to you. I lean toward a straightforward system that uses readily available materials, and is easy to build, easy on subs, and well insulating. This seems to be the general trend among the builders I interviewed.

No matter what system you use, it pays to maintain a high level of workmanship. The best thought-out details will do little good if they are poorly executed in the field. Because tightness counts almost as much as R-value when it comes to energy efficiency, pay particular attention to caulking, sealing air and vapor barriers, and reducing penetrations through those barriers.

The issue of ozone depletion and the CFCs (chloro-fluorocarbons) used in rigid-foam insulation may have a big influence on construction details over the next several years. Because of restrictions in the use of CFCs (which are used in producing almost all insulation board stock except expanded polystyrene), rigid insulation may become more expensive, scarcer, or less effective in R-value. Keep an eye on this issue, since its outcome may affect the way we all build. ■

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