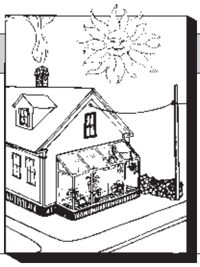

In Search of Easy R-30 Walls

by Chuck Silver

Twenty years from now, when fuel prices are substantially higher, it will be relatively easy to go back and add some more insulation in the attic. Perhaps it will be less simple, but possible, to improve the foundation R-value, and windows could be upgraded, by replacement if necessary. The toughest area to improve will be the walls.

The options for walls will likely be the same as those available today, forcing the removal and replacement of siding, or the destruction and renovation of the interior of the shell. Because this component is the most difficult and costly to improve later, I build R-30+ walls and thus I'm always in search of the elusive "easy" way to do this.

If one were to design the perfect energy-efficient wall from scratch, it is very unlikely that our conventional studwall construction system would be the result. This building method was not developed with energy in mind. We are reduced to placing insulation *between* the structural members, a system that automatically determines that the thermal performance will be compromised at every piece of framing lumber, and that there will be thousands of lineal feet of crack where the insulation meets the wood.

Past Successes

One approach to the R-30+ wall is foam-core panel construction, which does indeed eliminate most of the thermal bridging due to framing, and creates an airtight, vapor-tight wall. Probably the biggest complaint about this approach (aside from the fact that it's radical) is the difficulty or complexity of integrating wiring and plumbing into the wall.

A second method is the double-stud wall, popularized to some degree by a group of Canadian builders. With this approach, the inner and outer walls are spaced apart, preventing heat loss through the framing members, and allowing for ample insulation. The trade-off here is that you spend more on framing lumber and labor, but are able to use inexpensive insulation since fiberglass is typically one-quarter the *cost-per-R* of most foams. The system is viable, but suffers from sacrificing floor area to accommodate very thick walls.

A third system is the one I've used most often (see Focus on Energy, 7/89), which involves adding foil-faced foam to the inside of a 2x6 studwall, and then strapping the wall horizontally with 2x4s to create a mechanical chase inside of the vapor retarder. I like this method, and it does a number of things right without driving contractors crazy, but it involves multiple applications, and therefore some additional labor.

Something Completely Different

I recently looked at another method for achieving an airtight R-30+ wall. The "Barrier System" was the topic of a news story in Miscellany, *NEB/JLC*, 8/88. This system uses an I-beam shaped stud and pre-cut rigid foam board that is "locked" into stud bays to create an airtight system. The stud is made from two lengths of 2x2 (actually a ripped 2x4), which are dadoed to accept 7/16-inch oriented-strand board (OSB), which is held in place by staples. The overall stud dimension is 1 1/2 x 7 1/4 inches, which conforms to a standard 2x8. Two stud lengths are available, which will create a finished wall height of either 8 feet 1 1/8 inches or 9 feet 1 1/8 inches. The advantages of a stud with an I-shaped profile include minimal interruption of the insulation, straight, defect-free studs, and excellent strength characteristics with light weight. The system has been tested to ASTM E-72 for racking, transverse, axial, and impact loads, and has met or exceeded all requirements.

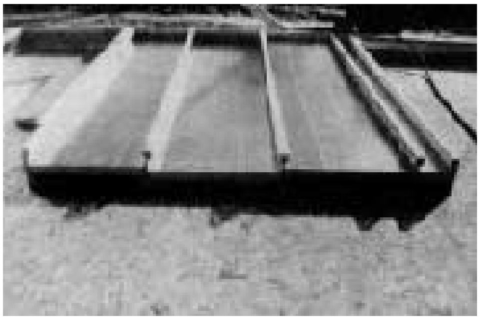

Figure 1. *The wood I-beam studs must be installed on accurate centers for the pre-cut foam inserts to fit correctly. The top and bottom plates—also wood I-beams—are nailed into the 2x2 flanges on the studs.*

Figure 2. *The walls are light and easy to lift into place. A conventional 2x8 upper top plate splices the sections together.*

The idea of an I-shaped stud is not new. In some Scandinavian countries, builders use these studs in conjunction with rigid fiberglass batts that are available pre-notched to exactly fit the profile of the stud bay. What's different about the Barrier System is that the *shape* of the stud is used to create a lock for the rigid insulation, and thereby make the wall airtight. The system is manufactured by Lincoln Environmental Services, Inc. (New Yorker Professional Building, P.O. Box 346, Canastota, NY 13032; 315/697-7224) and is marketed through stocking lumberyards in New York and New England. They sell the I-shaped studs, insulated plates, pre-cut foam for the stud bays, and small foam strips that lock the foam in place.

Assembly on Site

I went to see a Barrier System under construction to find out whether it was as easy to assemble in the field as it looked on paper. The general contractor was Dean Durst, of Durst Construction, Inc., Ballston Lake, N.Y., and the framing sub-contractor was Joe Wilkins. They had worked together on a previous house using the Barrier System with good results.

Just as in conventional framing, the plates are laid out and marked for studs, headers, jacks, and shoulders. Since the foam must be inserted as the wall is assembled, measurements for stud bays that are non-standard are noted, and foam stock is ripped to size. Next, the I-studs are laid on edge, inside face down, and the bottom I-beam plate (which comes pre-insulated) is nailed on by driving nails into the 2x2 sections of each stud. The pre-cut foam pieces are then fed down into the bays from the top. Since there is only 1/16-inch clearance in each direction from the foam to the wood, it's critical to get the centers correct (see Figure 1). This did not present a problem on this job site.

Figure 3. *Foam strips are tapped into place against each stud to hold the large panels of foam tightly against the outer 2x2 flanges. This makes a tight seal and leaves room on the interior for plumbing and wiring.*

The top plate is then nailed on in the same manner as the bottom plate. Finally, a conventional 2x8 second top plate is added to span splices in the I-beam top plate, and to spread the floor joist or rafter load. Exterior sheathing is usually applied to the wall before raising it.

The walls are light, rigid, and easy to lift (see Figure 2). With conventional framing, the bottom plate is usually nailed down through the subfloor into the joists. The same is done with this system. Only in this case, the half of the base plate toward the exterior cannot be nailed, since the rigid insulation is already in place. Because of this, construction adhesive is applied to the edge of the floor deck before the wall is raised. The inner part of the base plate is then nailed conventionally. Lastly, the foam "gasket" strip is applied in each bay against the web of the studs and plates (see Figure 3). The installation of these strips forces the wall foam against the 2x2 section of the stud, and creates a tight seal. This results in a typical wall section as follows: 3 1/2-inch drywall, 3 5/8-inch foil-faced air space, 2-inch polyisocyanurate foil-faced foam, 1 5/8-inch foil-faced air space, 2 1/2-inch sheathing, and siding.

Where's the R-30+?

Lincoln Environmental had a 52-square-foot sample wall with two switch/outlet holes tested by National Certified Testing Laboratories in York, Pa. With a 50° temperature difference and a 30-mph wind, the sample was rated at R-33.8. A second test conducted six months later on another sample also exceeded R-30.

How is this possible with only 2 inches of foam in the wall? I can only speculate. ASHRAE calculations for the same wall would come out to about R-24. The most logical explanation is that since the foam was fresh from the manufacturer, its R-value was up around 10 per inch. The value used in calculations, is the ten-year *aged* value of the foam which, according to the manufacturers, is around R-7.2 per inch. I think that it's fair to assume a total R-value for the system of around 24. I should also point out that the total R-value of a typical 2-foot on-center 2x6 wall with fiberglass batts *very carefully installed* is around R-19 including the siding, drywall, etc., due to the slight insulation compression, and the interruptions of the studs and plates.

This is still not R-30+, but the company does offer a "super" version that uses a 3-inch foam insert instead of a 2-inch insert. This reduces the inner airspace to 2 5/8-inches (still workable for a mechanical chase) and would boost the calculated R-value to about 31.

The Benefits

There are several things I like about the Barrier System. It's fast to assemble, and after the gaskets are in place, the wall is framed, sheathed, and insulated with vapor retarder already installed. The mechanicals are installed in the chase *inside* the vapor retarder, and if any damage is done, it

Figure 4. *The insulation and vapor barrier are not penetrated by electrical boxes or plumbing. Interior partitions are tied in to nailers.*

can be repaired easily with foil tape. The insulation and vapor retarder are not penetrated by electrical boxes or plumbing, nor do the partition walls interrupt the system (see Figure 4). The walls are very tight. They rely on neither a perfect air/vapor retarder with meticulous detailing at outlets, nor an effective exterior wind barrier, in order to derive airtightness. Because of the wood sheathing, and the 1$^5/_8$-inch air space behind it, wood sidings may be installed directly on the surface without fear of premature failure associated with wood siding installed directly over foam.

Finally, the system is flexible. It is a stud system, not a wall panel. It was not pre-fabricated from your plans, so changes are easily accommodated on-site up to the last minute. In addition, like other engineered wood products, the I-beam studs are straight, true, and free of defects, which speeds assembly on the job and eliminates bows in the wall.

The Cost

Of course, this type of wall costs more than a 2-foot on-center 2x6 wall to build. Durst estimates his additional costs to be around 85¢ per square foot of house when compared with the 2x6 option, and only 30¢ per square foot additional when compared with the 2x6 wall with foam sheathing. However, he's quick to point out that we're not comparing apples to apples. For one thing, the batt insulation would have to be installed *very carefully* in order to achieve R-24, and remember the wiring is running *in* the insulation.

In addition, to properly seal an air/vapor retarder around electrical boxes is extremely painstaking and time-consuming, and this work is not assumed in the cost comparison. The Barrier System requires none of this meticulous sealing work. At the time that I'm writing this, the system retails in lumberyards for about $17.21 per lineal foot of 8-foot wall for the 2-inch-thick foam system, and $20.21 per lineal foot of 8-foot wall for the 3-inch foam system.

Final Comments

So, it sounds like a good idea. What's the hitch? I don't think there is one, but I offer some cautions: As with anything new, the first time you try it, allow some extra time. I also suggest that the studs be weather-protected before installation, since OSB has been known to grow in thickness when wet. Since tolerances are small, the stud spacing and site foam cutting (on non-standard bays) must be done accurately. Don't hire a framer who's fast but butcher-like. Lastly, the small foam strips that are installed to gasket the foam in place and make the wall airtight are usually considered "pick-up" work, since they can be installed anytime after the walls are up, and require no specialized skills. Just as with the installation of fiberglass batts, the "low man" on the crew is often given this task. But this job, like insulating, is actually critical to the final performance of the building, so pick someone from the crew who will take some care and get it right. ■

Chuck Silver designs custom homes, and Terry Brennan consults on energy design. They work together training builders in energy-efficient construction for the New York State Energy Office, and take turns writing this column.