The Future of Framing

Smarter strategies can save money, speed construction, improve energy efficiency, and cut down on job-site waste

BY JOSEPH LSTIBUREK

Back in the '70s, as a young engineering student studying energy efficiency, I wondered, "When the price of oil doubles, will the walls we're building now look smart or dumb?" The answer was obvious: They'll look dumb. That's when I started my quest for the future of walls.

Contrary to Hollywood's advice in *The Graduate*, the future is not plastics. The present is plastics. The future is wood (actually, it's cellulose, the stuff wood's made of), and the future is now. That's good news for the United States because we're the Saudi Arabia of cellulose. Saudi Arabia has sand and oil; we've got dirt and cellulose. Oil is nonrenewable, but cellulose grows on trees.

The future lies in better wood products and better use of those wood products. OSB, engineered beams, and I-joists are already common products; in the future, we're going to get a lot more of these types of products.

To use all this "engineered cellulose" simply and elegantly, we need to convince hundreds of thousands of builders that the way they're building now no longer makes sense. Welcome to my world.

Smarter walls are being built today

As part of the U.S. Department of Energy's Building America program (www.buildingamerica.gov), our team focuses on the future of housing. Our target is an affordable

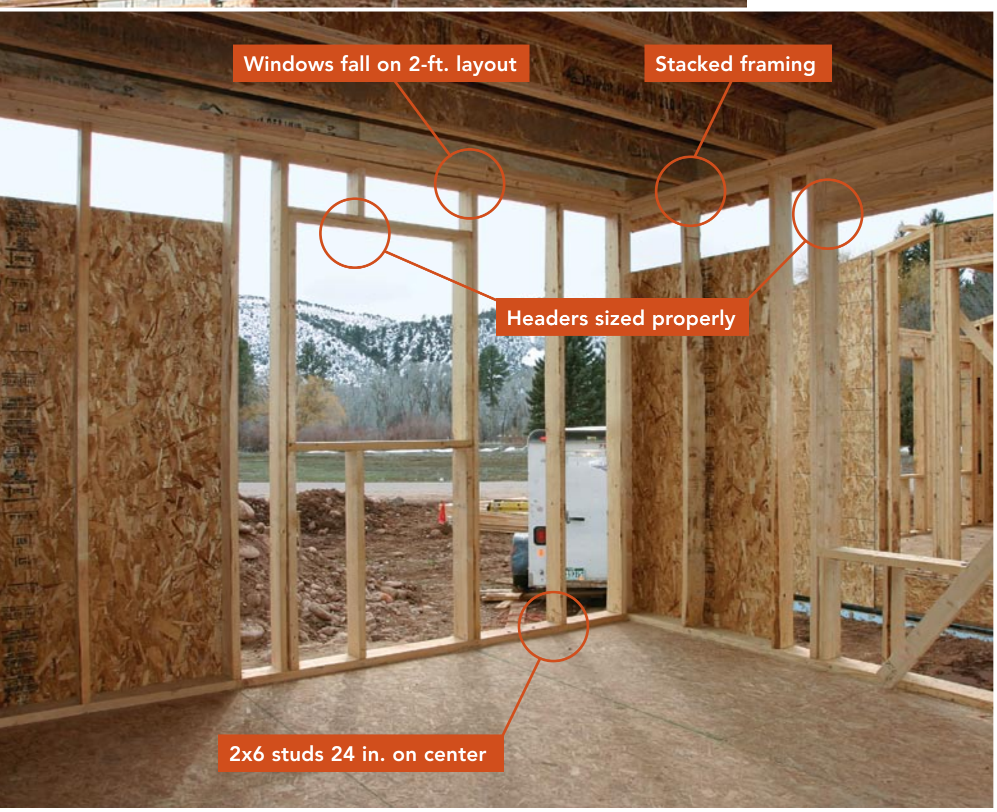
Is Here

Smarter framing means less wood

Extraneous studs, headers, and plywood don't boost structural integrity as much as they sabotage energy performance. For 30 years, engineers have been trying to convince us that the way we frame houses is inefficient; there's too much redundancy even for them. But with houses and energy costing more than ever, it's time to listen.

This Colorado subdivision illustrates that some builders not only are listening but also are using smarter framing strategies. The minimalist skeleton, which makes room for more insulation, is visible in the house in the foreground and in the photo below. The insulating skin, visible on the house in the background, boosts the R-value. The nearly finished product (center house) looks normal, but its energy performance is superior.

Unfortunately, missing headers, minimal framing, and foam sheathing just look like a flimsy house to many skeptical builders who will look at these photos and say ...



Yeah, but...

Q What about shear strength?

A When sheathing with 1-in. foam, shear strength can come from strategically placed ½-in. OSB covered with ½-in. foam or from site-built shear panels (see p. 55).

Q What about bouncy floors?

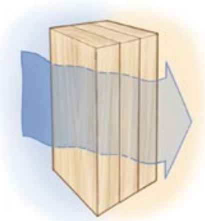
A Yes, removing every third joist could make the floors more bouncy, but using thicker subfloor (1⅛-in. panels) will stiffen it back up.

Q What about blocking for drywall?

A Using drywall clips and floating the corners (leaving them unattached to the framing) are excellent ways to reduce drywall cracks.

Q What about flimsy walls?

A Half-inch drywall over studs 24 in. on center isn't all that flimsy (especially over dense-pack cellulose), but if you don't believe it, then use ⅝-in. drywall.

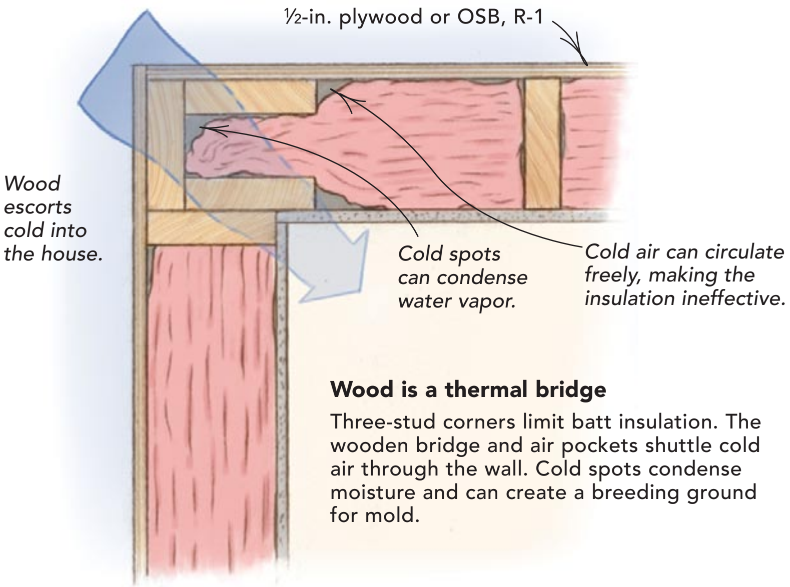


Q How can smart framing affect R-value?

A Wood is not a good insulator.

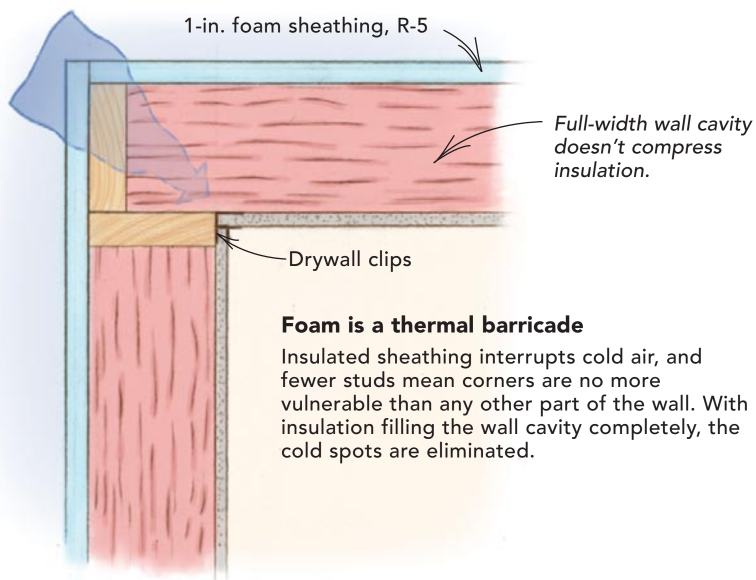
More often than not, the R-value of walls is assumed to be the same as the insulation in them. But this assumption doesn't consider all the wood framing connecting interior and exterior surfaces. Thermal bridging across framing members reduces overall R-value because a 2x4 or 2x6 is a poor insulator compared to fiberglass or cellulose. That's why eliminating unnecessary framing in exterior walls is so important.

By the way, if you're interested in knowing the actual R-value for a given wall assembly, you can use the handy calculator at the Oak Ridge National Labs Web site: www.ornl.gov/sci/roofs+walls/AWT/InteractiveCalculators/rvalueinfo.htm.



Wood is a thermal bridge

Three-stud corners limit batt insulation. The wooden bridge and air pockets shuttle cold air through the wall. Cold spots condense moisture and can create a breeding ground for mold.



Foam is a thermal barricade

Insulated sheathing interrupts cold air, and fewer studs mean corners are no more vulnerable than any other part of the wall. With insulation filling the wall cavity completely, the cold spots are eliminated.

Most framers think structurally, not thermally. *This photo was taken three miles down the road from the houses on the previous page. These massive thermal bridges and hard-to-insulate cavities will make this a frigid wall. Because it's a bathroom, a mold problem is likely.*

"net-zero" house (one that produces as much energy as it consumes) built by production builders at no extra cost. Our target date is 2020, but I think that we can do it sooner.

To accomplish the goal of an affordable net-zero house, we have focused mostly on the enclosure. The enclosure of the future will be a lot like today's best enclosures, which use foam sheathings, housewraps, and spray insulations. But the materials of the future will be smarter (more on that later), and framing redundancies will be gone.

The easy part of our job is figuring out how builders should be framing houses (drawing p. 54). Thirty years ago, the NAHB Research Center developed optimum-value engineering (OVE) to cut the cost of houses by omitting unnecessary lumber (*FHB* #84, pp. 46-49). OVE framing increases joist, stud, and rafter spacing to 24 in.; places doors and windows on stud layout; and demands that framing members be lined up (or stacked) for direct load transfer. Coupled with better insulation detailing, those same smart-framing strategies also can reduce the cost of heating and cooling houses.

Stack framing simplifies load paths

Lining up framing members directly on top of each other shouldn't be a big deal, but apparently it is because many builders don't do it. Stack framing makes everything simpler. Connections for high-wind, seismic, and high-snow-load areas are easier to detail, and mechanicals are easier to run when floor framing is spaced farther apart.

Drawings: Chuck Lockhart

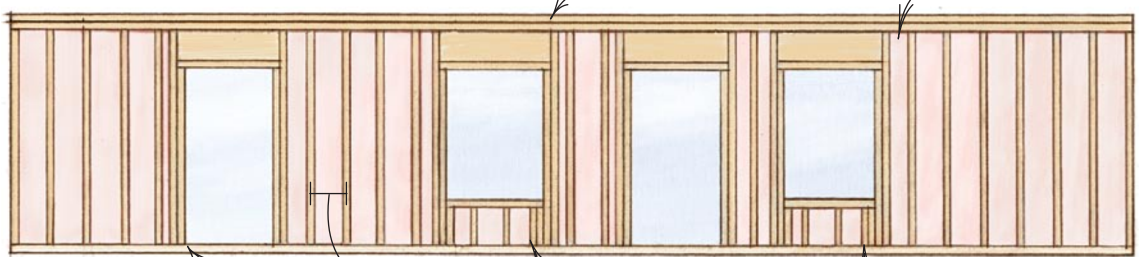
Q How can smart framing save money?

A Fewer pieces go together faster, make less work for everyone, and leave more room for insulation.

A case study of two identical 2000-sq.-ft. houses designed for a Centex Homes subdivision in Minnesota illustrate the magnitude of savings a single house can achieve. A comparison of wall elevations shows why one is cheaper to build, cheaper to heat and cool, and more polite toward environmental issues (such as greenhouse-gas emissions, resource conservation, and landfill congestion). Similar cost and resource efficiency also has been demonstrated on building sites in hot and mixed climates.

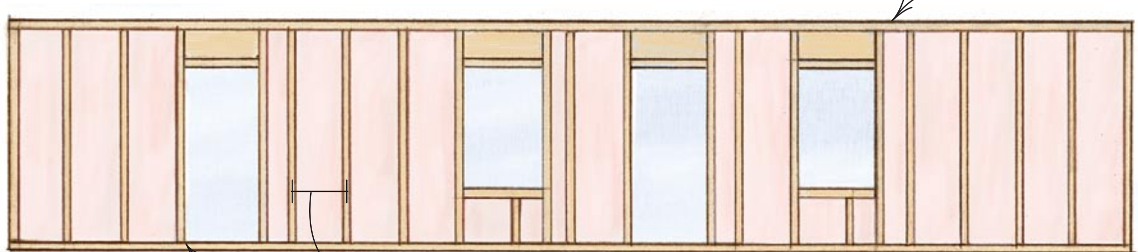
Standard wall framing

- Materials in 40-ft. wall: 35 studs, 10 cripples, 28 insulation pieces
- Amount of wall that can be insulated: 68%
- R-value: 13
- Cost of wall framing, sheathing, and housewrap for entire house: $4,039
- Annual heating and cooling costs: $1,003



Smart wall framing

- Materials in 40-ft. wall: 21 studs, 2 cripples, 20 insulation pieces
- Amount of wall that can be insulated: 75%
- R-value: 24 (R-19 fiberglass batts, plus R-5 foam sheathing)
- Cost of wall framing and sheathing for entire house: $1,927
- Annual heating and cooling costs: $710



"A dimension of 23 ft. 6 in. makes no sense to anyone except town planners, architects, and designers."

You have fewer holes to drill and more room to work. Old-school builders may argue that framing on 24-in. centers makes bouncy floors, but if you glue and screw thicker sheathing, you can have a squeak- and bounce-free floor. The extra cost of thicker sheathing is offset by the lower cost of floor framing. Unfortunately, stack framing requires planning. Therein lies the problem.

Design houses to use materials efficiently

Because many materials come in 8-ft. sheets, we should account for that fact in our basic dimensions. We also should slide doors and windows to the nearest stud. As a hypothetical exercise, let's design two sheds out of OSB and wood studs. One is 8 ft. by 8 ft., and the other is 7 ft. by 7 ft. The materials list and the total cost of materials are the same for both. To figure out the cost per square foot for the 8-ft. shed, divide by 64. The cost per square foot for the 7-ft. shed is 25% higher because we now divide by 49. Which one is faster to build? And which one needs a Dumpster? A 23-ft. 6-in. size makes no sense to anyone except town planners, architects, and designers. If carpet comes in 12-ft.-wide rolls, it is dumb to have a bedroom 12 ft. 4 in. wide.

When wood moves, drywall cracks

In the words of renowned Danish woodworker and furniture maker Tage Frid, "Vood moves." Drywall doesn't like to move. It prefers to crack. The more you attach

I blame town planners for stupid dimensions. They set the lot size and the setbacks. House widths are fixed, based on "how big can I make this and still fit it on the lot." There should be a bylaw fixing frames at 2-ft. increments. As for architects, if I see one more "green and sustainable" house that is built with silly dimensions, my head is going to explode. Too much green design is an exercise in shopping to build a shrine to the architect. The goal for green design should be "no Dumpsters." Dumpsters are a function of poor planning.

Q I'm still skeptical. Do I have to adopt all of these strategies?

A They all make sense, but some give more bang for the buck.

You don't have to use all these details, but a couple of them will save you a bundle. Rather than switching all at once, start with the most efficient upgrades, then phase in new details after each is incorporated into your standard operating procedure. Cost savings are based on a 2000-sq.-ft. house (see case study on previous page).

PHASE 1

Design in 2-ft. modules

The best thing you can do is to switch from 2x4 studs at 16-in. spacing to 2x6 studs at 24-in. spacing. Stack the floor, wall, and roof framing, and place windows and doors on the stud layout. Next, replace plywood or OSB wall sheathing and housewrap with at least 1 in. of rigid-foam sheathing. These steps will save you significant money and labor, and they'll boost R-value by 50%. And walls framed on the deck will be much lighter and easier to stand up. Cost saving: $500.

PHASE 2

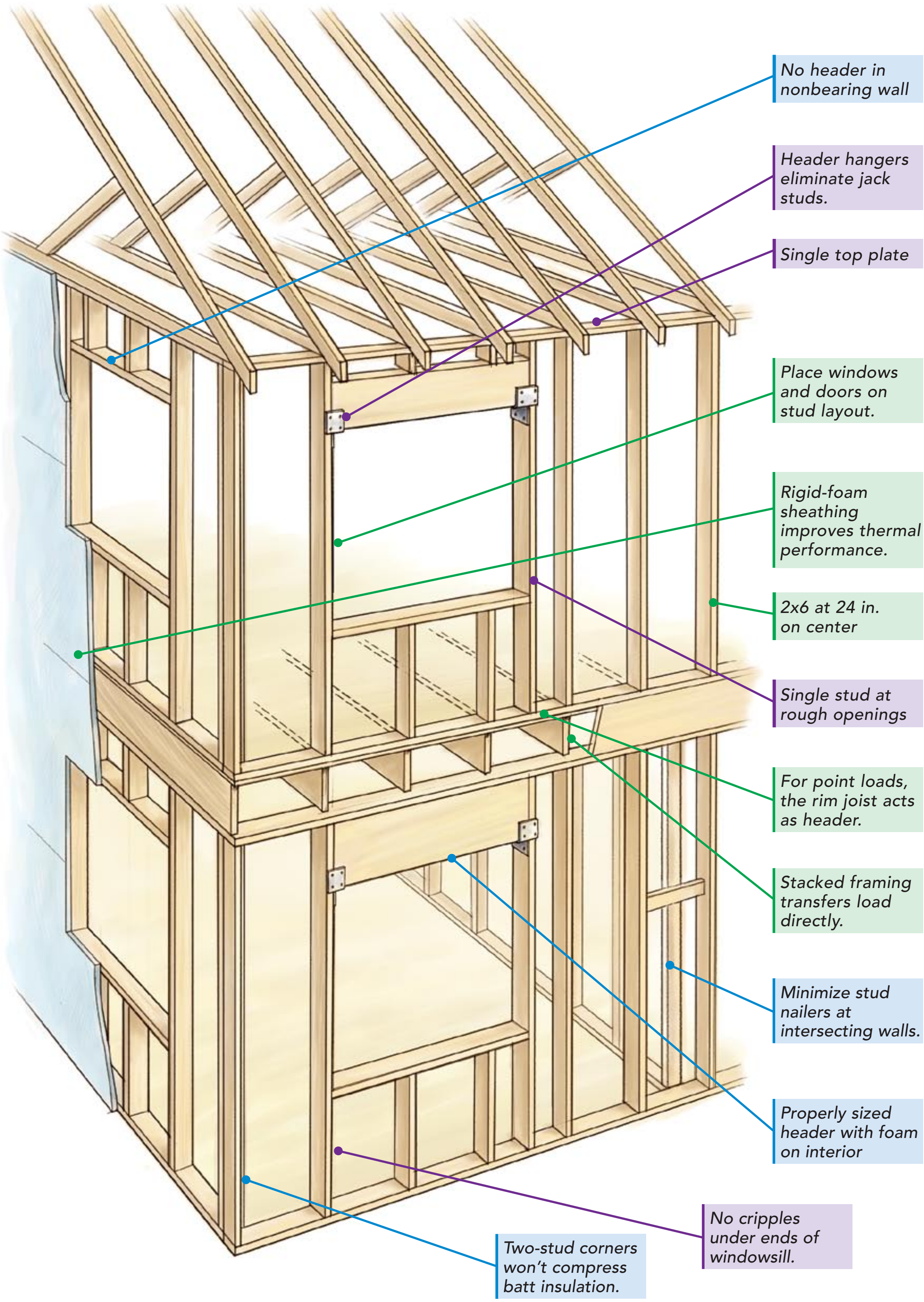
Eliminate cold spots

Structural headers aren't needed in non-load-bearing situations; size them properly in bearing situations. Corners and wall blocks make more cold pockets in a standard-frame wall. Use two-stud corners, and eliminate blocks to keep insulation consistent. Drywall can be floated at the corners (which reduces cracks anyway) or fastened with drywall clips. Cost saving: $135.

PHASE 3

Fine-tune the savings

Use header hangers rather than jack studs at door and window openings. If cripples under windows are less than 24 in. tall, eliminate them altogether. This saves labor and materials, but may make trim installation more difficult. Eliminating one of the top plates is a final material-saving upgrade, although until precut studs are available at 94 in., this may complicate drywall installation. Cost saving: $120.



"We're the Saudi Arabia of cellulose. Oil is nonrenewable, but cellulose grows on trees."

Because we can make sheathing, beams, joists, and rafters with small trees that are chipped up, we really don't need to cut down old-growth forests in the mountains to get the wood we need. We can grow trees on flat land, such as Ohio and Indiana. But cellulose also can be extracted from fast-growing plants rather than from trees, so maybe that's what we should plant in Ohio.

drywall to wood, the more drywall cracks you'll have, unless you let the drywall bend.

Remember drywall cracks caused by truss uplift? The solution was floating the corners: Let the wood move and the drywall bend. The same theory reduces drywall cracks at wall intersections and saves a bundle of studs. But don't just take my word for it. Here's proof: When we used smart framing with floated corners on a Building America subdivision with a production builder in Chicago, we reduced drywall cracks by over 50%. Because this builder frames 1,000 homes a year, his savings translate to about $500,000 per year on service calls.

Shear strength is a big deal

For plywood or OSB to provide shear strength, nails must be far enough from the edge of the panel that they don't tear the panel when under stress. With a double top plate, the panel can sit flush with the bottom plate and still have lots of "meat" to nail into at the top. Not so with a single top plate on a typical 8-ft. 1-in. wall frame. In fact, it just doesn't work.

The traditional solution is diagonal bracing, either metal straps nailed to the face of the wall frame or a 1x4 let in to the wall studs. Another solution is a commercially available inset shear panel, popular on the West Coast because of tremendous seismic activity. None of the shear-panel manufacturers we approached was interested in modifying a proprietary system for smart framing, but the Army Corps of Engineers was. Together, we developed an inset shear panel for 2x6 24-in. on center framing (sidebar right). This panel will be available commercially (www.tamlyn.com) in 2006, but the design and engineering works for site-built applications, too.

What does the future hold?

In the future, building materials will work a lot harder. Foam sheathings will pass water vapor selectively if a wall gets wet. Housewraps will change characteristics depending on orientation, season, and climate. Ballistic housewraps will protect houses from projectiles in seismic and hurricane areas.

But smarter materials can't achieve their potential without smart building. Why aren't more houses built smarter? Because it's different. What we have is an inefficient framing system that we are all doing incredibly efficiently. We need to refocus on a more efficient system. The transition can be in phases to reduce the learning curve, but it still takes about 10 houses for a framing crew to execute smoothly. If you want to change, you will; but with the current building boom, everything sells so quickly that there's no incentive to slow down your system. When the boom fades, change will take place. Of course, oil at $65 a barrel helps, too. □

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Q What about seismic and hurricane areas?

A Build a shear panel to slip between the studs.

Insulating sheathing is an attractive alternative to OSB, but a major drawback is the lack of shear strength in a foam panel. One way to gain shear strength is to install ½-in. plywood or OSB at critical locations of a house, and then skin over it with ½-in. foam sheathing.

A better solution is a shear panel that fits into the wall framing, leaving the exterior foam intact. Leave one stud out and insert the 46½-in. panel. Built with readily available building materials for around $100, the panel is secured into the wall with nails and framing-connector plates and bolted continuously from the top plate to the foundation anchor bolts. This panel (developed and tested by Building Science Corp. and the Army Corps of Engineers) is engineered for site-built applications, but an engineer should specify where and how many to use.