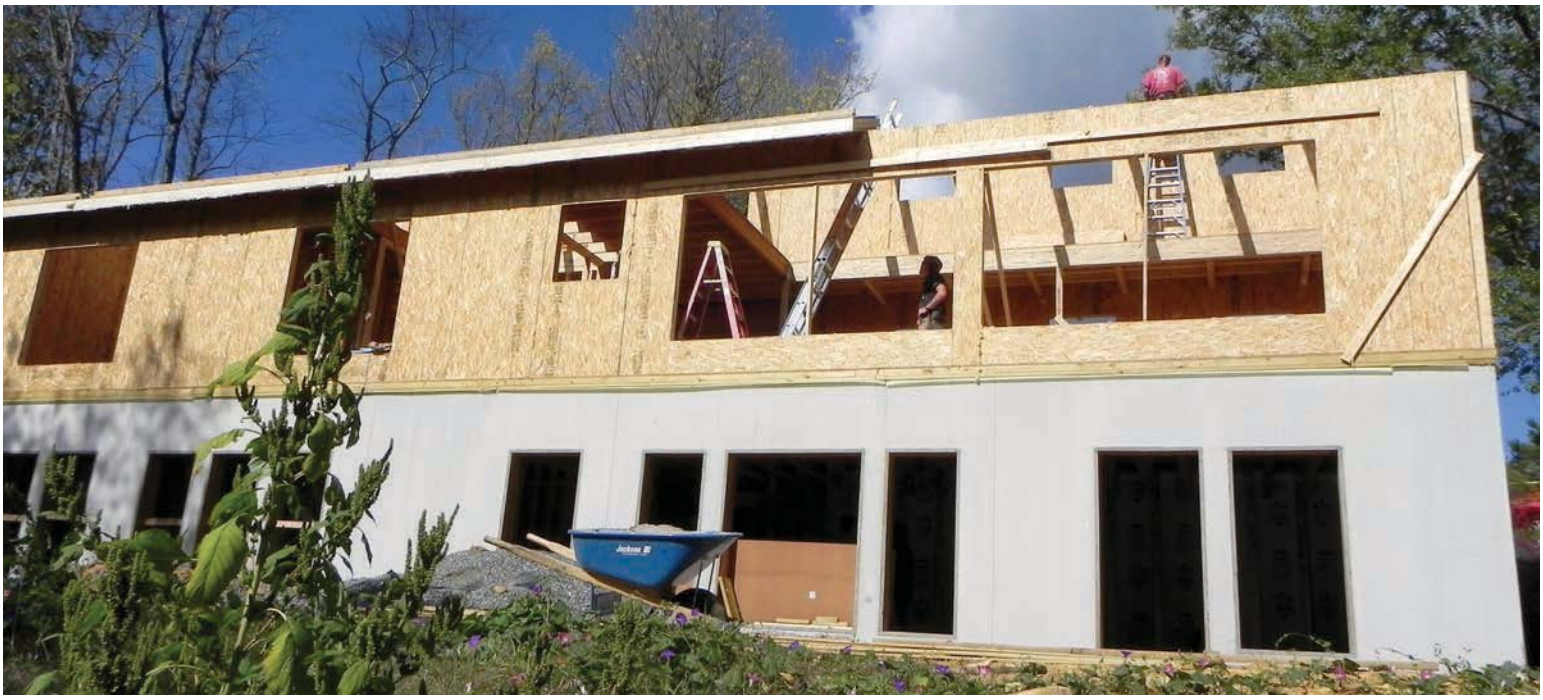

Structural insulated panels (SIPs) on a Superior Wall foundation for a passive solar home. VandeMusser Design photo

The right wall system

A comparison of five common wall systems for new construction

▫ By Marcus Renner ▫

Do you want to build a house that's more energy-efficient but doesn't cost an arm and a leg? It may be easier than you think.

Most homes today are built using a method called Western platform framing; you may know it as 2-by-4 or stick framing. Stick framing is a time- and cost-efficient way to build a home, but it is by no means the only one. During the last half century, other wall systems that have considerable advantages over our current form of building have been developed and tested. These systems are also accepted by the building code officials in most areas of the country.

First, let's address stick framing and how it can be made more energy efficient. Engineers studying building science have created a system known as Optimal Value Engineering (OVE). This idea, commonly called Advanced Framing, restructures the way a stick-framed wall is built. The amount of wood is minimized and the space for insulation is maximized, increasing the overall efficiency of the building envelope (see the next page for a checklist on Advanced Framing).

Platform framing is the most common form of house construction in the U.S., but there are other methods that have been developed, many with great advantages. Although a home can be framed to perform well, we have to understand that we, the consumer, often place cost and quantity (square footage) over quality. This often leads to homes built to minimum building code standards. Imagine putting your family in a car built to minimum highway safety standards and going on your summer vacation. Would you do it? That is what many of us are living in, a home built to the minimum required standards of health and safety.

Enter the engineered wall system. These are wall systems that have been engineered to improve quality, efficiency, durability and sometimes even cost. As we will see below, they often incorporate insulation and structure into one system. The structural, insulating and sealing qualities of the product were developed at the same time by the same person, unlike framed homes. Although these systems may seem more costly we have to make sure that apples are being compared to apples.

First, keep in mind that the walls of a home generally account for only 12 percent of the overall cost of a home. Second, many of these wall systems incorporate more than one phase of construction. For instance, a framed wall only provides the wall structure for a building. Insulation still has to be added. In the case of structural panels, for instance, you get both structure and insulation. Both designed for optimal performance. We'll see more examples below. Let's review some common engineered wall types.

Structural insulated panels (SIPS) are the most popular form of construction after stick framing. They are composed of foam insulation sandwiched between a "skin" of oriented strand board (OSB). Together the foam and wood create a strong wall section that provides a continuous layer of insulation. Few if any structural members divide the insulation. The layer of OSB on the two sides also provides a continuous nailing surface for drywall and siding.

There are two different types of foam insulation that are used between the layers of wood; the most popular and least expensive is extruded polystyrene (EPS). You know it as bead board or by the brand name Styrofoam. When we look at all types of insulation, we use the R-value measurement. The "R" of a material is its Resistance to heat transfer. The higher the R-value, the better a material will be at insulating the home from the heat or cold. EPS foam, which is glued to the OSB, has an R-value of about 3.5 per inch. Individual panels can be factory cut to the specifications of the plans or can be cut on site. An average home can be erected within a few days, which is an advantage in our rainy climate.

Polyurethane foam SIPS have insulating foam that is injected into a mold, adhering the OSB to the foam. The foam hardens and has an R-value of about 7 per inch. Although their insulating value diminishes slightly over time, polyurethane panels are better insulators. Being stronger, there is no need for structural wood in the panel like what is needed in EPS SIPS. This creates an unbroken layer of insulation around the envelope of the home. SIPS homes are a favorite of some green builders because they are well insulated, create a superior air seal and offer fast "dry in" times during construction.

Another popular form of engi-

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Advanced framing

▫ By Marcus Renner ▫

Developed 150 years ago, wood-framed (also called stud-framed or western platform framed) buildings now account for 90 percent of our homes. As with all technologies, decades of use fostered innovation. One of the latest innovations for framed construction is now called Advanced Framing. Advanced Framing addresses efficiencies in speed, cost, materials and energy. Redundant wood is eliminated, layout is simplified and insulation is increased – less wood, more insulation.

Below is a list of code-approved advanced framing methods:

■ **Corners constructed with two studs, not three**
Corners inherently carry less of a structural load than the wall. The only reason a third stud is installed is for connection of the drywall, but doing this creates a cavity which can't be insulated. Eliminate the stud and install drywall clips or a smaller one inch board to connect the drywall to.

■ **Ladder bracing where partition walls meet exterior walls**
Additional studs are traditionally placed in the exterior wall on either side of the last interior wall stud. These are placed there for the drywall connection. Ladder bracing is just as strong and allows insulation to be placed in the exterior wall. Small scraps of wood can be used.

■ **Raised heel trusses or rafter ends**
Trusses are often designed with no room above the top plate. Site-framed homes often have the rafter sitting on the top plate next to the ceiling joist, also providing minimal space above the top plate. Insulation is usually compressed at the edge of the building. Raised heel trusses are designed to allow ample room above the top plate so the insulation can keep its fluff. In a framed roof, a ledger board can be placed flat on top of the joist ends and the rafter sits on the ledger.

■ **Single headers flush with the outside or insulated headers**
Most homes never have the forces to require a double header. Eliminate the interior board. This will allow the insulators to fill the space in the header. Drywall is less likely to crack when not connected to the larger piece of wood. If you do need to install a double header be sure to fill the center with insulation before constructing and installing it, or stack the headers together and put the insulation in last.

■ **No headers in non-load bearing walls**
If there is no load above a window, why put an expensive header that requires large boards and compromises the insulation? Frame out the opening with one flat 2x6. Non-load bearing openings are usually under gable ends.

■ **No cripple studs connected to jack studs under windows**
Windows aren't heavy. Follow the framing layout for the small studs under windows but don't add additional wood at the jack or king stud.

■ **No jack studs for headers**
Jack studs hold up headers. Jacks can be replaced with header hangers. Less expensive than wood, and quicker to install, header hangers allow more insulation in a wall.

■ **In-line framing**
Framing in a way that all the structural elements line up increases strength and minimizes wood. The layout of the floor joists, studs, ceiling joists and rafters are the same. The stud is directly over the floor joist, the ceiling joist is stacked on top of the stud and the rafter is on top of the ceiling joist. This more efficient and stronger way of building also looks better and gives a perception that the building is stronger, which it is.

■ **Single top plates**
When doing inline framing, the double top plate can be eliminated and a single top plate will suffice. Metal plate or wood splice connections can be made at partition wall intersections and top plate butt joints. Although this is an easy way to minimize wood and increase insulation, many code officials won't approve this method, so be sure to consult with them.

Ladder T wall's use scrap wood as a nailer for drywall and increase the amount of insulation at every interior-exterior wall intersection.
Jim Forward, Forward Construction photo

■ **2x6 exterior stud walls, 24 inches on center**
Increased room between studs enables more insulation. 24-inch centers (versus 16-inch centers) require less wood, even though the size has increased. Many builders are eliminating interior window and door trim and rounding the drywall to terminate at the window frame. Only a wood sill is installed, saving money.

■ **2x4 interior walls, 24 inches on center**
Non-structural interior walls don't need 16-inch spacing. Less wood means less work for the framers and trades people.

■ **Floors and roofs framed on 24-inch centers**
With the advent of floor decking that is ¾-inch thick, there is no need to use 16-inch spacing. Two foot centers with ¾ inch decking are faster and have a lower materials cost than other methods. Keep in mind that the trades people will also have less wood to cut or drill through when running plumbing, electrical or other services.

■ **Insulating sheathing**
Although not a framing method, using rigid insulation as the exterior sheathing is an excellent way to increase the efficiency of the home. Framed homes have a break in the thermal insulation every time a stud is installed. If the walls are insulated with R-19 rated insulation, the effective R-value of the wall is actually around R-13 because of the wood break. Insulation as sheathing actually creates a thermal break and adds additional R-value to the wall. If the seams are caulked and taped, then the house wrap can be eliminated, saving money. Taping the seams also provides an air seal that stops air leakage, the No. 1 type of energy loss in our homes. Diagonal loading has to be addressed, and there are a number of ways to do it. Wood sheathing can be installed at corners or diagonal bracing of wood or metal can be nailed into the wall.

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neered walls is Insulated concrete form (ICF) construction. ICF walls are a solid concrete based form of wall construction that uses foam blocks to create a form into which concrete is poured. Unlike conventional concrete work, the form stays in place, providing a layer of insulation on either side of the wall. This interesting configuration creates a layer of thermal mass that essentially becomes energy storage since it is insulated on both sides. ICF homes can be fifty percent more energy efficient during the life of the home and much quieter than a common stick framed home. Concrete walls also make the home stronger, allowing it to better survive severe storms and earthquakes

There are as many as 50 manufactures of ICF form systems. Most use EPS foam to create the form walls and plastic to separate the foam, creating space for the concrete. The blocks are stacked like Legos®, reinforced with rebar and then filled with concrete. Some ICFs are made with recycled materials such as mineralized wood chips and recycled EPS foam and cement.

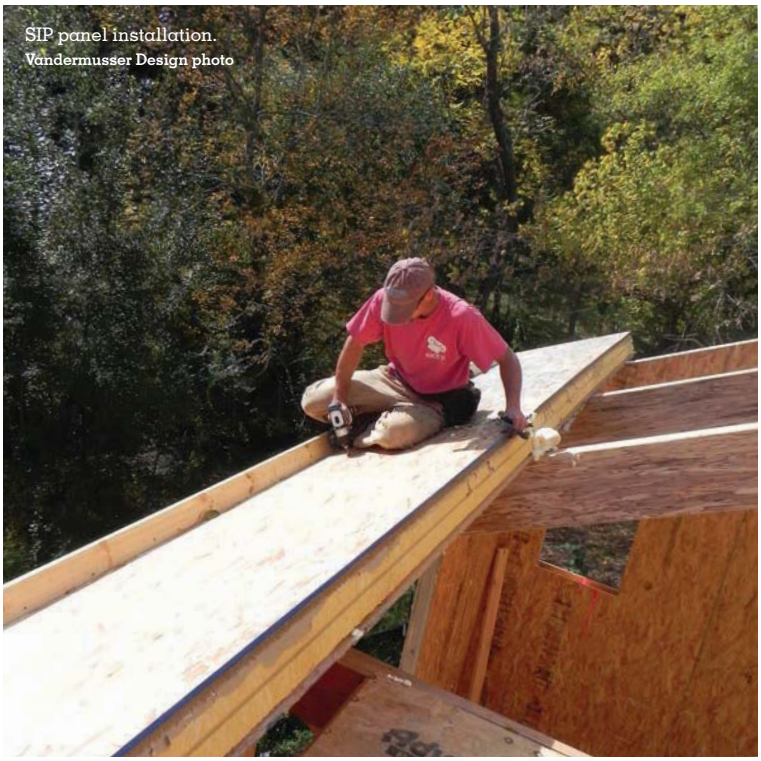
An engineered wall system that is gaining popularity is a pre-cast concrete wall. Pre-cast concrete is mostly used for earth-bermed basements and lower floors, although they can be stacked three stories high.

The concrete wall is usually two to three inches thick and the interior of the wall is insulated with rigid insulation that has an R-value of 12.5. Pre-cast walls typically don't need a concrete footer as most below-grade walls do (make sure that is noted in the budget). All that is needed is a gravel trench that allows water to drain away. A slab floor is poured and drywall can easily be attached to special ribs on the interior. The exterior comes finished to look somewhat like stucco (or other choices) and can be painted. This wall system can be installed in a less than a day and provides an insulated concrete wall with a small amount of concrete use.

A product that truly incorporates insulation and structure together is Autoclaved aerated concrete (AAC). This product uses cement to create a lightweight material that is filled with tiny air bubbles, one description calls it "foamed cement". The material comes pre-cut into blocks or panels. For residential construction, blocks that are from eight to twelve inches thick are used for the walls. AAC provides both structure and insulation; one product that does both! Any type of interior and exterior finish can be used, but plaster and stucco are the easiest and most popular.

AAC construction is fast and easy. Common carpentry tools can be used and the process is quickly learned. The material is easy to sculpt and architectural details can be adhered anywhere with the glue-like mortar. AAC walls are also very soundproof, since the tiny air bubbles act as thermal and sound insulation. AAC has been found to perform best in climates that require more cooling than heating, however; your location and the configuration of the blocks may affect the wall's performance.

These are a few of the most popular forms of wall systems. Each has advantages and disadvantages, and each should be studied and understood by the builder before the decision is made to use them. Keep in mind that a house is a system made up of many other systems. A holistic approach needs to be taken to understand how all these systems interact. Framed walls that are sealed well and well built engineered wall systems inherently provide a tighter building, and we have to allow the home to breathe through a well-designed passive or mechanical ventilation scheme to avoid moisture build-up on the interior of the building and to provide fresh air.Today's wall systems can be designed to provide more insulation, a tighter building envelope, and a stronger wall than a minimum building code stick-framed building of the past. By utilizing these products and methods, we can save money and the environment while being comfortable.



SIP panel installation.
Vandermusser Design photo

After 20 years in the green building industry Marcus Renner became co-owner of Conservation Pros, Inc. a local building performance contractor. Conservation Pros conducts energy audits and performs the work to make buildings more efficient, comfortable, healthy and durable. He can be reached at marcus@conservationpros.com or 828.713.3346. www.conservationpros.com.

Hempcrete

An innovative wall system

▫ By Tim Callahan ▫

Marcus has done a wonderful job of outlining some of the more common wall systems and the pros and cons of each.

Another type of wall system that is gaining acceptance and popularity is hempcrete. This is an insulative, monolithic system that is made up of a combination of industrial hemp mixed with a lime binder. Hempcrete has been used extensively in Europe for over 25 years in commercial residential and affordable housing projects. Hempcretes entry into the U.S. market was in 2009, right here in Asheville, NC.

In the US, hempcrete currently costs more than common walls types since industrial hemp is not federally approved for cultivation in all states. Based on support for currently pending House Bills in North Carolina, we anticipate local production of industrial hemp within the next two years. Local production holds the promise of reducing material transportation costs and stimulating the regional economy.

Hempcrete may be cast-in-place around a typical stud-frame structure or implemented as a panelized system, in a manner similar to structural insulated panels (SIPS). Due to the unique hygroscopic characteristics of the lime admixture, this wall system is able to mitigate and prevent vapor condensation inside of the wall and inhibit the growth of mold, making it particularly attractive to individuals with chemical and mold sensitivities; this is a distinct advantage, particularly in local humid sub-tropical climates. Typical hemp walls have an R-value of 26; the thermal performance of the wall is adjusted to project-specific requirements by adjusting the thickness of the wall.

Hempcrete is usually finished on the exterior with a lime stucco, though other finish materials may also be used. The interior may be either lime-stucco, or clay plaster - these finishes provide protection from the weather and maintain the vapor permeability of the system… one of its unique advantages! Hempcrete is a suitable material for a broad range of architectural expressions, but tends to naturally lend itself to a timeless, old-world aesthetic.

Hempcrete installation. Alembic Studio, LLC photo

Tim Callahan is a partner at Alembic Studio, LLC; the leading hempcrete design specialist in the United States, and founder of Hempsteads.info; a hemp construction knowledge base lab.