Chapter 6

Energy-Efficient Walls

Recommendations	First Cost	% Potential Savings	
		Cooling	Heating
1. Reduce the number of framing members.	R	0-2	0-5
2. Fill gaps with insulation.	N/S	0-5	0-10
3. Prevent insulation compression.	S	0-2	0-5
4. Use wall details designed for energy efficiency.	S/M/H	0-5	0-10
5. Air-tighten walls and minimize the use of potentially harmful building materials.	M	0-10	0-10
6. Apply light-colored exterior finishes.	N	2-10	—
Maximum Combined Total	H	15	20

Cost Codes: R = reduced
N = negligible
S = small (<$0.25/ft² of floor area)
M = medium (>$0.25 and <$1.00/ft² of floor area)
H = high (>$1.00/ft² of floor area)

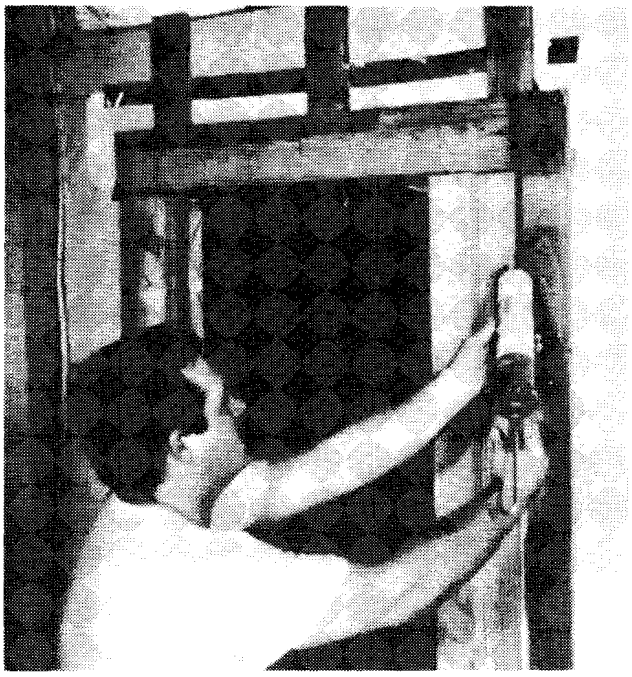
Marketing Energy-Efficient Walls

To sell the energy benefits of walls built to include the recommendations in this chapter, let buyers know how your walls are constructed differently than those of other builders. Inform them that many locations often are not insulated when walls are built, but you have made sure these locations are insulated in your homes. Show photos you have taken of exterior wall corners and partition wall tees during construction of your house and make comparisons with other builders' homes. Explain that many builders leave 2- to 4-inch uninsulated gaps the entire height of the wall at corners and tees, and that more heat can escape or enter through those gaps than through the rest of the wall.

Point out that most homes have wiring in the center of the wall, causing insulation around the wiring to be compressed and lose effectiveness. Show photos of what you have done to prevent that problem. When it comes to walls, time-of-construction photos can be your best sales tool. The photographs will help buyers see what they're getting. Most of them will associate these energy-efficient construction details with quality.

Tell your clients that humid summer air leaking into the house accounts for one-fourth of the air conditioning energy bill. They will react favorably to your attempts to block the entrance of moisture. Again, show photographs of air infiltration barriers (defined later in this chapter), caulking or other measures you have used to reduce air leakage through floors, ceilings and walls.

You may also need to explain that an infiltration barrier blocks the moisture-laden air that increases their home's humidity, whereas a vapor barrier is designed to protect the wall material in cold climates. Point out that research shows vapor barriers are unnecessary in Florida



Show clients photos of the efforts you take to construct energy-efficient homes.

because of our mild winters. And give them a dollar estimate of how much this fact has saved them.

If you are using concrete block construction and have insulated it to more than the minimum levels usual in your area, be sure to say so, and explain the difference in terms of R-value. If you have applied a stucco finish or sealer on the block, point out that the finish seals the block against air leakage.

Constructing Energy-Efficient Walls

Wood-frame and concrete-block walls account for more than 95% of Florida home construction. Other wall types — brick, log, post-and-beam, etc. — are too infrequently used to include in this discussion. A recurring question is: Which is more energy-efficient — concrete block or wood frame? Wood-frame walls generally are better insulated but tend to have greater air leakage than concrete block walls. Concrete block can absorb and store more heat and therefore may prevent rapid temperature changes in the house. So the question has no simple answer. It is more important to construct wood-frame or concrete block walls *well* than to speculate about which one may perform better.

Wood-Frame Walls. There are six key ways to improve the energy-conservation aspect of wood-frame walls:

- Reduce the amount of wood in the walls.
- Reduce or eliminate any gaps in wall insulation.
- Prevent compression of insulation around wiring.
- Choose walls designed for higher R-value levels of insulation.
- Air-tighten the wall.
- Use a light-colored exterior finish or use wall radiant barriers with brick veneer.

Concrete Block Walls. To improve the energy efficiency of concrete block walls:

- Use insulation with high R-values.
- Prevent compression of insulation around wiring.
- Prevent or reduce gaps in the insulation.
- Properly apply a light-colored, good-quality exterior stucco or sealer paint.

These methods are discussed in the following sections.

1. Reduce quantity of wood

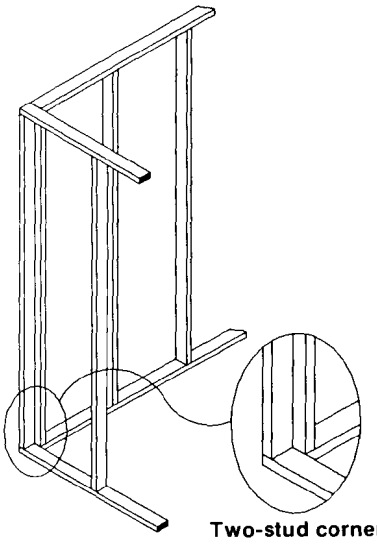
Using less wood saves not only money, but energy too. The resistance of wood to heat flow is only about one-third that of insulation. For example, a 2x4 has an R-value of about 4.4, while a 3½-inch fiberglass batt has an R-value of 11 or 13. There are many opportunities to reduce the use of wood without jeopardizing the stability or quality of your homes.

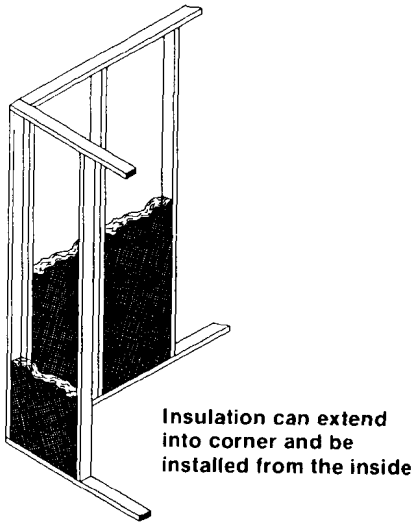
Framing. There are well-engineered and tested methods for reducing the number of framing members. Excellent resource books are available from the Department of Housing and Urban Development and The National Forest Products Association. (See the "For further information" section at the end of this chapter.)

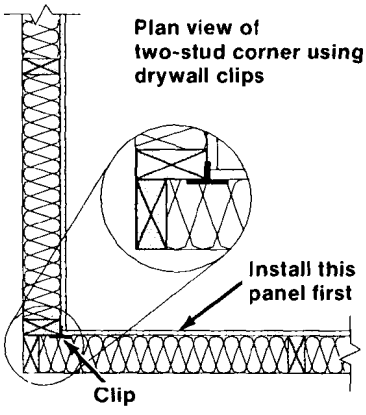
By using 24-inch-on-center rather than 16-inch-on-center framing, you can reduce the number of framing members by approximately 30%. Your costs can be further reduced by 2-foot and 4-foot-wide windows so that extra framing members are not necessary. If you use wood siding, refer to the manufacturer's recommendations for stud spacing. In some instances, wood siding may warp if supported only every 24 inches. Most gypsum manufacturers also recommend 5/8-inch gypsum with 24-inch-on-center studs.

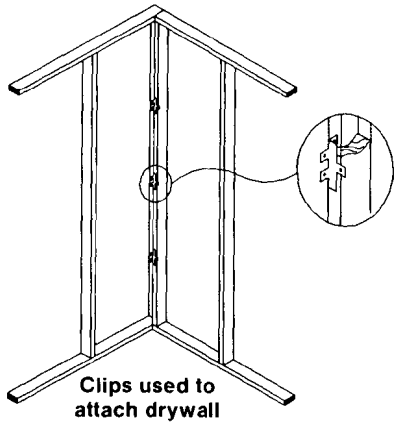
Corners. Most corners in exterior walls are made with three studs, leaving a U-shaped channel facing the outside. This channel should be filled with insulation. However, because the wall sheathing normally is installed before the insulation, this void is often not filled. A desired alternative, illustrated on the next page, is a two-stud corner which permits the insulation to be installed from the inside. Further, since there is insulation where there otherwise would be a stud, the cost of a stud is saved. Note there are two methods of connecting drywall: Either clips or a 1x4 nailer can be used.

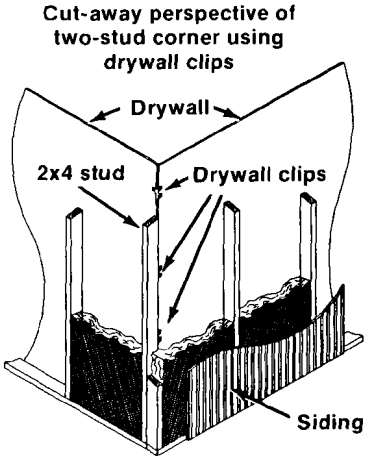
Tees. A typical tee for joining a partition wall to the exterior frame uses three studs, leaving a 3½-inch-wide U-shaped channel facing the exterior. The channel usually goes uninsulated. Instead, the partition wall can be attached to the exterior frame with the use of only two studs. A better alternative is the one-stud tee, consisting of the leading stud of the partition wall plus a 1x6 or two 1x4s used as drywall nailers. Drywall clips can also be used to join drywall pieces where there is no exterior framing member. See details on page 6-5.

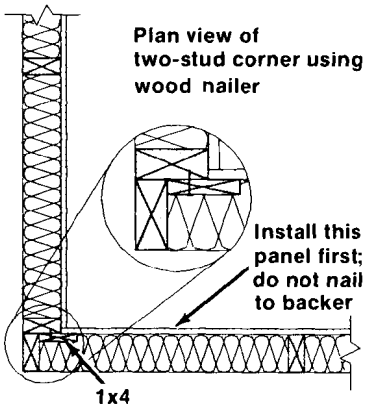


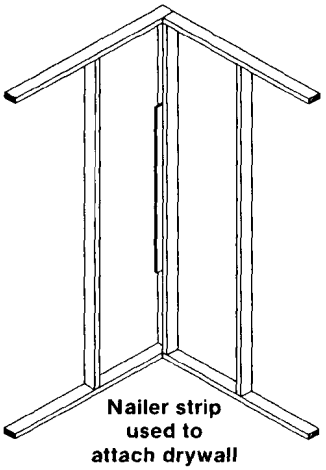


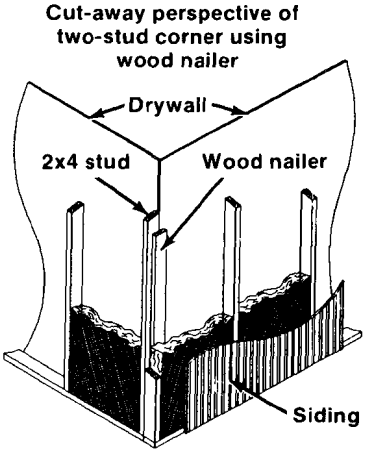




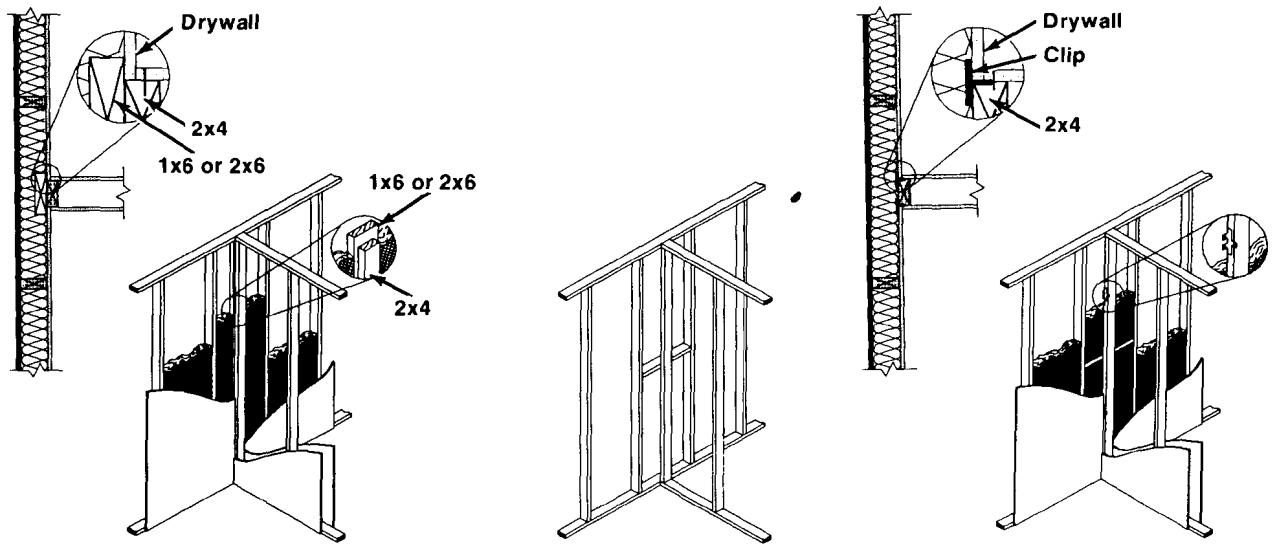








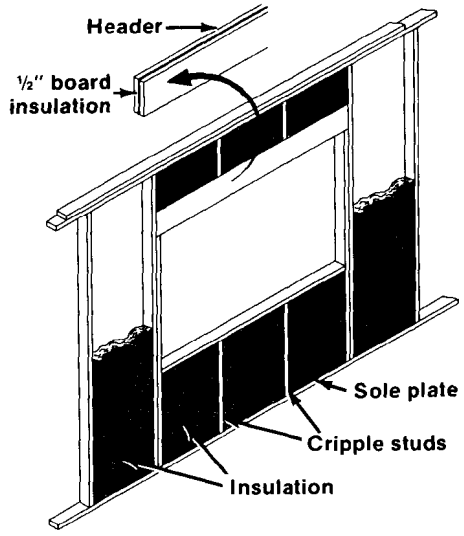
An energy-efficient corner is constructed using two studs. Drywall can be attached using drywall clips or nailer strip.



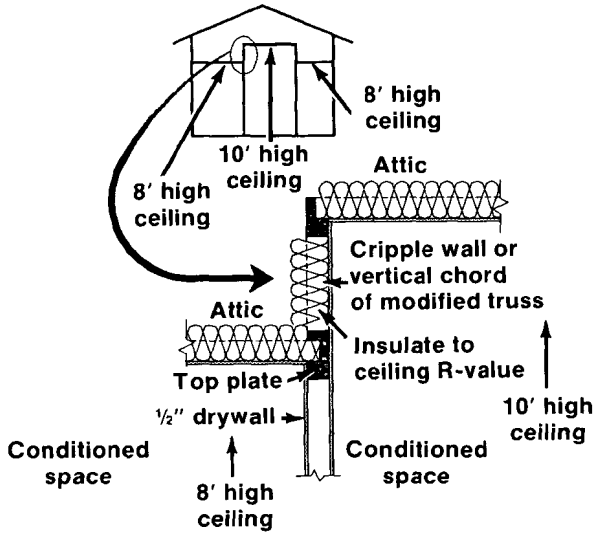
An energy-efficient partition wall is constructed by toe-nailing the leading stud to the frame. Insulation fills wall area. Drywall is attached using a nailer or drywall clip.

2. Fill gaps in wall insulation

In addition to insulating at tees and corners, it is important that insulation is provided around and above window frames and doors. If you are building a home with 9-foot or higher ceilings, be sure to install insulation the full height of the wall. Any wall section that adjoins an attic space should be insulated to the same R-value as the ceiling. Staple the insulation so it will not fall out. Also, always use blocking between studs at the ceiling height to prevent air leakage from the attic into the wall and then into the house via electrical outlets. In a kitchen, treat the drop wall above cabinets in a similar manner.



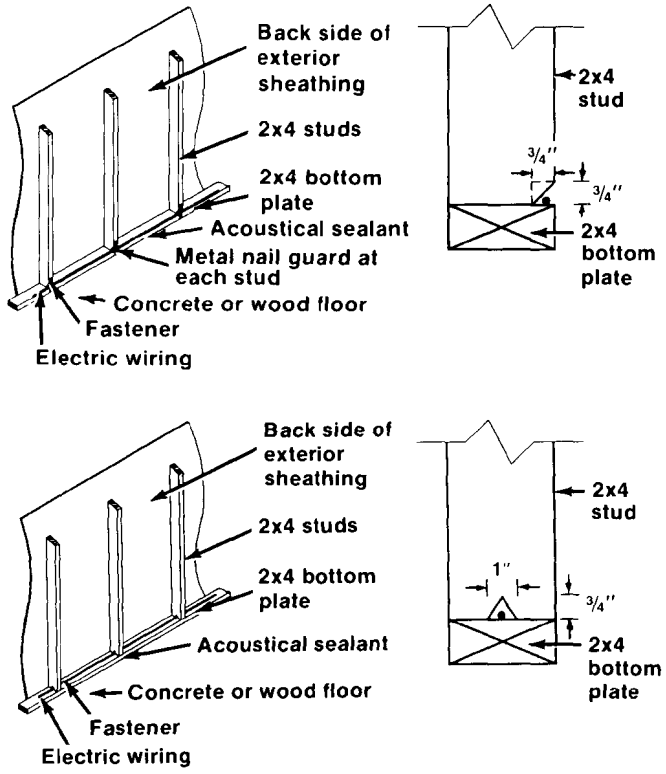
Insulate below, above and around window frames.



Insulate walls between attic and conditioned space.

3. Prevent compression around wiring

Insulation that is compressed is less effective than if allowed to expand to its recommended thickness. For example, a 3½-inch fiberglass batt with an R-value of 11 at full thickness has only an R-value of 7 at a thickness of 2 inches. Unfortunately, in a typical



Use notches for wiring to prevent insulation from being compressed.

situation the electrician drills his holes and runs wire through the center of the stud thickness, and the insulating contractor places the insulation on one side of the wiring so that it is compressed to half its thickness. To overcome this problem:

- Have the electrician place the wire in a notch at the bottom inside corner of the wall (make sure nails used on baseboard trim go into floor or stud), or through a notch at the bottom center of the studs (see drawing).
- Have the insulating contractor tear apart the insulation and place it behind and in front of the wiring.
- Place patches of insulation behind the wiring; put the insulation batt in front of the wiring.

4. Use wall details designed for energy-efficiency

There are many methods of improving the insulation characteristics of walls. By using larger dimensioned lumber or different types of insulation, the R-value of the wall can be increased. The illustration on the next page shows seven different types of wood-frame wall construction.

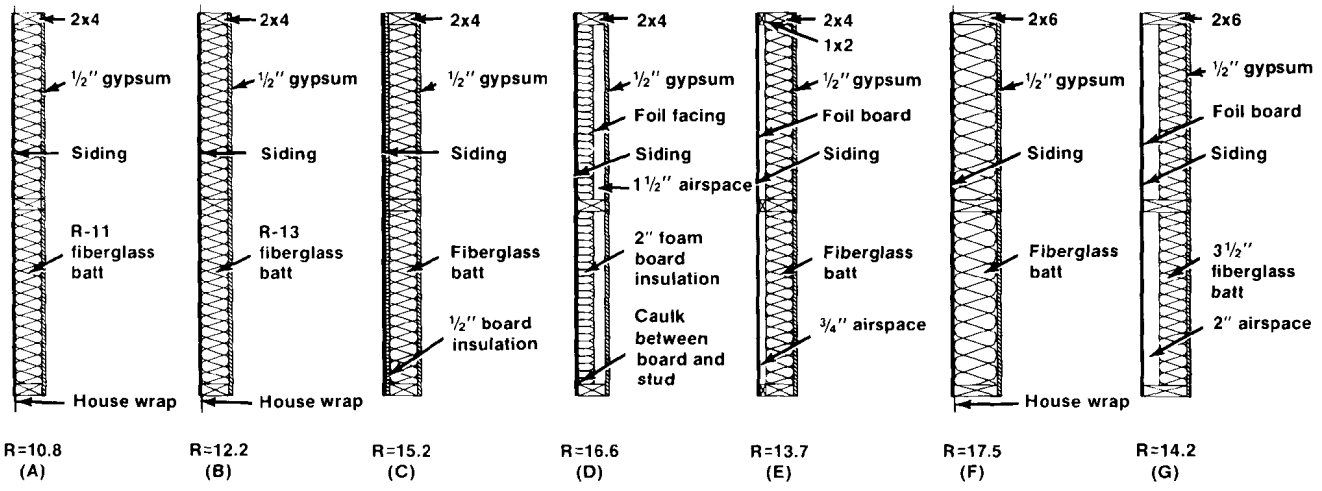
What kind of barrier is it?

Three types of barrier materials for walls are available to home builders: air infiltration barriers, radiant barriers and vapor barriers. Each has a distinct function.

An *air infiltration barrier*, if properly installed and sealed, reduces the quantity of air passing through a wall. It is highly recommended for wood frame homes to reduce the 20% to 30% of air conditioning and heating loads caused by air infiltration. It can be a wood or foam board sheathing or a plastic wrap. Some plastic wraps (generally white in color) reduce the passage of air while permitting water vapor to pass through, thus avoiding moisture problems. Other products, such as polyethelene, prevent the passage of both air and moisture (see vapor barriers below). A layer of stucco can act as an infiltration barrier when properly applied and is commonly used on concrete block homes.

A *radiant barrier* is an aluminum-foil material next to an airspace. It is used to reduce the transfer of radiated heat. Although radiant barriers would be beneficial for walls in Florida, the cost of providing the airspace is usually too high to make the system economical (unless an air-space is already present, as in a brick wall). A radiant barrier system for attics is covered in Chapter 8.

A *vapor barrier*, generally polyethylene or aluminum foil, is used in northern climates on the inside of insulated walls (behind gypsum) to prevent moisture from condensing in the wall in winter. However, experts say **a vapor barrier is not needed in walls in Florida** and, if used at all, should go on the outside of the wall. All vapor barriers are also air infiltration barriers.



Plan views of energy-efficient stud wall construction.

Wall A - Standard. This wall includes an air infiltration barrier (see the next section of this chapter). It uses faced or unfaced R-11 batt insulation. Generally, unfaced is less expensive than faced insulation and can be used whenever the drywallers will be following closely behind. Some builders experience problems with unfaced insulation falling or blowing out of the wall before the drywall is installed. To minimize problems, select friction-fit unfaced batts. The walls B-G are improvements over typical wall construction.

Wall B - R-13 Batts. You can purchase R-13 batts for 2x4 walls. This creates a wall with a higher R-value (compare wall B with wall A).

Wall C - Exterior Insulation Board. Many codes require some type of wall bracing. Usually a simple diaphragm panel (for example, wood sheathing or ⅛-inch foil-faced laminated paper sheathing) is used. However, a ½-, ¾- or 1-inch board insulation with a structural rating provides bracing and does a better job of insulating at the same labor cost. Insulation boards that are not rated as structural may be used in conjunction with plywood bracing to achieve the same R-value. Foil-faced board insulation that is properly caulked can serve also as an infiltration barrier — as can foil-faced laminated paper sheathing. Foil-faced products that are sealed also create a vapor barrier.

Wall D - Board Insulation in Wall. Most board insulations reduce the heat transfer through a wall twice as well as fiberglass insulation for any given thickness. (See the next page for characteristics of many types of insulation.) Wall D above, shows board insulation used instead of fiberglass batts. Foil-faced board insulation can gain added R-value by having an airspace next to it. Wall D obtains an R-value of 10.8 for the insulation (if phenolic type) and an R-value of 3.3 for a 1½-inch airspace that serves as a channel for wiring. Caulk the foil-faced board insulation to the 2x4 studs to form an infiltration barrier. Use an insulation product not degradeable by moisture.

Wall E - Radiant Barrier Walls. Foil facing an enclosed airspace is referred to as a radiant barrier. In wall E an airspace has been created especially for that purpose. It is most appropriate for east- and west-facing walls heated by the summer sun.

Wall F - 2x6 Construction. To enable greater thickness of insulation, walls can be constructed with 2x6s instead of 2x4s. That permits 57% additional insulation.

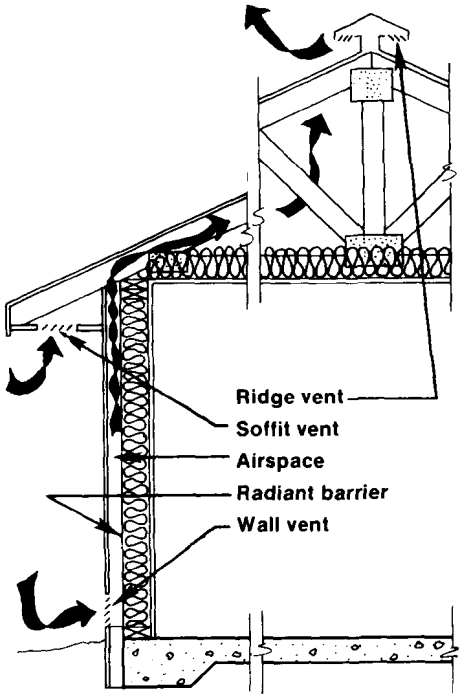
Wall G - 2x6 With a Radiant Barrier. For the southern areas of the state where winter is of little concern, a radiant barrier on unshaded walls may be about as effective as an extra thickness of insulation. Wall G shows the use of 2x6 construction with normal 3½-inch fiberglass insulation and foil-board on the outside to obtain a 2-inch airspace as a radiant barrier. This is an alternative to wall type E. In South Florida, it is best to vent radiant-barrier walls by providing an inlet vent at the bottom of the wall and a screened outlet into the

Generic Building Insulation Comparison

Generic insulation	R/inch	lb/ft³	Advantages	Disadvantages
Batts and blankets				
Fiber glass	3.2	0.6-1.0	Low cost, noncombustible without facings, stable	Facings may be combustible
Rock wool	3.6-3.7	1.5-2.5	Low cost, noncombustible without facings, stable	Facings may be combustible
Boards				
Cellular glass	2.63	8.5	High compressive strength, noncombustible, impermeable to moisture, stable	High cost, low R per inch, freeze-thaw damage possible when in contact with water
Mineral fiber with binder	3.45	15	Provides structural support, fire resistant, stable	Moderate cost, modest R per inch
Polyurethane and polyisocyanurate foam	Unfaced: 6.2-5.8 Faced: 7.1-7.7	2.0	High R per inch, may provide infiltration seal, low moisture absorption, stable	Moderate cost, combustible (polyisocyanurate less so than polyurethane), nonstructural
Phenolic foam	Faced: 8.3	2.5	High R per inch, may provide infiltration seal, low moisture absorption, stable	Combustible
Fiber glass	4.25	3.0	Good R per inch, low combustibility, good acoustical absorption, stable	High cost, binders may burn out
Expanded polystyrene foam	Extruded: 5.0; Molded: 3.9-4.4	0.8-3.0	Good R per inch, may provide infiltration seal, low moisture absorption, stable	Combustible, nonstructural
Perlite	2.8	11	Low combustibility, stable	Low R per inch
Mineral fiber with foam	3.7-7.3	N/A	Mineral board acts as fire barrier to protect foam, can provide structural support, stable	Foam is combustible
Wood fiber	2.1-2.4	25	Availability, can provide structural support, stable	Combustible
Insulating concrete	0.8-2.0	20-40	Noncombustible, can provide structural support, stable	Low R per inch
Loose fill				
Cellulose	3.2-3.7	2.2-3.0	Low cost, good R per inch, availability	May settle 0-20% if installed at too low a density
Fiber glass	2.2	0.6-1.0	Low cost, noncumbustible	Low R per inch
Rock wool	2.9	1.5-2.5	Low cost, noncombustible	Modest R per inch, may settle
Perlite	2.5-3.7	2-11	Low cost, noncombustible, stable	
Vermiculite	2.4-3.0	4-10	Low cost, noncombustible, stable	
Foam in place				
Polyurethane/ polyisocyanurate	5.8-6.2	2	High R per inch, may provide infiltration seal, low moisture absorption	Moderate cost, combustible (polyisocyanurate less so than polyurethane), may shrink
Urea-based mixtures	4.2	0.6-0.9	High R per inch, may provide infiltration seal	Moderate cost, combustible, improperly installed foam may shrink significantly and/or cause lingering formaldehyde vapors
Reflective insulation				
Two-layer	R-5	N/A	Low cost, noncombustible, can provide infiltration seal, very effective as a radiant heat barrier	Dust on reflective surfaces may reduce performance, best when used with conventional insulation, best when vented
Three-layer	R-7.5			

Adapted from U.S. Navy's Building Insulation Material Compilation, 1980.

attic space, as shown below. Check building codes for fire safety standards of vented airspaces.



Vented radiant barrier wall section.

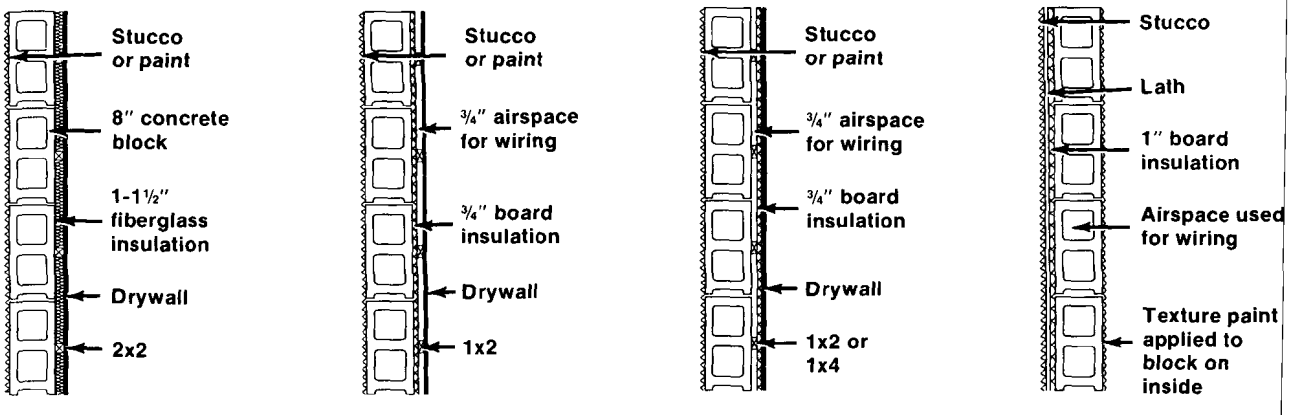
Concrete Block Walls. Concrete block walls are typically constructed with less insulation than wood-frame walls. Energy-efficient block wall construction requires more insulation than the traditional ¾ inch of fiberglass. A sealer or sealing paint or stucco finish serves as an air infiltration barrier; house wraps are not necessary.

Wall A in the drawing below shows 1½ inches of fiberglass batt being inserted between 2x2s. All conventional block construction techniques apply.

Wall B shows one of two methods of using a board insulation product on the inside surface of the block. Here, board insulation goes up first, next to the block, and furring strips are then nailed through the insulation into the block. Wall B is no thicker than wall A but has a much higher R-value.

Wall C shows a similar wall, but the furring strips go up first, followed by the insulation board. The drywall is attached with fasteners pressing through the insulation into the furring strips. Since the insulation is not in contact with the block, it tends to stay drier and may be less affected by mortar chemicals. Dryness is of more concern with brick construction, where you should use wall C and not wall B.

Wall D displays a method for making concrete block walls work as the thermal mass for passive heating and cooling (see Chapter 4 for details). In this wall, insulation is attached to the outside of the wall, and building paper, lath and stucco are applied over the insulation. Use insulation products that are highly resistant to moisture absorption, such as extruded polystyrene. The block can be painted on the inside with a texture paint for maximum contact between room air and the concrete block. Run wiring in conduits through the holes in the block or limit wiring to interior partition walls. As an alternative, furring strips and drywall can be used, but this will reduce the effectiveness of the thermal mass.



Plan views of energy-efficient block wall construction.

5. Air-tighten the wall

Air leakage is a major factor in air-conditioning and heating costs. Infiltration is air leakage into or out of a building by non-purposeful means, such as through cracks in the floor, walls or ceiling. When the heat and humidity of outside air are not desirable, the infiltration of this air into the building is unwanted and can produce discomfort, energy waste, or both.

To prevent significant air infiltration, seal all points of potential leakage. Leakage frequently occurs at the sole plate and at the ceiling. Chapters 5 and 8 cite the locations that require sealing.

Concrete block walls can be effectively sealed against air infiltration by a uniform application of exterior stucco or sealer and paint.

Wood-frame walls can be sealed in one of four ways:
- sealing the exterior sheathing
- using continuous house wrap
- sealing the drywall
- applying a layer of stucco.

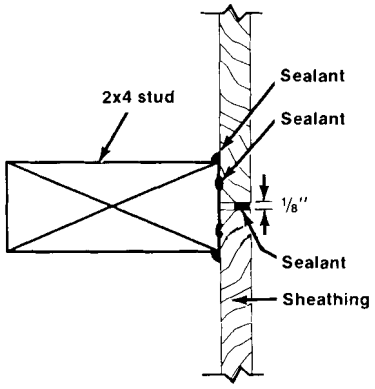
Frequently it is least expensive to seal the sheathing. House wraps can be installed quickly on many wall sections but care must be taken to obtain a proper seal at windows, doors and exterior electrical and plumbing outlets. These first two methods should not be interchanged on a given house and there is no proven advantage to doing both. Air-tightening the drywall may prove to be more difficult or costly, as it may require a skilled drywaller with knowledge of the method. However, this method is appropriate for ceilings and garage (or other nonconditioned) partition walls. The following details of how to air-tighten frame walls to reduce air infiltration are adapted from a checklist developed by the Jacksonville Electric Authority. Air infiltration barriers are required by the energy code for practice No. 2.

Wall Sheathing Techniques. Seal:
- the sheathing directly to the foundation wall or
- the sheathing to the bottom plate and the bottom plate to the foundation wall.

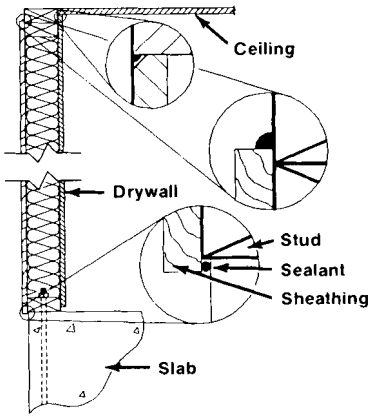
The energy code requires that suitable long-life materials be used when installing infiltration barriers for practice No. 2 houses. JEA recommends oil-based (OB) acoustical sealant for most circumstances. Where the sealant is used in conjunction with gypsum board, JEA recommends a water-based acoustical sealant. Information on which sealants are best with which materials can be obtained from manufacturers and distributors.

Apply the sealant on the outside. For off-grade floors, seal the sheathing directly to the floor deck. Seal the sheathing to the top plate.

Seal the joints of the sheathing (where two panels of sheathing meet) using one of the following methods for plywood, waferboard or foamboard sheathing:
- From the wall cavity side, seal the sheathing to both sides of the framing member at joints between panels.
- After the sheathing has been placed, seal the joint between the side of the stud and the sheathing.
- Seal the joint between the two sheathing boards.



Sealant locations for sheathing joints.



Seal sheathing to top and bottom plates and air-tighten drywall at the ceiling.