

Keys to effective wall insulation

Walls are the most complex component of the building envelope to insulate, air seal, and control moisture.

The keys to an effective wall are:

- ❑ Airtight construction –all air leaks sealed in the wall during construction and prior to insulation installation.
- ❑ Moisture control – exterior rain drainage system, continuous air barrier, vapor barrier located on the appropriate side of the wall.
- ❑ Complete insulation coverage– Optimum Value Engineered framing to maximize insulation coverage, no gaps or compressed insulation in cavity insulation, continuous insulated sheathing.

Air sealing

Air sealing reduces convective heat flow and prevents water vapor in the air from entering the wall. In a 100-square-foot wall, one cup of water will diffuse through drywall without a vapor barrier in a year, but 50 cups will enter through a 1/2" round hole. Thus, sealing air leaks is about 50 times as important as installing a vapor barrier.

Moisture control

Air sealing and moisture control make insulation more effective. It is a myth that installing vapor barriers is the most important step for controlling moisture in walls. Most moisture enters walls through either a fluid capillary action or as water vapor through air leaks.

Prevent rain penetration

Causes of rain leaks through exterior walls include improper installation of siding materials; poor quality flashing, weather-stripping, or caulking around joints in the building exterior (such as windows, doors, and bottom plates); and wind-driven rain that penetrates the exterior finish. To enhance protection against rain penetration, create a drainage plane within the wall system of the home.

Vapor barrier placement by geographical location

□ Interior

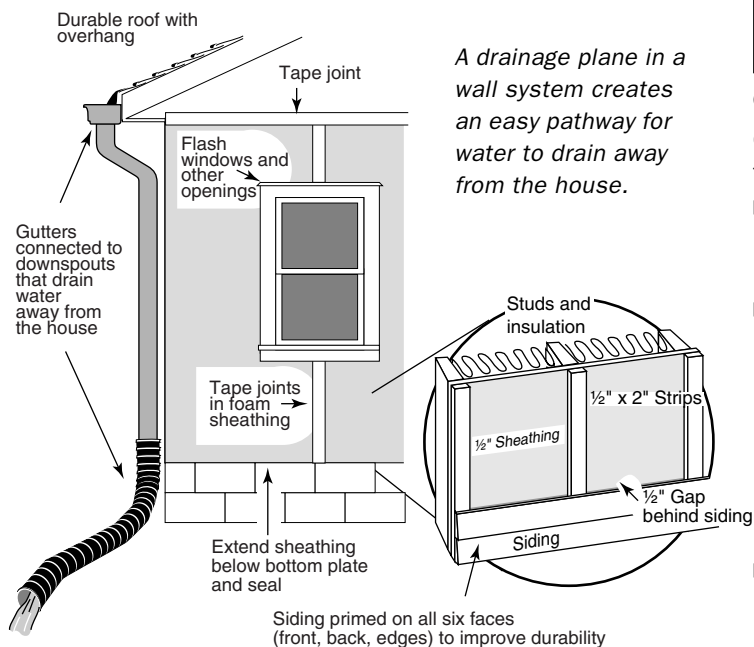
▒ Omit vapor barrier

■ Exterior or no vapor barrier

Perm Ratings of Different Materials

(Rating of 1 or less qualifies as a vapor barrier)

Asphalt-coated paper backing on insulation	0.40
Polyethylene plastic (6 mil)	0.06
Plywood with exterior glue	0.70
Plastic-coated insulated foam sheathing	0.4 to 1.2
Aluminum foil (.35 mil)	0.05
Vapor barrier paint or primer	0.45
Drywall (unpainted)	50
Drywall (painted - latex paint)	2-3



Control moisture in walls

Controlling moisture in all climates involves the following steps:

- ❑ Install a polyethylene ground cover on the earth floor of houses with crawl spaces and slope the earth away from the foundation of all houses.
- ❑ Install a vapor barrier which has a Perm rating of less than one. In most cold climates, vapor barriers should be placed on the interior (warm-in-winter) side of walls. However, the map shows that in some southern climates, the vapor barrier should be omitted, while in hot and humid climates, such as along the Gulf coast and in Florida, the vapor barrier should be placed on the exterior of the wall.
- ❑ Place a termite shield or other vapor impermeable membrane on the top of the foundation wall. This will prevent moisture from wicking into the framed wall from the concrete foundation wall by capillarity.

Wall Framing with O.V.E.

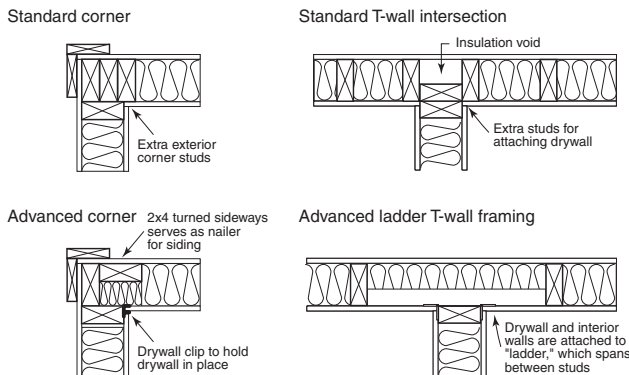
Building experts have performed considerable research on ways to reduce the amount of framing in our homes. The U.S. Forestry Products Association and other organizations have devised a framing system using Optimum Value Engineering (O.V.E.) that reduces unnecessary framing, yet maintains structural integrity. The goals of O.V.E. are to:

- Reduce framing time and lower construction costs
- Save on increasingly scarce dimensional framing lumber
- Increase energy efficiency, thus reducing annual energy costs

Many builders have been resistant to adopt O.V.E. practices due to concerns about compromising structural integrity. With quality installations, the home's framing strength should not be altered by O.V.E. Approaches include:

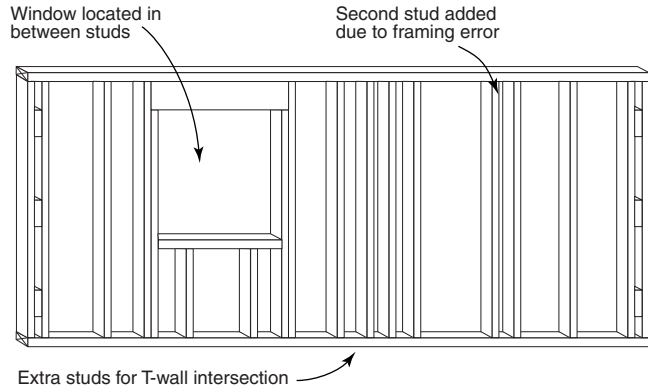
- Less corner framing
- Less framing around partition walls
- More energy-efficient headers
- Eliminating curtailed studs (cripples)
- Using single top plates via point loading

Comparison	Standard	O.V.E.
Insulation Voids	3%	0%
Framing factor	15-25%	10-15%
Batt R-value	R-13	R-13
Sheathing R-value	R-0.5 to 2.0	R-2.5
Effective Average R-value	R-11.1	R-14.6 (30% higher)

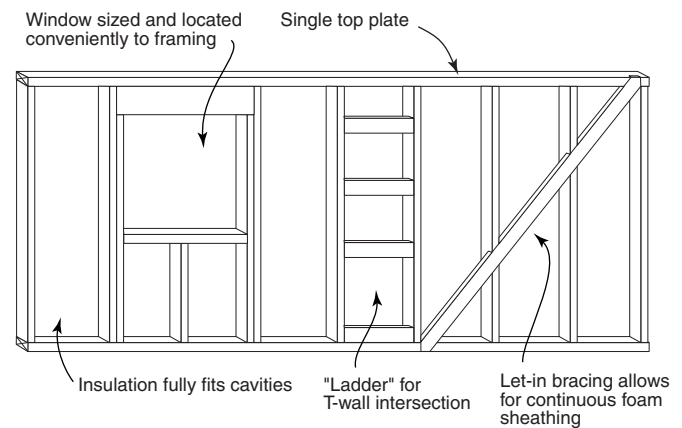


Standard Framing versus O.V.E. framing cross-section - standard method uses unnecessary studs.

Typical standard framing



O.V.E. framing



Standard Framing versus O.V.E. framing

2x6 Wall Construction

Many homes in the United States use 2x6's for construction. In most code jurisdictions, 2x6's can be spaced on 24-inch centers, rather than 16-inch centers used for 2x4's (some locations permit 2x4, 24" O.C.). The advantages of using wider wall framing are:

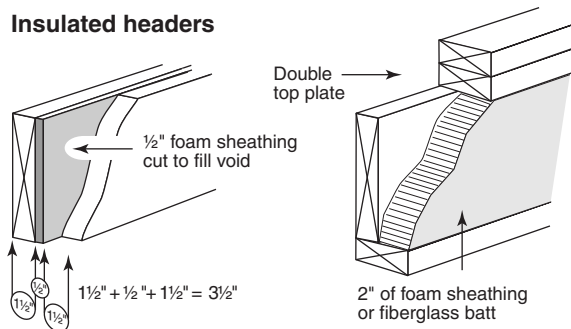
- More space provides room for R-19 or R-21 wall insulation
- Thermal bridging through studs is reduced due to the higher R-value of 2x6's. Plus, overall thermal bridging is reduced due to less stud area in wall
- Less framing reduces labor costs
- There is more space for insulating around piping, wiring, and ductwork

Disadvantages of 2x6 framing include: the interior finish or exterior siding may bow slightly between studs due to the wider spacing; the window and door jambs must be wider and can add \$12 to \$15 per opening; walls with substantial window and door area may require almost as much framing as 2x4 walls and leave relatively little area for actual insulation. Also, adding thicker insulated sheathing may be a less expensive way to increase overall R-value.

Steps for effective wall insulation

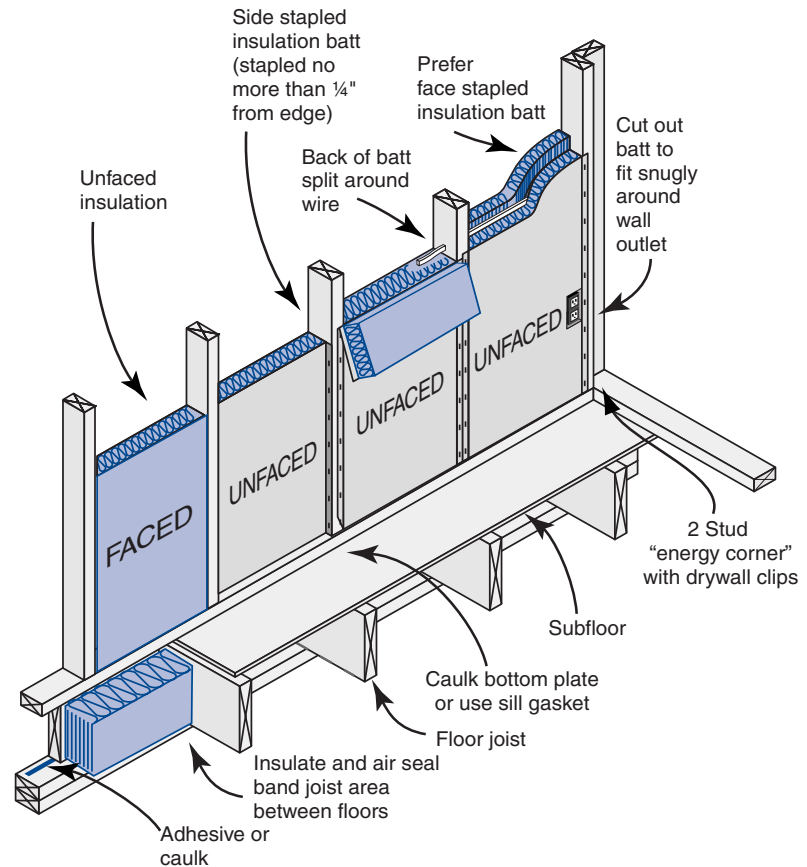
1. Review the plans and specifications and identify all walls between conditioned (heated and cooled) spaces and unconditioned spaces (exterior, attics, crawl spaces, unheated garages, and mechanical rooms). Utilize O.V.E. framing to save energy and dimensional wood lumber.
2. Use diagonal corner bracing (let-in bracing) on exterior walls to substitute for corner plywood sheathing and allow continuous insulated sheathing. Let-in bracing can be 1x4 wood or a metal T-brace.
3. Seal all air leaks in walls before insulating, including under the bottom plate, around windows and doors, band joint area between floors and all electrical, plumbing, and HVAC penetrations.
4. If fixtures such as stairs or shower/tub enclosures cover exterior walls and do not allow easy installation of insulation after the sheathing is attached, insulate behind these components in advance and cover with a weatherproof barrier.
5. Use caulk and backer rod, not insulation, to seal around window and door jambs. Use foam sheathing for insulating headers to reduce framing heat loss.

Insulated headers



6. Face staple batts as side stapling creates channels for air flow and compresses the insulation, thus reducing the R-value. If face stapling is not an option, use unfaced batts or carefully side staple within 1/4" of the stud face.
7. Obtain full coverage of batt, roll, or blown wall insulation. Cut insulation to fit snugly into non-standard stud spaces.
8. Slit the insulation around the back or front side of electrical wiring without compressing or tearing the insulation.
9. Notch out the insulation around electrical boxes, but leave sufficient thickness to insulate behind the box.

Wall insulation details



10. Use R-13 or R-19 batts for insulating areas during framing behind shower/tub enclosures and other hidden areas and use 1/2" drywall, plastic, or other sheet material for sealing behind shower-tub enclosures and other areas that cannot be reached after construction.
11. Once the interior drywall is in place, seal all penetrations with durable caulking.

Miscellaneous materials to have on-hand

In addition to standard framing lumber and fasteners, provide the following materials during construction:

- caulking or foam sealant for sealing areas that may be more difficult to seal later
- Foam sheathing for insulating headers
- 1x4 wood or metal T-bracing for let-in corner bracing
- R-13 or R-19 batts for insulating areas during framing behind enclosures and other hidden areas
- 1/2" drywall or other sheet material for sealing behind shower/tub enclosures and other areas that cannot be reached after construction

The economics of 2x6 wall insulation depend on the number of windows in the wall, since each window opening adds extra studs and requires the purchase of a jamb extender. Walls in which windows and doors occupy 10% or less of the total wall area should use 2x6's in areas with significant winters. However, in walls where windows make up over 10% of the total area, the economics become questionable because of the cost of jamb extenders and the minor improvement in average wall R-value.

Batt Insulation Characteristics		
Thickness (inches)	R-value	Cost (¢/sq.ft.)
3½	11	12-16
3⅝	13	15-20
3½	15 (high density)	34-40
6 to 6¼	19	27-34
5¼	21 (high density)	33-39
8 to 8½	25	37-45
8	30 (high density)	45-49
9½	30 (standard)	39-43
12	38	55-60

This chart is for comparison only. Determine actual thickness, R-value, and cost from manufacturer or local building supply.

What type of insulation should I use?

The home designer has an increasing array of insulation products from which to choose to insulate wood-framed walls. The wide variety of insulation materials often makes it difficult to determine which products and techniques are the most cost effective. Refer to the Model Energy Code (MEC) for R-value recommendations.

- ❑ *Fiberglass and rock wool batts.* 2x4 walls can use R-13 or R-15 batts; 2x6 walls use R-19 or R-21 products. Generally, batt insulation is the least expensive, but requires careful inspection to ensure it has been installed effectively.
- ❑ *Cellulose insulation,* made from recycled newsprint, comes primarily in loose-fill form. It can be installed in walls via a dry-pack process and a moist-spray technique. It generally costs more than batt insulation, but offers reduced air leakage through the wall cavity plus improved sound deadening.
- ❑ *Fiberglass and rock wool loose-fill insulation* provide full coverage with a "Blow-in Blanket" System (BIBS) which involves blowing insulation into open stud cavities behind a net.
- ❑ *Rigid foam insulation* has a higher R-value per inch than fiberglass or cellulose and stops air leaks, but is considerably more expensive. It is manufactured in sheet good dimensions and is often used as the outer layer of insulation.

- ❑ *Icynene foam* can be blown into walls and has an environmental benefit - it is manufactured using carbon dioxide rather than more polluting gases such as pentane or hydro-chloro-fluoro carbons like other foams.

Wall Sheathings

Some builders use ½-inch wood sheathing (R-0.6) or asphalt-impregnated sheathing, usually called blackboard (R-1.3), to cover the exterior framing before installing siding. Instead, use ½-inch expanded polystyrene (R-2), extruded polystyrene (R-2.5 to 3), or polyisocyanurate (R-3.4 to 3.6) foam insulated sheathing. Sheathing thicker than ½" will yield higher R-values.

Advantages of foam sheathing over wood or blackboard include:

- ❑ Energy savings and improved thermal comfort by providing a continuous layer of insulation - reduces framing shortcomings
- ❑ Easier to cut and install
- ❑ Protects against condensation by keeping the interior of the wall warmer
- ❑ Usually costs less than plywood

Ensure that the sheathing completely covers, and is sealed to, the top plate and band joist at the floor. Most sheathing products come in 9 or 10-foot lengths to allow complete coverage of the wall. Once it is installed, patch all holes, penetrations, and seams with caulk or housewrap tape. See Airsealing Energy Bulletin.

Because of its insulation advantages over plywood and oriented strand board (OSB), foam sheathing is best when used continuously in combination with let-in bracing, which provides structural support offered by plywood or OSB. Some builders use two layers of sheathing - plywood or OSB for structure and support, and foam for insulation. When the total depth of the sheathing material exceeds ½ inch, make certain the window and door jambs are adjusted for the total wall thickness.

Let-In Bracing Opportunities for Wall Framing

