Industrial Revolution

Every home makes compromises among different and often competing goals: comfort, convenience, durability, energy consumption, maintenance, construction costs, appearance, strength, community acceptance, and resale value. Often consumers and developers making the tradeoffs among these goals do so with incomplete information, increasing the risks and slowing the adoption of innovative products and processes. This slow diffusion negatively affects productivity, quality, performance, and value. This department of Cityscape *presents, in graphic form, a few promising technological improvements to the U.S. housing stock. If you have an idea for a future department feature, please send your diagram or photograph, along with a few, well-chosen words, to dana.b.bres@hud.gov.*

Framing for Strength and Efficiency

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Abstract

Typical construction for a single-family home uses lumber to create a light-wood frame, commonly called "stick framing." This construction method can be refined to consume less material, cost less, and provide greater energy efficiency through the application of concepts collectively called Optimum Value Engineering (OVE). OVE techniques identify inefficiencies in the design and framing of a home, yielding a project that provides the necessary strength and performance more affordably.

The Status Quo

Most conventional home construction relies on the use of dimensional lumber, generally 2 x 4s or 2 x 6s that provide the frame for a house on the job site. Often called light-wood framing (in contrast to timber framing, which uses heavier timbers), the design relies on the prescriptive (using established design requirements) provisions of the building code. Some disadvantages of the current approach include the following:

- Materials costs increase because light-wood framing uses lumber that does not contribute to the strength of the home.

- Insulating the home for energy efficiency is more difficult because the wood is not as good an insulator as the insulation used and excess wood may actually make insulation more difficult.
- Labor costs are higher because light-wood framing uses more lumber than optimized framing methods would.

Traditional residential framing methods suggest the use of 2-x-4 lumber installed every 16 inches for wall panels, regardless of whether the wall is load bearing, transferring the load of upper floors or the roof, or is nonload bearing.

Optimum Value Engineering

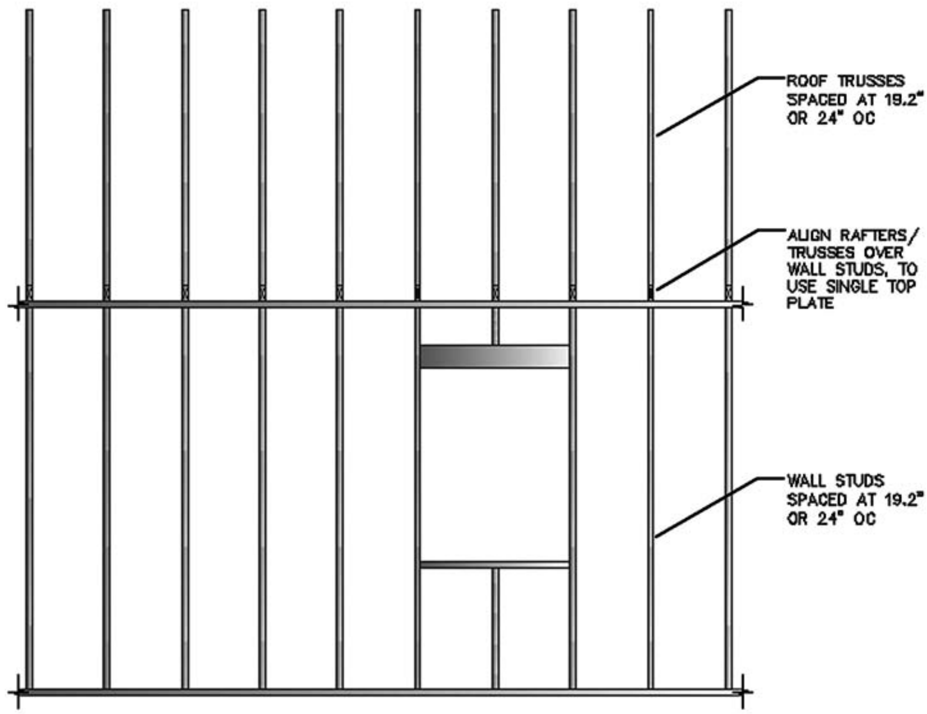
Framing using engineering principles can improve performance and save money. This framing concept, called Optimum Value Engineering (OVE), is a design and construction process that installs lumber where it is needed and omits lumber that does not contribute to the structural strength of the home. Although the term suggests that engineering is required, OVE framing is more of a process that follows the load path, or the route building loads follow when going from the roof to the foundation. When load paths are not considered, builders may use additional lumber (at additional cost) that provides little or no benefit. Load paths must be continuous for the structure to be effective, where a load in one framing member is cleanly transferred to another member.

OVE techniques can result in lower material and labor costs and improved energy performance for the building. Although OVE processes can be applied comprehensively in a home, many OVE elements can be used independently, depending on a project's specific needs. OVE can include the following:

- **Increasing stud spacing.** Studs, or the vertical members of walls, are typically spaced every 16 inches (generally called 16 inches on center, or 16" OC). Increasing the spacing of the studs to 19.2 or 24 inches on center decreases the amount of lumber needed while still allowing for easy attachment of the drywall on the interior or sheathing on the exterior. (Spacing studs at 16 inches means an 8-foot-long piece of sheathing is attached to seven studs when the sheathing is installed horizontally. At 19.2-inch spacing, the number of studs is reduced to six and, at 24-inch spacing, the number is just five studs.) Framing with studs at 16 inches on center requires additional lumber, which must be purchased and installed, and typically provides no structural benefit to the home.
- **Eliminating double top plates.** Conventionally framed walls consist of a horizontal bottom plate attached to the studs, the vertical studs, and a double horizontal top plate fastened on top of the studs. An OVE approach allows the double top plate to be changed to a single top plate by ensuring the studs or rafters above are directly aligned with the studs located above to provide a continuous load path. If one places a rafter in the center of a stud bay (the area between two studs) rather than directly above the studs, there is little strength to resist vertical loads from the roof. Exhibit 1 shows a wall with a single top plate and the rafters aligned directly over the studs in the wall.

Exhibit 1

Rafters Aligned Over Studs Use a Single Top Plate and Provide Structural Strength



OC = on center.

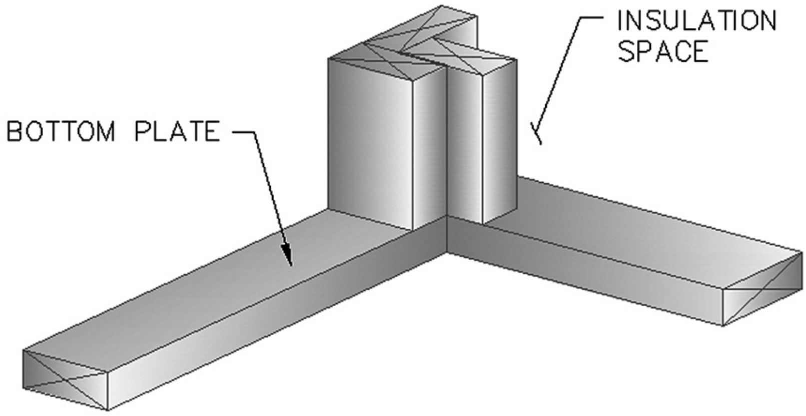
- **Reducing members used for corner framing.** In the past, corners were often framed with as many as four studs. This technique was generally done not for strength but to allow the interior drywall to be fastened easily. Using OVE framing techniques, the corner can be reduced to three or two studs without any decrease in building strength. Exhibit 2 shows a three-stud corner.

- **Eliminating headers or reducing header sizing.** Often, builders may install unnecessary or oversized headers over doors and windows to simplify the construction process by doing the construction only a single way (that is, using a single design approach in all cases to avoid confusion). In nonload-bearing walls, however, headers may not be required or they may be reduced in size.

Although the initial benefit of OVE framing techniques may be considered as decreasing the construction costs for materials and labor, these framing techniques also yield a two-fold energy benefit. The first benefit is increased opportunities to insulate the house and the second is the opportunity to reduce the energy losses associated with lumber. With an insulation value of R 1.25 per inch, lumber is not as good an insulator as any of the commonly used fiberglass or foam insulation materials (with R-values ranging from R 3.3 per inch for fiberglass to R 5 to 6 per inch for many types of foam).

Exhibit 2

A Three-Stud Corner Reduces the Amount of Lumber Without Decreasing Structural Strength



In the case of a 2-x-4 wall, changing from 16-inch OC framing with a double top plate to 24-inch stud spacing with a single top plate reduces the amount of the wall that is wood (and therefore uninsulated) from 13.8 to 9.8 percent. In a 4-x-8-foot section of wall (that is covered by a sheet of drywall), that means 186 square inches of wall that can now be better insulated. The lumber savings are also significant. Continuing the example described previously, the lumber required for a 4-x-8-foot section of wall is reduced by 11 feet, which amounts to about $3 worth of lumber.

Some walls will continue to require additional framing as specified by the building code or designers to accommodate seismic, wind loading, or other environmental requirements.

Training

Because framing carpenters may be unfamiliar with many of the techniques for OVE framing, crews may require training and additional supervision until mastery is achieved. After the carpenters learn the techniques, however, framing will be faster and less expensive.

Sources

ToolBase TechSpecs: Advanced Framing Techniques at http://www.toolbase.org/pdf/techinv/oveadvancedframingtechniques_techspec.pdf.

Consult the International Residential Code for specific framing requirements.

Author

Dana Bres is a research engineer at the U.S. Department of Housing and Urban Development, Office of Policy Development and Research.