

TOOLBASE™ TECHSPECS

Cold-Formed Steel Framing

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TECH @ A GLANCE

BENEFITS (+) / DRAWBACKS (-)

- + ENVIRONMENTAL PERFORMANCE:** According to the 2006 U.S. Geological Survey, the 2006 combined average post-consumer recycled content of steel manufactured in the U.S. was 50.8%. Steel is 100% recyclable and the most recycled material in the world.
- + DURABILITY:** Steel has a proven track record in commercial construction, transportation structures, and vehicles. Steel is fire, rot, and termite resistant. Steel is not susceptible to insect infestation nor will it support mold growth; material characteristics that can mitigate risk for all users. Studies indicate that zinc galvanized cold-formed steel has a 200 year life span.
- = AFFORDABILITY:** Initial cost is higher than conventional wood framing materials. Costs can be partially offset by greater design capability, and performance in extreme conditions and climates. Because steel is 100% recyclable, jobsite trash handling and hauling costs may be lower. Building with fire resistive materials, like cold-formed steel, can net builders 25% or more savings on Builder's Risk premiums through commercial insurers like Zurich. Allstate offers 10% premium discounts for policies covering homes of fire-resistant construction.
- ENERGY EFFICIENCY:** Because steel is more thermally conductive than wood, construction details such as exterior rigid foam insulation are often necessary to prevent "thermal bridges" across the studs.

INITIAL COST

Cost comparison studies have shown that the net effect of framing with steel can be as little as a 3% cost increase per house.

OPERATIONAL COST

Operational costs associated with space conditioning will be similar when rigid foam is installed as a thermal break and 24 inch-on-center spacing is employed. The cost of insurance may decrease with fire-resistant construction.

WARRANTY PERFORMANCE

Steel-framed homes can be enrolled in the same homebuilder warranty programs as wood-framed homes. The consistency and dimensional stability of steel members as well as the strength of screw connections may minimize call backs due to poor wall surface irregularities like cracks and nail pops.



THE BASICS

Steel has a proven track record in a number of industries from automobile and railroad manufacturing to bridge and commercial construction. Over the past two decades, cold-formed steel has seen increased usage as the structural frame for residential and multi-story commercial buildings due to inherent features that overcome the downsides of conventional products. Rigorous building environs, like Hawaii and California have seen the largest increase in residential steel framing where earthquakes, high winds, termites and brush fires wreak havoc on less-durable materials. Steel is:

- **Code Compliant.** Cold-formed steel (CFS) framing can be used prescriptively in single and multi-family structures. The specifications for cold-formed steel, span tables and prescriptive use methods are contained in the International Residential Code (IRC), sections *R505 Steel Floor Framing*, *R603 Steel Wall Framing* and *R804 Steel Roof Framing*.
- **Consistent In Quality.** Steel is manufactured to strict tolerances, dimensionally stable in all climates and does not contain knots, twists, or warps.
- **Light Weight.** Steel members weigh less than conventional lumber, reducing total building loads, transportation and storage costs and worker fatigue.
- **Resistant to Termites and Pests.** Cold-formed steel members are impervious to termites and cellulose-eating insects.
- **Noncombustible.** Steel does not burn and can be designed to meet multi-family fire rating requirements in the building codes.
- **Framed In-line.** Cold-formed steel frame assemblies do not usually include structural top plates. Joists, studs, and roof members are installed in-line for continuous load transfer from roof to footing. When 24" spacing is specified,

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DOLLARS AND SENSE

A real-world example of the cost differences between wood and steel framing.

Location: Valparaiso, IN Frame Start: Dec. 1999 Finished Sq. Ft. 2,259	Wood	Steel	Cost differences
Material Cost	\$16,178.00	\$13,836.00	-14.5%
Total House Hard Cost	\$78,208.00	\$80,835.00	+3.4%
Rough Frame Labor (hrs.) ^A	267.9	293.0	+9.4%

^ARigid foam board was applied to the exterior of the steel structure. The foam required 17.64 additional labor hours and \$706 in materials (included in these totals).



FOOD FOR THOUGHT

This section provides some things to think about before switching to this building technology – make sure it's the right choice for you.

- Cold-formed steel framing will be most successful in designs and projects where its use resolves multiple challenges – for instance, a home in a high wind speed zone and hot-humid climate with heavy termite infestation probability.
- In-line framing requires the framers' full attention to plans and layout. An accurate bill of materials, pre-planning, and precision are required.
- Steel designs should include details to minimize thermal conductivity like rigid foam sheathing board and full size (24") insulation batts.
- Some builders advocate starting with one assembly, such as the floor joists, in steel and working up to framing the whole structure with CFS. Others successfully converted to steel framing with pre-fabricated systems – wall panels, floor decks, and trusses.
- All trades will be required to modify their practices. Engage the trades in project planning from the start.
- Steel integrates easily with many alternative building materials such as structural insulated panels (SIPs), insulated concrete forms (ICFs) and formed concrete walls. Resource materials detailing connections to these and other materials are available at www.toolbase.org/steelframing.

TECH CHECK

Below is a checklist of steps to follow in order to implement this technology in each of your projects.

- To reduce waste and streamline the project, work with designs that are based on 4-foot modules and space studs at 24 inches-on-center.
- Include panel layout drawings on architectural plans to simplify lining up joists, studs, and roof rafters.
- Work with a supplier that will furnish exact lengths of stud, joist and rafter material. Or work with a wall panel, floor assembly and truss fabricator that will also provide the installation team.
- Include a steel veteran on the team – on-site technical representative (panelized approach) or framing crew lead person.
- Encourage trades people to purchase, use and maintain the right tools and fasteners for the job.
- Encourage trades persons using steel for the first time to experiment with fasteners and equipment before beginning the job. As the trades become more familiar with steel framing tools and techniques (usually within three to five houses), the time spent operating or adjusting equipment or reworking a job should become insignificant and a reasonable pace should become established.
- Enforce safety – gloves and glasses should be worn at all times when working with steel.
- Streamline the job, by fostering training and education. Keep current, as the CFS marketplace is continually evolving.

MAKING THE SWITCH

What is required to transition from your current building practices to using this technology?

Design. Finished cold-formed steel homes will be indiscernible from all of the other homes on the block as seen from the curb because the framing material doesn't affect the architectural style. The greater span capability of steel allows designs to incorporate larger interior open spaces and dramatic architectural features.

Architectural plans should be amended to include the cold-formed steel structural details that satisfy the design requirements, like member size and header size and configuration. Plan approval and site inspections should follow the same protocol as conventional houses, but it is always good practice to have a conversation with your local building department before you start.

Structurally, CFS designs that follow the IRC will have all members, from foundation to roof, installed with a continuous load path or in-line framed. In cold climates a continuous thermal barrier, usually ½" to 1" of rigid foam board, is applied to the exterior.

Training. Gaining cold-formed steel framing experience on the job is possible with homework and prior planning. Some builders introduce steel members on a small scale initially and work up to a complete steel framing package as successive houses are built. Using steel studs for interior walls or floor joists is a good way to gain experience with the material. The Steel Framing (SFA) Alliance's [How to Build Interior Walls with Steel](#) provides guidance; numerous manuals developed by the [SFA and the NAHB Research Center for PATH](#) are also available. A National Training Curriculum that covers steel framing and the [sub trades has been developed by SFA for trade instruction](#) through community vocational/technical colleges across the country. The

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Association of the Wall and Ceiling Industry (AWCI) and the SFA developed [Steel Doing It Right](#), a steel framing seminar that is offered at different locations across the country.

Using panelized walls and floors is another way to start working with cold-formed steel. Factory fabricated wall panels minimize the site labor required to layout structural members and make connections while subcontractors become familiar with the material. Panel suppliers will provide engineering and technical assistance.

Tools. Steel framers use variable speed screw guns instead of hammers and nail guns and chop (miter) saws or aviation snips along with circular saws with steel cutting blades. As framers develop their steel skills, they may want to add pneumatic guns to their tool set for sheathing attachment to steel. Pins (nails) used to make cold-formed steel connections have a hardened, knurled or ridged shank designed to penetrate the steel and then hold tightly. The pneumatic equipment can be used with either framing method. Pneumatic nail guns that can fire knurled pins for cold-formed steel framing require similar capital investment as those for wood.

Fasteners. Steel shapes are hollow so most steel to steel connections are made with screws. Screws are intrinsically more resistant to the dynamic forces caused by unpredictable movements than nails are. Nails and pins, however, are easier to install. Overcoming the CFS learning curve involves using the right screw gun, learning an ergonomic hold of the gun and correct screw selection for each application.

Drywall and finish trades will also use screws or knurled pins to install their specialties. Appropriate screw size and style may vary on interior versus exterior walls, which are often specified as different thicknesses of steel.

Grommets and Pipe Isolators. Because studs and joists are manufactured with pre-punched holes (called punchouts) for routing pipe and wire, service trades may find rough-ins in steel-framed homes faster than those where the utility path has to be drilled through wood. Pipes and wire are isolated from steel contact by accessories like grommets and pipe isolators that snap into position in the punchouts. Grommets and isolators are required by the building codes to keep the sharp edges of the steel punchout from cutting plastic pipe (CPVC or PEX) or a wire sheath. Copper pipe will corrode when in direct contact with galvanized steel so isolators and pipe clamps are designed to separate the metals from contact. A hole punch or hole saw can be used to create a hole if a factory punchout is not in the required location. Typically, wire ties, utility boxes, and pipe clamps or standoffs are secured to the frame with screws.

THE BASICS *continued*

members are typically aligned and the style is recognized as [advanced framing techniques](#) or best use of resources.

- **Thermally Conductive.** According to [RESCheck](#), a software program that assists in evaluating residential structures for compliance with energy codes, the thermal resistance of a steel-framed wall assembly is between 3% and 9%

lower than that of a wood-framed wall. In colder climates, where rigid foam exterior sheathing is specified for both types of construction, the thermal resistance of a steel-framed home is closer to that of wood.

SPECIFYING STEEL COMPONENTS

Shape. Cold-formed steel comes in a variety of sizes and shapes. Some are equivalent to dimensional lumber with greater span capability. The acronym STUF-L covers the common steel shapes - stud, track, U-channel, furring, and L-header. Stud and track shapes are used for walls, joists and rafters. In a typical layout, studs are aligned between a top and bottom track to make vertical walls, much like conventional framing. Joists and rafters usually have webs of a larger dimension than studs and are, likewise, rimmed with track material. U-channel can serve as bridging material, backing for intersecting walls and an attachment surface for cabinets, or “nailer.” Furring channel, or “hat” channel, may be used to brace walls or as a component in sound-attenuating assemblies. Headers can be constructed with joist material or L-Header material, dependent on load condition. In some engineered designs, L-Headers can be used to provide a structural top plate.



Thickness. Steel thickness is expressed as “mils” or thousands of an inch. When designs are calculated according to prescriptive methods in the IRC, structural components will be a minimum of 33 mils in thickness (roughly, 1/32”). Non-load bearing components can be specified of lesser thicknesses, but are often upgraded to the minimum structural requirement for ease of handling during assembly and to prevent the possibility of mistakenly incorporating them in a bearing assembly.

Size. Studs and track are sized by web and flange dimension in a manner equivalent to conventional lumber, but denoted in hundredths of inches. Each piece of CFS is marked thickness, yield strength, coating, and manufacturer identification every 96 inches on the member. Thus, a replacement for a 2x4 stud might be specified as 350S162-33 (3 1/2” stud with 1 5/8” flange of 33 mils.)

Corrosion Resistance. Cold-formed steel members used in construction are galvanized to resist corrosion. The zinc coating makes steel capable of withstanding humidity, wetting and drying, and other aggressive conditions without deterioration. CFS structural members are manufactured with a G60 coating and non-structural a G40.



Stud or Joist



Track



U-Channel



Furring Channel



L-Header

RESULTS FROM THE FIELD

This technology has been used by other builders in real-world building situations – learn from their experiences.

Beaufort Demonstration Homes, SC

- Two side-by-side homes of 1,428 sq. ft.; one framed with lumber and the other with cold-formed steel.
- The cost of the steel framed home was 14.2% more than the wood home.
- Framers' labor hours for the steel-framed home were 4.3% higher than the wood home
- The steel interior non-load bearing walls were cost competitive with wood.

Davis, Maryland and Hopke, Missouri

- Comparison of actual labor time and construction cost of two floor assemblies - wood and steel.
- Net steel floor assembly savings of 8% on a framer's first cold-formed steel effort.
- Wood floor required less labor.

DEFINITIONS

Furring Channel

A cold-formed steel shape that are primarily used like shims between a finish material and structural members. Hat channel and resilient channel are furring channels.

Grommet

An accessory used in steel frames to finish the edges of factory punchouts in studs and joists so that wire and pipe will not be damaged. Insulators and isolators are similar accessories.

In-Line Framing

A framing style whereby all structural members are aligned vertically to transfer loads continuously to the foundation. In-line frames will have floor joists, wall studs, roof joists and rafters stacked atop each other and at the same spacing from member to member.

Knurled Pin

A fastener used to attach sheathing and finish materials (drywall and trim) to cold-formed steel frames that is seated with a pneumatic gun. Some pins are designed for making steel to steel connections.

L-Header

An angle-shaped piece of sheet steel that can be used as a structural member to transfer loads over door and window openings. L-headers can be used prescriptively in pairs whereby one angle is installed on each side of a wall.

Mils

Thousandths of an inch; a measure of the thickness of cold-formed steel.

Track

The steel shape that is used as the top or bottom plate of steel studs, as well as, the rim (band) board for joists and rafters.



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RESOURCES

ToolBase Services

Information on this building technology and many others brought to you by PATH and the building scientists at the NAHB Research Center.

www.toolbase.org/steelframing

Steel Framing Alliance

Offers many resources, manuals, education opportunities, and more about steel framing.

www.steelframing.org

Guide to Fire and Acoustic Data for Steel Floor and Wall Assemblies, available for purchase at:

www.steelframing.org/PDF/Fire_Acoustics/SFAGuideVersion6-October12-06.pdf

Standard For Cold-Formed Steel Framing – Prescriptive Method For One And Two Family Dwellings, 2001 Edition With Supplement 2, available for purchase at:

store.steelframingalliancestore.com/prmeforonean.html

Thermal Design of Cold-Formed Steel Exterior Walls, available for purchase at:

store.steelframingalliancestore.com/thdeofcostex.html

PATH

PATH addresses barriers to innovation, provides information on advanced building technologies, and advances housing technology research; making affordable, quality American homes a reality. For more information on the PATH program, visit www.pathnet.org

Hybrid Wood and Steel Details – Builder's Guide

www.pathnet.org/sp.asp?id=10230

Canadian Sheet Steel Building Institute

www.cssbi.ca

Light Weight Steel Framing House Construction Handbook

www.cssbi.ca/Eng/Residential-SSJ.html

Steel Stud Manufacturers Assoc. (SSMA)

www.ssma.com

