A BUILDER'S GUIDE TO
STEEL FRAME CONSTRUCTION

Steel Framing Guide

steelframing.org

Steel Framing Alliance™

Steel. The Better Builder.

STEEL FRAMING GUIDE

AN EASY-TO-USE GUIDE FOR STE

Introduction

Steel framing is a practical, code approved solution to many of the limitations that builders face today when using traditional building materials.

The strength and ductility of structural cold-formed steel (CFS) framing, along with the holding power of CFS connections, make it the ideal material for construction in high wind speed and seismic zones such as the U. S. eastern seaboard, the Gulf Coast states, California and Hawaii. Characteristics such as non-combustibility, termite resistance, and dimensional stability can lower construction and home ownership costs. CFS can provide the framework for a solid sustainable building program. Each piece of CFS shipped to the jobsite contains a minimum of 25% recycled content and is 100% recyclable at the end of its lifespan. And a recent study, conducted by the NAHB Research Center, showed that the zinc coating on steel framing materials can protect against corrosion for hundreds of years.

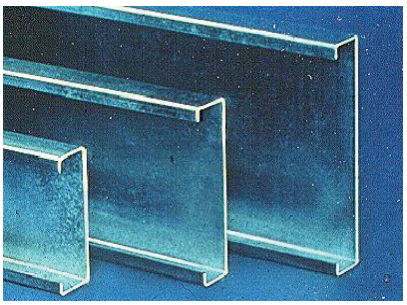
For these reasons, and many others, the use of steel framing continues to grow every year with more than 40% of commercial structures now using steel framing and with nearly 500,000 homes built with steel framing over the past decade.

This Builder's Guide answers the most commonly asked questions regarding CFS and describes the fundamental process for converting to steel framing. In addition, this document provides a guide to where more detailed knowledge or resources are available.

Builder FAQ's

1 one

WHAT IS COLD-FORMED STEEL FRAMING?



Cold-formed steel framing is sheet steel that is formed into shapes and sizes that are similar to what builders are accustomed to seeing in dimensional lumber (2x4, 2x6, 2x8, 2x10, 2x12, and so forth). Steel framing members are formed in a process called roll forming by passing sheet steel through a series of rollers to form the bends that make the shape, e.g. the web, flanges, and lips of a stud or C-shape. Because this process is done without heat (also called "cold forming") the studs and joists are made stronger than the original sheet steel.

2 two

WHY SHOULD I CONSIDER BUILDING WITH COLD-FORMED STEEL FRAMING?

Steel framing can **lower construction costs**.

- Warranty call-backs are minimized because steel does not shrink, split, or warp. As a result, there are no nail pops or drywall cracks to fix after the structure is completed.

- Consistent quality means that scrap is drastically reduced (2% for steel versus 20% for wood). These savings also translate into lower costs for jobsite culling of wood materials and haul off and disposal of discarded material.
- Discounts on builders risk insurance for steel framed structures can result in significant cost savings for builders.

Steel framing is **easier to handle** because steel studs weigh 1/3 less than wood studs, and can be installed at 24" on center.

Steel framing **offers marketing advantages** because consumers recognize steel as a superior framing product for its fundamental characteristics:

- Long term maintenance costs are reduced because steel is resistant to rot, mold, termite and insect infestation.
- Good indoor air quality (IAQ) is promoted because steel does not emit volatile organic compounds (VOCs).
- Steel is "Green" because it contains a minimum of 25% recycled steel and is 100% recyclable.
- Steel framing has proven performance in high wind and seismic zones.

The non-combustibility of steel allows a significant density increase in commercial and multi-family structures, offering building owners with the **potential for higher revenue.**

3 three

HOW MUCH WILL COLD-FORMED STEEL FRAMING COST COMPARED TO WOOD FRAMING?

The method of construction, stick framing or panelization, and type of project will have a direct bearing on the cost of the steel frame system.

Stick Framing

"Stick framing" is the method most commonly used to build wood framed homes today, and involves assembling the floors and walls using individual studs and joists on the construction site. This method often requires extensive cutting of individual framing members, and requires a fairly high level of skill of framers who must know how to assemble the elements within the house.

Framing and trusses represent approximately 20% of the total cost of the house construction. If the conventional "stick framing" method of construction is used, steel framing can add 3% to the total cost of a house. When only the framing system is considered, studies have shown that a stick-framed steel system can cost 15% more than wood framing. However there are a number of savings that builders realize when they use steel framing[1], including;

- Warranty callbacks associated with the seasonal movement of framing members are virtually eliminated ($400)
- Save on waste haul off ($210)
- Insurance savings ($60)
- Site culling of wood framing ($100)

Panelization

Panelization, or assembling the components of the house (walls, floors, roofs) in a controlled manufacturing environment, is increasingly being used in home building today. Steel framing is particularly suited for panelization because it is precision manufactured to meet exacting tolerances, and its light weight allows for easier handling of assembled components. Panels are typically shipped unsheathed which, when combined with the light weight of cold-formed steel, allows

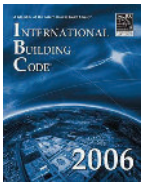
[1] Numbers have been interpolated for a 2,800 square foot home with a sale price of $373,300 from NAHB statistics. Insurance information from a Zurich brochure 2004.

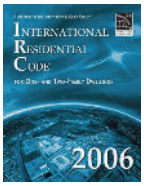
CFS fabricators to service a large distribution area. The capability of delivering product to a large market allows fabricators to recognize economies of scale that keep CFS panel costs in check.

The component (panels) approach will speed construction and reduce the number of skilled framers that are required on site. **As a result, steel framing can cost the same or less than wood framing in many parts of the country.**

4 four
HOW DOES THE DESIGN PROCESS WORK?

Comprehensive provisions for steel framing are found in the International Code Council's (ICC) International Building Code (IBC) and International Residential Code (IRC), which are recognized as the governing building codes by most building departments in the United States. (See Resources for the ICC website that provides an overview of code adoption across the United States.) The building codes also reference a series of Standards that have been developed by the American Iron & Steel Institute (AISI) to provide additional information for the design of steel structures. (See Standards for Cold-Formed Steel Framing table.)





Residential Conventional Construction

Builders can design one- and two-story structures without the support of an engineer by using the American Iron and Steel Institute's *Prescriptive Method*, one of the AISI standards referenced by the building codes. The Prescriptive Method provides load and span tables, fastener requirements, etc. in a "cookbook" format similar to what is available for wood framing design. The Prescriptive Method and other design standards can be purchased from the Online Store on the Steel Framing Alliance's website (www.steelframing.org).

Standards for Cold-Formed Steel Framing

AISI Standard	Title	IRC Code Section
	Standard for Cold-Formed Steel Framing – Prescriptive Method for One and Two Family Dwellings	R301.1.1, R301.2.1.1(4), R301.2.2.4.1, R301.2.2.4.5
Wall Design		R603
Joist Design		R505
Rafter Design		R804
Header Design	Standard for Cold-Formed Steel Framing – Header Design	R603.6
Truss Design	Standard for Cold-Formed Steel Framing – Truss Design	R804.1.3

Should the structure go beyond simple design or the applicability limits of the *Prescriptive Method*, a qualified engineer will be needed to develop or complete the structural design. This is also true for certain states, like California, as well as other jurisdictions, where prescriptive design is not allowed. Fortunately, the number of professional engineers who have experience with steel framing has grown exponentially over the last decade and the Cold-Formed Steel Engineers Institute (CFSEI) has an on-line member database (www.cfsei.org).

Pre-fabricated Systems

Walls, floor panels and roof trusses of CFS that are built in a factory will require engineered drawings and layouts for building code approval, just like any other pre-manufactured structural component. Panel and truss manufacturers are staffed to provide engineered designs, based on the builder's architectural drawings, along with the components and jobsite delivery. Some manufacturers can offer a "turn-key" solution to builders with the inclusion of product installation by trained crews.

Non-residential Construction

Commercial designs will require an engineer's review and seal regardless of material of construction.

5 five

HOW DOES THE PLAN CHECK AND BUILDING INSPECTION PROCESS WORK?

One of the first steps in implementing any project should be a conversation with the local building department. This is the best way to uncover the particulars that relate to your project and building code jurisdiction.

The plan check process is similar to what is encountered for other structural systems:

1. The reviewer will verify that all specifications are accurate and that they match local code requirements.
2. Architectural drawings are checked to ensure that wall types are correctly marked, fire-rated assemblies, if required are shown, details are provided for key connections, and mechanical, electrical and plumbing drawings are coordinated with the structural drawings.
3. Structural drawings will be reviewed for consistency with the architectural drawings, and to ensure that specific system detailing for items like components and trusses, are provided.

Progress inspections by the building department are required at the same stages of completion as structures built with any other building materials.

The Steel Framing Alliance (SFA) has provided training to thousands of building plan reviewers and inspectors across the United States. Training seminars for state and municipal building departments, builders, and trades persons, as well as, vocational/technical school curriculum development are some of the on-going activities sponsored by the SFA.

6 six

HOW DO I ORDER STEEL FRAMING?

The process for ordering steel framing materials will differ greatly according to the type of construction method that will be used.

Conventional Framing

Although some large builders order steel directly from the stud manufacturers, cold-formed steel is typically supplied by a regional distributor. Steel distributors include traditional lumber yards and gypsum board supply warehouses. The SFA's membership includes some of the major manufacturers of cold-formed steel in North America which can be identified through the Member Directory found on the SFA website (www.steelframing.org). Many manufacturers will provide a link to distributors and a technical service contact on their website. Please visit the Steel Stud Manufacturer's Association website for further information (www.ssma.com).

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In addition, manufacturers of proprietary products (which often consist of non-generic steel shapes) will work directly with the builder to develop a framing package.

Specifying:

When ordering steel framing materials, it's important to be aware of the variety and applications of the various shapes, encapsulated by the acronym **STUFL**.

These letters stand for **S**tud, **T**rack, **U** channel, **F**urring, and **L**-header, pictured at the bottom of the page.

A **stud** includes wall studs, joists and rafters because they are all of the same shape.
Track is the top and bottom "plates" of a steel wall or the rim of floors and rafters.
U-channel can be used for bridging, blocking and customized for cabinet backing.
Furring channel is used as purlins, bridging, backing, and for subassembly sound separation.
L-headers are brake-metal shaped members that can be doubled and used as headers.

Cold-formed steel is specified by a universal designator system called out by web dimension, shape, flange dimension and thickness. Web and flange sizes are expressed in 1/100ths of an inch and thickness is expressed in 1/1000ths of an inch, or "mils".

Typical Wood and Steel Dimensions

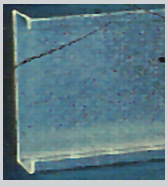
Wood	Steel	Web Depth	Flange Size	Thickness
				(mils)
2 x 4	350S162-43	3 ½"	1 ⅝"	43
2 x 6	600S162-43	6"	1 ⅝"	43
2 x 8	800S162-43	8"	1 ⅝"	43
2 x 10	1000S162-43	10"	1 ⅝"	43

Material Cut Lists:

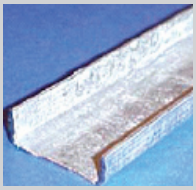
Distributors may not be staffed to develop cut lists or provide quantity take offs for steel framed jobs. Details on how to raise material cut lists can be found in the SFA's *National Training Curriculum* and in *Steel Framed House Construction*, a publication of the Craftsman Book Company.

Pre-fabricated System Suppliers

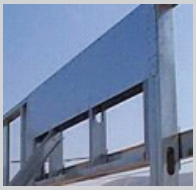
Some builders have found that ordering factory fabricated steel wall panels and trusses is an ideal way to move into steel framing because it minimizes the need for highly skilled framers on site and provides access to experienced design and layout professionals. Typically, the builder simply provides the panel or system manufacturer with architectural drawings and they do the rest. There are numerous CFS panel manufacturers across the country that can be located by using SFA's online Member Directory (www.steelframing.org).


Stud or joist

Track


U-channel

Furring channel


L-header

7 seven

WHAT ARE THE DIFFERENCES IN CONSTRUCTION DETAILS BETWEEN CFS AND WOOD?

- Steel framing is usually spaced at 24” O.C. and wood framing is typically spaced at 16” O.C.

- C section studs replace wood studs and single tracks replace top and bottom wood plates.

- Studs are connected to track flanges with screws, or pins, installed through the face of the track flange into the stud flange. Three threads or 3/8” of the screw should be visible on the back side of the connection.

- Headers are built up from multiple steel members just like with wood, or by using time saving L-headers.

- Layouts proceed just as they do with wood frame construction. Installation is typically handled by building a wall section on the deck and later raising it.

- With panelized construction many of these steps are eliminated, reducing the framing responsibility to positioning and fastening the pre-assembled components.

- In most residential applications, plywood or OSB is used for floor, wall and roof sheathing, just as in a wood framed house. Sheathing is attached to steel framing using pins shot from a pneumatic gun at a cost and rate of speed similar to the tools used for wood construction.

- Backing the frame for cabinet installation requires some customization with C-shaped stud, steel strap, track, or there are a handful of proprietary products that can be used.

- The only major differences in building with steel framing are in-line framing techniques, the tools, fasteners and accessories used, and the need for foam insulation on the exterior side of the wall studs in some geographic regions.

- In addition, MEP trades will see minor differences in how they install wiring and plumbing (see MEP Trades section 8 for more detail).

8 eight

HOW WILL MY TRADES BE AFFECTED?

Framers

Experienced framers will find it relatively easy to transition to steel framing. They understand floor plans and elevations and can covert these to floor and wall layouts. With assistance and training, experienced carpenters adapt to CFS very quickly. However, there is a learning curve associated with new tools and fasteners.

Basic steel framing tools are a screw gun (adjustable torque, 0-2500 rpm), bits and bit holders for structural steel to steel connections, chop saw, pneumatic pin nailer for steel to steel connections and sheathing to steel connections, clamps,

aviation snips, swivel head electric shear, and a magnetic level.

New, faster and more efficient tools are coming onto the market all the time. Please follow the manufacturer's specifications for products and applications. The Steel Framing Alliance website is a good source of contact information for tool and fastener manufacturers.

Screw Gun

Use: Steel to steel and sheathing to steel fastener seating
Max steel thickness: 97 mils
Cost: Corded starting at $199
Specs: Adjustable clutch/torque; industrial grade; 0-2500 rpm (var. speed); 5.4 amp motor; reversible with bit tip holder release

Hand Seamer

Use: Position and bend steel
Max steel thickness :n/a
Cost: $30
Specs: 3 1/4”

Locking C-clamps

Use: Clamp steel members for fastening
Cost: $10 - $45
Specs: 6”, 9” and 11” regular tip, 2 pair

Aviation Snips

Use: Coping track flanges; cutting studs and track
Max steel thickness: 33 mils
Cost: Starting at $20

Magnetic Level

Use: Plumb walls
Max steel thickness: n/a
Cost: $30 and up
Specs: 48”

Electric Shear

Use: Quick field cuts
Max steel thickness: 68 mils
(One per Framing Crew)
Cost: Starting at $300
Specs: Swivel head

14” Chop Saw

Use: Repetitive cutting of studs, rafters, joists, track
(One per Framing Crew)
Max steel thickness: 97 mils
Cost: Starting at $200

Pneumatic Nailer

Use: Steel to steel and substrates to steel fastening
(Optional)
Cost: Starting at $525
Specs: Pneumatic

Collated Screw Gun

Use: Gypsum board to structural steel fastening
Max steel thickness: 97 mils
Cost: Cordless $250
Specs: Adjustable clutch/torque; industrial grade; 0-4000 rpm (var. speed); 5.4 amp motor; reversible with depth locator

Mechanical / Electrical / Plumbing

MEP (mechanical, electrical and plumbing) trades can be retrained rather quickly for cold-formed steel installations.

For the plumber and electrician, routing wire and pipes through steel walls may prove simpler than what they're used to with wood frames, as the studs come pre-punched with holes along the stud and joist length.

Plastic grommets, installed by the trades, snap in place through the punchout openings. The grommets protect wire and PEX from the sharp steel edges or provide corrosion protection for copper. Duct, pipe, and wire supports will be fastened to the framing with screws and accessories that are widely available.

The allowable electrical wiring methods referenced in Table 3701.2 of the International Residential Code include non-metallic sheathed cable, also known as "Romex", which can be used in steel framing. The code also covers grounding.

9 nine

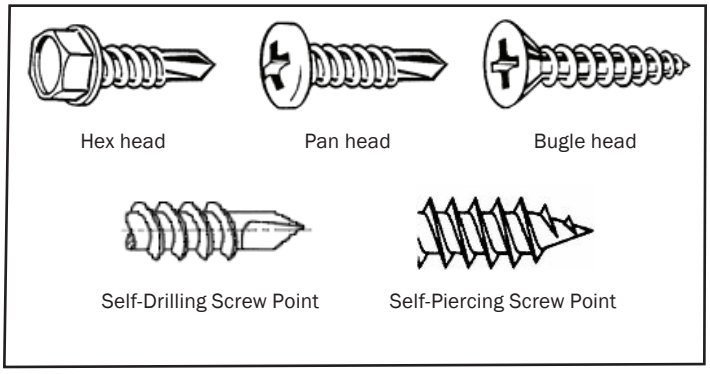
WHAT FASTENERS WILL I NEED?

The key to fastener selection with steel framing is to keep it simple. Basically there are three head and two point styles.

Hex, pan and bugle head screws will easily address almost all applications.

- Hex heads are used where they won't be covered by another material like drywall or sheathing.
- Pan heads are typically used in areas where drywall or sheathing will be applied.
- Bugle heads are designed to countersink into the material they are driven into, so are ideal for installing drywall.

There are two types of screw points to choose from, self piercing when working with thinner material (like interior drywall studs), and self-drilling when penetrating into the thicker structural steel studs.



The *Prescriptive Method* requires that structural connections be fastened using No. 8 and No. 10 screws. Generally, No. 10s are required for roof member to member connections and No. 8 fasteners are appropriate in other locations. Drywall can be installed with No. 6 screws. Screws for all applications are readily available from local supply houses.

Other Types of Fasteners

Other cold-formed steel connection techniques exist and many are code approved.

Pneumatically-driven fasteners, powder-actuated fasteners, crimping and riveting have all been developed for steel-to-steel and sheathing-to-steel connections. Review the application with a manufacturer's representative and local code officials before implementing usage of alternative fasteners.

Sheathing and drywall may be attached to steel frames with pneumatically-driven nails. These nails are specifically designed with spiral grooves or knurls on the nail shaft to penetrate the steel and, like automatic nail delivery in wood framing, are applied with air guns.

10 ten
WHERE CAN I GET TRAINING?

Wood framers can adapt fairly easily to cold-formed steel material with a good set of blueprints, the right tools and some on-the-job training. The Steel Framing Alliance has developed a *National Training Curriculum and Field Installation Guides* on the construction of various assemblies, such as floors and walls, which are available from the SFA. A formal technical training program is offered at community colleges nationwide. SFA and the Association of the Wall and Ceiling Industry (AWCI) jointly developed *STEEL Doing It Right,* a three-day training program given in a format that promotes interaction between the participants and the professional engineer instructors, is offered in major cities and at builders' events throughout the year (see www.awci.org).

Resources

The Steel Framing Alliance

http://www.steelframing.org

Member Directory
Directory of Training Centers
National Training Curriculum

Association of the Wall and Ceiling Industry

http://www.awci.org

STEEL Doing It Right

Cold-Formed Steel Engineers Institute

http://www.cfsei.org/index.php

Low Rise Residential Construction Details

International Code Conference

http://www.iccsafe.org/government/adoption.html

Steel Stud Manufacturers Association

http://www.ssma.com/

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Information in this publication is based on the "Prescriptive Method," basis of the steel requirements in the International Residential Code (IRC) and International Building Code (IBC). Some information has been summarized from the Steel Framing Alliance's (SFA) "National Training Curriculum." For more information or to obtain these publications, visit www.steelframing.org.

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