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Steel-Frame House Construction

Tim Waite

NAHB Research Center

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The author dedicates this book to his two sons, Cameron and Etienne, who already see at a very early age the benefits of building a steel framed home.

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Contents

Chapter 1

What Is Light Gauge Steel?

Light gauge steel framing members (sometimes called cold-formed steel) are made from structural-quality sheet steel that's formed into shapes either through press-braking blanks sheared from sheets or coils, or more commonly, by roll-forming the steel through a series of dies. Unlike hot-formed structural I-beams, neither process requires heat to form the shape, thus the name "cold-formed" steel. Light gauge steel products are usually thinner, faster to produce, and cost less than their hot-formed counterparts. Figure 1-1 shows a typical steel-framed house under construction.

Why Switch from Dimensional Lumber?

Why are we looking for alternatives to dimensional lumber? Let's start out with a little history.

The United States has enjoyed an abundant supply of timber products over the past two centuries. The availability and workability of wood has enabled builders to construct millions of homes in North America. Today, new residential construction and remodeling consumes two-thirds of the lumber used. Any change in the supply and cost of lumber directly impacts the homebuilding market.

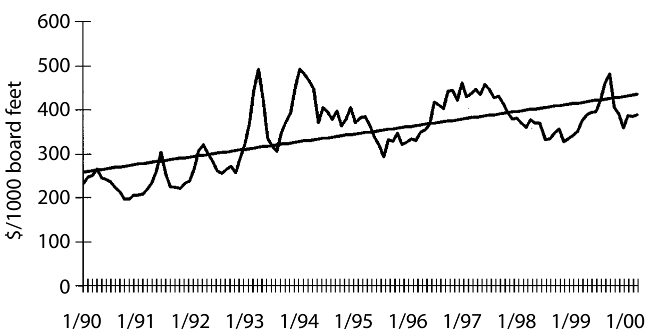
This impact was strongly felt in 1993, when lumber prices more than doubled. Framing lumber composite prices jumped from $200 per 1,000 board feet in 1990 to $500 in 1993. You can see this unusual leap in prices shown in the graph in Figure 1-2. The rising price sent a panic throughout the residential construction industry. While homebuilders lobbied for lower lumber prices, they also looked for alternatives to lumber.

There's a lot of speculation as to why prices jumped so drastically. Some environmentalists were concerned that too many old growth forests had been cleared. Concerned about wildlife habitats, they lobbied to protect endangered species, such as the spotted owl, and require the selective cutting of timber.

The wood industry looked toward imports from Canada to satisfy construction needs. They assured builders that the supply would meet demand, especially through a combination of imports and managed forests. They described timber products as a "sustainable" industry, with new growth satisfying demand. However, over the past decade overall lumber prices have both increased and become more volatile.

In 1991, lumber costs for a 2,000 square foot home averaged about $5,000. In 1993, the lumber cost for the same size home was about $12,200 (up to $491 per 1,000 board feet). Though lumber prices dipped back down a bit in 1995 and 1996, it's become apparent that the framing costs of construction are now taking up a larger part of the total cost of building a home. In January 2000, the framing lumber composite price was $387 per 1,000 board feet, compared with $231 in January 1990. Today, framing costs are almost consuming 20 percent of the total cost of the home. Figure 1-3 shows the relationship between the rise in the cost of lumber per 1,000 board feet and framing as an increasing cost of the overall lumber expense for the average 2,000 square foot home.

Figure 1-1
Steel-framed house



Courtesy: Random Lengths, Eugene, Oregon

Figure 1-2
Lumber composite price

Cost per 1,000 Board Feet	Framing Lumber	Structural Panel	Lumber Costs
$200	$3,488	$1,394	$4,882
$300	$5,232	$2,091	$7,323
$400	$6,976	$2,788	$9,764
$500	$8,720	$3,486	$12,206
$600	$10,464	$4,183	$14,647
$700	$12,208	$4,880	$17,088

Courtesy: National Association of Home Builders

Figure 1-3
Cost of lumber for a 2,000 square foot home

We all know that the bottom line for homebuilders is always cost, profit, and staying in business. No matter how many advantages steel may have over wood, framers won't begin using the product until it can compete in the market. In 1993, for the first time, the price of a steel framing package started to become competitive with the wood package for the same components of the home. That's when builders began thinking about switching from wood to steel framing.

In that year, the National Association of Home Builders (NAHB) Research Center initiated an alternative materials program in response to increasing lumber prices and a perceived decrease in lumber quality. Light gauge steel framing was considered as one possible solution. The NAHB Research Center generated a report called "Alternative Framing Materials in Residential Construction: Three Case Studies." It identified light gauge steel as a cost-competitive solution in 1994, especially in wall framing. This was the first time in a long while that the home building industry was able to find an immediate solution to a problem with a product.

The NAHB Research Center Tool Base Hotline has handled thousands of calls over the last few years from builders seeking information on steel framing. Total shipments of light gauge steel framing used in residential construction grew in 1998 by 44 percent to 140,000 tons, up from 97,000 tons in 1997. The biggest gains in market share were in non-loadbearing studs and floor joists.

The North American Steel Framing Alliance (NASFA) was formed as an affiliate of the American Iron and Steel Institute in 1998. NASFA's mission is to enable and encourage the widespread, practical and economic use of and preference for light gauge steel framing in residential construction. In order to achieve its mission, NASFA has identified several strategies to help accelerate the use of steel framing. One of them is to reduce the cost of construction.

NASFA also plans to develop the infrastructure necessary to support local builders. By building local alliances, finding less expensive construction details, and providing training opportunities, it's working to achieve its goals.

For more information for contractors and the consumer, NASFA maintains a hotline to field calls. You can reach them at 1-800-79-STEEL, or visit their Web site at www.steelframingalliance.com.

Advantages of Steel Framing

A steel-framed home is a high-quality home. By virtue of its material characteristics and properties, steel offers significant advantages to both homebuilders and consumers. Steel studs and joists are strong, lightweight, and made from uniform-quality material. Steel walls are straight, with square corners, and all but eliminate pops in drywall. This virtually does away with the need for costly callbacks and adjustments,

Consumers enjoy steel framing for fire safety and termite protection. Steel framing doesn't contribute combustible material to feed a fire. In Hawaii in 1998, over one-third of all new homes were built with steel to protect against the voracious Formosan termite. These termites, as well as some other harmful parasites, can destroy a house there in one year.

Steel-framed houses can be designed to withstand wind and seismic loads caused by hurricanes and earthquakes. The strength and ductility of steel allows it to meet the strongest wind and seismic ratings in the national building codes. And steel joists and trusses can achieve greater spans, opening up large spaces inside a home.

One extra advantage: steel is also recyclable. Most steel manufactured today contains an average of 25 percent recycled content. Steel takes the pressure off of renewable resources and saves valuable landfill space.

. . . And Some Disadvantages

With all of these advantages, why don't we see more steel houses being built? Several barriers still inhibit the growth of this alternative construction material. Most of the barriers impact the cost of the home. While steel framing material costs are now competitive with lumber, the labor and engineering costs tend to be higher. Several factors impact higher labor costs. There is a lack of skilled framing labor in steel framing. This makes it difficult to find competitive steel carpenters. There is an inherent higher connection cost using screws and screw guns versus nails and nail guns. It just takes longer to apply a screw than a nail. There is also, in colder climates, an added cost for applying a thermal break. Because there are no standards in the energy codes, steel suffers a penalty in the extra insulation costs.

In addition to cost problems, there is a lack of infrastructure to support the construction of a steel-framed home. Consider code approval, design, material suppliers, and framers. There are a lot of people working in these fields who don't know how to inspect, design, sell and work with steel studs, rafters and joists. Prescriptive design tables are only now being introduced in the building codes.

Finally, consumers aren't aware of all the benefits steel has to offer. When it comes to amenities, most homebuyers select a family room, spa or a three-car garage. What is hidden in the walls doesn't have a perceived value until there's a fire, termite damage, nail pops or crooked walls.

The Growing Interest in Steel Among Framers and Consumers

Despite these disadvantages, there has been a growing interest in steel among framers and consumers. As a result, in 1994 and 1995 the American Iron and Steel Institute teamed up with the NAHB Research Center to conduct introductory seminars on residential steel framing. The seminars, called

Figure 1-4
Steel framing seminar

"Learn to Frame with Steel," were conducted in over 70 cities across the country and have reached more than 2,000 home builders, design professionals, and code officials.

In 1996, in response to builder demand for "hands-on" training, the Institute expanded their program into a week-long training seminar. The last day of the seminar used the completed steel frame house shown in Figure 1-4 as a classroom to show how to work with steel, from concept to finishing. In 1998, the Institute published the *National Training Curriculum for Residential Cold-Formed Steel Framing*, which was written around the 1996 program. This Curriculum is available to training centers both in the form of a three-ring binder and on CD-ROM. Call NASFA at (202) 785-2022, or check their Web site at www.steelframingalliance.com.

Regional Training Centers

Over the past few years, regional training centers have been established to bring framers up to speed quickly. I've had the opportunity to work with students in several of these training programs. There always seems to be a similar mix of people, including experienced carpenters, home builders, architects, engineers, retired code officials, instructors, and foreign nationals.

Though everyone seems to be looking for something different to take home with them, most want to start framing with steel, or start up a company of their own. They may not be able to learn how to do everything in a one-week training program, but they do leave behind their fear of the unknown. The programs give them the confidence they need to go out and frame with steel on their own.

Here are the locations of some of these training centers:

Orange Coast College — College courses in steel framing
Costa Mesa, California
714-432-5582

Ivy Tech Training Center — Steel framing training sessions
Gary, Indiana
219-981-4402

USS-POSCO Training Facility — Two-week introductory course
Pittsburg, California
925-439-6241

As steel framing gains in popularity, more training centers are being developed. Hundreds of steel framing curriculums have been distributed across the country. Check the NASFA Web site for the latest information.

The Transition from Wood to Steel

One of the reasons framers can switch to light gauge steel without a major transition is that a steel house is framed much like a wood-framed house. You're still using 16- or 24-inch spacing for studs and floor joists; you can make up headers from steel members and fasten materials like plywood and Oriented Strand Board (OSB) to the steel framing in much the same way as wood. Basically, stick-for-stick, you can replace each of the wood framing members with steel. But new, innovative details for steel are being developed everyday. The L-header, for instance, is a new, cost-effective method to frame headers with steel.

Hybrid Framing

Another point that makes the transition to steel easier is the fact that you don't have to convert to framing completely with steel all at once. Many builders take a step-by-step approach to steel framing, switching over one part of the house at a time. This is sometimes referred to as "hybrid" framing. Some use steel for only the interior nonbearing walls, as shown in Figure 1-5. This way, they avoid today's steel engineering costs while paying less money for the steel studs. Others frame their floors with steel joists and frame the exterior loadbearing walls with wood. You may even choose to frame everything below the top plate with steel, and have your trusses delivered by the same wood truss manufacturer you use now. Or of course you can choose to have your homes 100 percent framed out of steel and use steel trusses or rafters.

Figure 1-5
Hybrid framing

Considerations with Steel Framing

If you're considering framing with steel, you'll have to do your homework and analyze the costs. You'll need to review the advantages described earlier and weigh them against the barriers.

Once you take a look at the pros and cons and apply them to your projects and model homes, it will become apparent what part of your homes you can frame with steel, practically and economically.

The purpose of this book is to familiarize you with the basic uses of steel framing in residential construction. As NASFA, the NAHB Research Center, HUD and others strive to reduce and eliminate the existing barriers to steel-framed construction, new products, tools and services will be introduced. Keep up-to-date by frequently checking NASFA's Web site or the ToolBase services at www.NAHBRC.org.

Workforce

One of the problems you may encounter if you're new to residential steel framing is finding carpenters and framers that have experience working with light

Figure 1-6
On-the-job training

gauge steel. In many parts of the country, especially away from the major urban areas, there simply aren't enough framers trained in steel to support this type of construction.

You'll need to either bring experienced workers in, or train your own crew. Many builders who switched over to steel didn't start with trained crews and lost a lot of money building their first few houses. Some didn't survive their first efforts. Remember, steel is a relatively new material, and it'll take longer to complete the jobs the first few times you work with it. Look into either getting a trained labor force, or professional training for your own people (Figure 1-6). The cost of investing in proper training will be offset by the manhours you'll save on your first few jobs. How long will it take you to try to figure out what to do with that soffit detail or how to tackle the outriggers without some outside help?

There are three main sources of framing labor available for training in steel:

- Experienced wood carpenters
- Commercial drywallers
- Unskilled laborers

Experienced Wood Carpenters — Experienced carpenters are excellent candidates for training in light gauge steel framing. They're already familiar with wood framing and understand 16- and 24-inch modules. They can take a floor plan and elevation and turn simple layouts into a well-constructed house. Master carpenters do this all the time with wood, without a single detail or section on how to complete a difficult roof hip and valley section, or how to cut in stairs. However, very few carpenters have worked with light gauge steel or even used a chop saw or electric shear. There's a learning curve to this, and not all carpenters are willing to make the change.

However, in the training seminars I've instructed, the students who catch on the fastest are the carpenters. They always stand out in the group because they're the first to understand layout, first to walk top plate, and the first to stack trusses. They already know how to frame a house, so your primary task is simply to help them make the conversion to steel.

Drywallers — Commercial drywallers, on the other hand, are used to framing interior walls out of steel. They're also very comfortable using a screwgun, which is one of the main tools you use in steel framing. They know how to work with a chop saw and they're comfortable coping and cutting steel. But not very many drywallers have framed an entire house. And even fewer have stayed up all night trying to figure out a difficult roof valley or how to calculate the ridge height on a conventional roof. You can see, looking at the hip detail in Figure 1-7, that these are not easy tasks to pick up. Training for commercial drywallers is heavy on the fundamentals of framing and layout.

Unskilled Labor — Some builders prefer to start from scratch with unskilled laborers who don't have preconceived notions about either wood or steel. The unskilled worker has nothing to compare with. Then again, like the drywaller, an unskilled laborer doesn't have the experience the carpenter has in the art of home building. An unskilled laborer needs to learn not only the basic skills necessary to frame a home, but also the specifics of how to work with steel.

Figure 1-7
Hip detail

Size of Framing Crews

You can use the same size framing crew for steel as for wood framing. A typical steel framing crew consists of two or three experienced framers and one or two apprentices. If most of your steel is cut to length, you won't need to dedicate one man to cutting steel on a chop saw or shears. I've known some steel framers who even work by themselves on a project, and stick-frame their wall in place.

As with any type of framing, if you have too many men, they'll get in each other's way; too few and you won't make the schedule. You're the one who has to ultimately decide how many men should be on your crew. One of the factors in deciding how large a crew you need is how long and heavy your walls are. There's more about this later.

Safety

Safety is an important part of any project. Common sense alone isn't enough to keep a job site safe. *The Model Safety & Health Program* put out by the National Association of Home Builders in Washington, DC is a great reference for job site safety and has many good suggestions for keeping your job site accident free. Here are some of the safety tips that you have to add to your list when framing with steel. These tips don't cover all situations but they will be especially helpful if you're framing with steel for the first time.

- Wear work gloves whenever possible. The gloves should be thick enough to protect your hands from cuts, but thin enough so you can easily finger the screws. Gloves will also protect your hands from hot steel in the summer and cold steel in the winter.
- Watch out for sharp edges! Just as you can easily pick up a sliver from a wood 2 × 4, you can cut your hand on a metal stud. Gloves help, but common sense and caution help prevent needless injuries.
- Always wear ear protection when cutting steel with a chop saw. Chop saws are loud!
- Always wear safety goggles when cutting steel or fastening steel overhead. The chop saw will send debris flying that could damage your eyes. There's also a good chance that some hot steel chips could fall in your eyes when you're screwing members together overhead. Safety goggles are a good idea whenever anything could fall into your eyes.

- If you use carbide-tipped blades to cut steel in circular saws, wear a face shield and long-sleeved shirts. The metal chips that fly out of the saw can damage your eyes and skin.

- Be careful not to damage electrical cords by dropping steel members on them. The sharp edges on the steel can easily cut through the plastic coating and produce an electrical hazard.

- Be especially careful when the steel is wet. Steel can be very slippery.

Familiarizing yourself with the advantages and current problems with working with cold-formed steel, as well as safety issues in the workforce, will help you make intelligent decisions in preparation for your first steel framing project. The next several chapters focus on other important issues you should consider before you frame that first house. I'll start with design considerations and move through tools, fasteners, and ordering steel. Once we have these basics under our tool belt, we'll tackle the actual framing of the house.

Chapter 2

Design and Standardization

When you build a typical wood or concrete block home, in most parts of the U.S. there's very little, if anything, that needs to be engineered. We're all familiar with the spanning capabilities of dimensional lumber for floor joists and headers. This comes from years of experience working with standard dimensional lumber sizes. When you need to check a span, you look at the joist span tables in the building code or in the manufacturer's literature.

Occasionally, you'll have a long span or header that needs to be checked by an engineer. Or, if your work is in a high wind or seismic area, you may have to have an engineer check your plans for anchors, hold-downs and bracing. With the exception of homes built in these areas, or up-scale housing that doesn't fit a prescriptive table, builders don't usually need to consult an engineer to build a house. This has kept the costs down, which benefits both the builder and the homebuyer.

Now that you want to use steel for framing, you're going to have to prove to the code official that the members you want to frame the home with are strong enough to support all the loads. There are still a few communities left in this country where the building department doesn't require a plans review and building inspection, but even there, builders need some kind of guidance on what size the steel members should be. Where do you go to find out what steel members to use — or to justify your choice to a code official? You'll either need to hire a design professional (architect or engineer) or consult standard tables to select member sizes (if your local building officials allow it).

At the time of this publication, there are span tables and details for cold-formed steel in the *CABO One and Two Family Dwelling Code*. Similar tables and details are also in the International Code Council's *International Residential Code*. There are also span tables in the steel manufacturers' catalogs. While there's good information in these catalogs, there's far more information than you need, because these manufacturers also supply many different steel shapes and sizes for the commercial industry. You or your engineer can use any of these documents to help you design the structural members in a home. NASFA also recommends new software, Steel Xpert®, to help with estimating steel members.

Until the IRC is adopted nationwide, steel framing won't be found in every building code. But that doesn't mean that you can't frame with it. Every building code in the country allows alternative materials, as long as they can be signed off by a professional engineer. Even in Dade County, Florida, one of the strictest building code jurisdictions in the country, plans have been approved allowing the use of light gauge steel framing.

Hiring an Engineer

If you need to hire an engineer, take the time to find one who has a strong background in cost effective, light gauge steel design. Very few engineers have studied this type of design in college, and engineers designing with light gauge steel for the first time tend to be very conservative. Conservative engineers select heavier studs and floor joists — and that will cost you more, both in material and time spent moving and fastening the pieces together.

The Light Gauge Steel Engineers Association (LGSEA) has a directory of engineers who are familiar with cold-formed steel. In just a few years, the LGSEA has grown into an international organization. Through them it's very likely you'll find an engineer in your area with access to the latest information on cold-formed steel design. You can contact LGSEA for a membership directory at:

Light Gauge Steel Engineers Association
1726 M Street NW, Suite 601
Washington, DC 20036-4523
Telephone: (202) 785-2022
Fax: (202) 785-3856
Web site: www.LGSEA.com

I also strongly suggest that you find an engineer who is willing to listen to your ideas. There are new details being developed in steel framing every day. You may come up with a field solution to a framing detail that saves you time and money. You need to be sure your engineer will be willing to look at that detail and consider including it on the plans if it does the same job and saves you time and material.

Framing Details

One of the things you'll find out rather early in the game is that there are many different framing details out there that do the same thing. With steel framing growing in the residential market, ingenuity and evolving techniques are creating simpler and less expensive framing details. It's interesting to observe these changes. Details that were first used only a few years ago are already being replaced with newer, better ones for items like headers, trusses, and X-bracing.

You can obtain detail manuals from several organizations. A few of them are listed here.

Low-Rise Residential Construction Details
Publication NT6-00 and CD-ROM
North American Steel Framing Alliance
Washington, D.C. March 2000
1-800-79-STEEL

Light Gauge Steel Framing Details
Light Gauge Steel Engineers Association
Nashville, Tennessee. 1996
(202) 785-2022

Light Gauge Residential Isometric Detail Package, Release 2.00
RES-TEK International and DEVCO Engeering
Salem, Oregon. January 1996
(541) 757-8991

Prescriptive Method for Residential Cold-Formed Steel Framing, 3rd edition
NAHB Research Center
Upper Marlboro, Maryland. January 1998
1-800-638-8556

Structural Guidelines for Detailing Cold-Formed Steel Framing
Structural Engineers Association of Hawaii.
SEAOH Treasurer
P.O. Box 3348
Honolulu, Hawaii. October 1996

Residential Steel Framing Construction Guide
E.N. Lorre
Technical Publications
Las Vegas, Nevada. 1994
(702) 598-4365

Different builders have different preferences for details. The details we show in this book are the ones we've found are the easiest to introduce to a first-time steel framer. Most of these details are being used by the leading steel framing trainers across the country today. Be on the lookout for easier methods in the future.

You need to become familiar with the details you plan to use. Don't let your engineer or another framer dictate what detail you need for a header. You can waste a lot of manhours framing unworkable details. Choose details that make sense, do the job, and save time.

Prescriptive Method

With all of this talk about engineering, many homebuilders get turned off. Why switch over to steel framing when you don't need all this engineering for a wood or block house? The engineering costs for a steel-framed house can range from $1.50 to $3.00 per square foot. That means a minimum of

$3,000 for engineering fees on a 2,000 square foot house! The NAHB Research Center found (not surprisingly) that this engineering requirement has been a major barrier in the development of steel framing.

In 1996, with funding from HUD, the AISI, the NAHB and the NAHB Research Center got together to develop a set of span tables, charts and details for steel like those found in wood frame building codes. The publication they produced is called the *Prescriptive Method for Residential Steel Framing, 1st Edition*. It was updated in 1997, and that second edition was the source document for the ICC's *International Residential Code*. It's reprinted in Appendix A of this book. You can request additional copies of the *Prescriptive Method* by calling HUD at 1-800-245-2691 or NASFA at 1-800-79-STEEL, or from the NAHB Research Center at 1-800-638-8556. Depending on the source, it costs between $10 and $20. You can also download free copies from NASFA's Web site at www.steelframingalliance.com.

What is a prescriptive method? A prescriptive method is a design method that uses pre-calculated values in tables to determine the size of members required for a structure. Because the values are pre-calculated, a prescriptive method usually has limitations as to the size of a building and its design loads. The current residential building code we use for wood framing is mostly a prescriptive method. It allows building inspectors to easily check to make sure that the wood studs, joists, and rafters you're using are the right size for the spans. These tables take into account the live and dead loads as well as wind, snow and seismic loads for the area you're building in. The span tables and charts in the model building codes have already been justified with engineering principles. So as long as you follow them, the plans examiner and building inspector will let you build a typical wood house without engineering. The *Prescriptive Method* provides the same type of charts and span tables for use in steel framing.

Prescriptive Method Accepted into BOCA Codes

In 1996, AISI submitted parts of the *Prescriptive Method for Residential Steel Framing, 1st Edition* to the International Code Council for acceptance into the *One and Two Family Dwelling Code*. It was accepted that same year, and is found in the *1997 CABO One and Two Family Dwelling Code*. Indiana was the first to accept this code in 1997. The new ICC 2000 code will replace the BOCA code. Once the ICC's *International Residential Code* is approved, prescriptive tables will be available for steel framing across the nation.

Adoption of the prescriptive methods will take away much of the mystery involved in framing steel houses. Not only will the manufacturers know what members to supply for the residential market, but the builder will know what size stud, joist, or rafter to use, and the building inspector will know if the builder is using the right size joist and the right number of screws. But most importantly, the cost for steel framed houses will be reduced — no more excessive engineering fees for the average house — making steel framing a more competitive alternative.

Cold-Formed Steel Standards

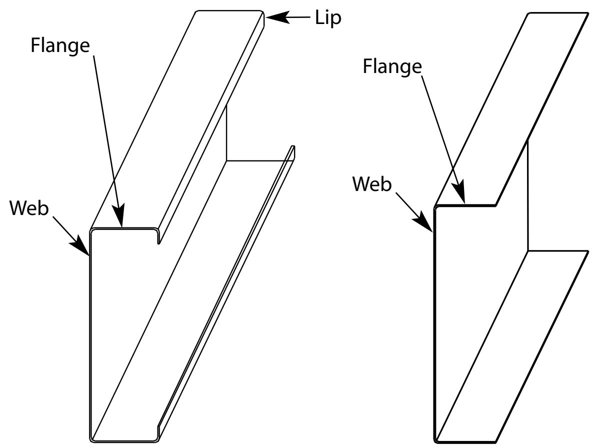
The *Prescriptive Method* identifies the types of steel that may be used for residential steel construction (see Section 2.1.1 in Appendix A). They are:

1. ASTM A653: Grades 33, 37, 40 & 50 (Class 1 and 3)
2. ASTM A792: Grades 33, 37, 40 & 50A
3. ASTM A875: Grades 33, 37, 40 & 50 (Class 1 and 3)
4. Steels that comply with ASTM A653, except for tensile and elongation requirements, shall be permitted provided the ratio of tensile strength to yield point is at least 1.08 and the total elongation is at least 10 percent for a 2-inch gauge length or 7 percent for an 8-inch gauge length.

Obviously, you must use the correct steel to support the building loads. If your manufacturer or supplier doesn't mark the studs, ask them to supply certification that the steel complies with ASTM standards, or test results, so both you and the inspector can be sure you're using the right type of steel.

Shapes

The C-shape is used for most of the structural members you'll use, including wall studs, floor joists, and roof trusses. You can purchase the C-



A C-shaped member configuration

B Track section configuration

Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing,* Second Edition

Figure 2-1
Cold-formed steel members

shape from nearly any roll-former, and from distributors, in many different sizes. The depth of a stud or joist is measured from outside of flange to outside of flange. In most areas of the country, a $3^{1}/_{2}$-inch web and $1^{5}/_{8}$-inch flange stud is adequate for wall framing.

You use top and bottom tracks to hold wall studs in place, similar to using plates in wood frame construction. The steel track is basically a U-shaped member. It receives the C-shaped studs that are then screwed into the track. Track pieces are measured from inside of flange to inside of flange to allow the corresponding stud to fit inside the track. Figure 2-1 shows these cold-formed steel members.

Size and Thickness

Light gauge steel members for residential framing now have standard sizes and dimensions. For instance, a 2 × 4 steel stud is the same depth as a wood stud. Figure 2-2 gives the standard sizes and dimensions of typical studs and joists. The minimum flange size is 1.625 ($1^{5}/_{8}$) inches and the maximum is 2 inches. The minimum lip size is 0.5 inch.

The steel thickness contributes to the steel member's strength. These values have also been standardized, as shown in Figure 2-3.

The trend today is to move away from referring to steel thickness in terms of "gauge" and to use the term "mil" instead. The mil thickness measures the uncoated base metal material. One mil is equivalent to $^{1}/_{1000}$ of an inch. Therefore, a 20-gauge stud measuring the minimum uncoated base metal at 0.033 inches is said to be 33 mils thick.

Universal Designators

In 1998, the steel manufacturing industry formed a group called the Steel Stud Manufacturers Association (SSMA). SSMA members represent about 80 percent of the steel stud manufacturing in the United States. The SSMA has published a catalog using a new designator system called "The Right

Nominal Member Size (reference only)	Universal Designator[1]	Web Depth (inches)
2 x 4	350S162 — *t*	3.5
2 x 6	550S162 — *t*	5.5
2 x 8	800S162 — *t*	8
2 x 10	1000S162 — *t*	10
2 x 12	1200S162 — *t*	12

[1] *t* is the uncoated material thickness in mils.

Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing,* Second Edition

Figure 2-2
Cold-formed steel standard sizes and dimensions

Designation (mils)	Minimum Uncoated Thickness (inches)	Reference Gauge Number
18	0.018	25
27	0.027	22
33	0.033	20
43	0.043	18
54	0.054	16
68	0.068	14
97	0.097	12

Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing,* Second Edition

Figure 2-3
Cold-formed steel thickness

STUF." The intent of the new designators is to make steel framing products easier to use and to accelerate their acceptance in new markets. They'll essentially eliminate the confusion in the market stemming from the widely-varying properties and loads published by the manufacturers. The new designators will greatly facilitate submittals for plan check, code approvals, prescriptive standards, and software development.

The new universal designator system uses the web depth, flange width, and minimum base metal thickness of the framing member, in conjunction with the S-T-U-F designators:

- S: Stud or joist sections with flange stiffeners (C-shapes)
- T: Track sections
- U: Cold-rolled channel or channel studs (without flange stiffeners)
- F: Furring channels (or hat shapes)

The web depth is listed first, followed by the S-T-U-F designator. Immediately after the letter designator, the flange depth is listed, followed by a dash and the material thickness. The web and flange depth are expressed in $^{1}/_{100}$ inch, and the minimum base metal thickness is expressed in mils ($^{1}/_{1000}$ inch).

For example, a metal stud most commonly used for one-story residential framing would be similar to the wood 2 × 4. This stud would have a $3^{1}/_{2}$-inch web, a $1^{5}/_{8}$-inch flange, a $^{1}/_{2}$-inch flange return or lip, and most likely be 33 mils thick. The universal designator for this stud would be: 350S162-33. See Figure 2-2 for other sample universal designators.

The minimum yield stress used in the *Prescriptive Method* is 33 kips (33,000 pounds) per square inch (see Section 2.5 of Appendix A). This greatly simplifies the span tables. Wood tables can get complicated because of all the different species of trees, each having their own bending stress and modulus of elasticity. With light gauge steel, it's basically the same composition, and has similar bending stress and modulus of elasticity properties. Use the types of steel listed above to guarantee consistency.

Corrosion Protection

Cold-formed steel members are coated to protect the steel from rusting during the storage and transportation phases of construction. Hot-dipped zinc galvanizing is most commonly used to protect the steel because of its effectiveness in preventing corrosion. Depending on the thickness of zinc applied to the steel and the environment in which the steel is placed, zinc coatings can protect the steel as long as 250 years.

It's important to realize that for bare metal or zinc to corrode, water contact must occur in the form of rain, condensation, fog or immersion. Without water present, corrosion will not occur. Therefore, even if the zinc is exhausted or removed during the construction process, once the steel in enclosed in a wall indoors, it won't corrode as long as moisture doesn't collect in the wall cavity. This is true for the steel at fastener penetrations, edge cuts, or scratches on the steel itself. For further information on corrosion, consult the following references:

American Zinc Association
1112 16th Street, N.W., Suite 240
Washington, DC 20036
(202) 835-0164

Corrosion and Electrochemistry of Zinc
Xiaoge Gregory Zhang
Cominco Ltd.
Mississauga, Ontario, Canada
(905) 822-2022

International Zinc Association
Paepsem Boulevard 22
B-1070 Brussels, Belgium
Tel: +32 2 529 19 80/81

Durability of Cold-Formed Steel Framing Members, Publication NT16-97
North American Steel Framing Alliance
1-800-79-STEEL

Figure 2-4 shows the recommended minimum coating requirements for residential steel framing.

Location	ASTM A653
Non-Structural	G40
Structural	G60
Harsh Environment	G90

Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing,* Second Edition

Figure 2-4
Minimum coating requirements

Labeling

The SSMA is adopting a standardized labeling system for stud material to include the following information:

1) The manufacturer's identification
2) The minimum uncoated steel thickness in decimal inches
3) The metallic coating weight (G40, G60, etc.)
4) The minimum yield strength in kips per square inch
5) The standard specification for the type of steel used

A sample label will read: ABC 0.043 G60 33 ksi, plus an ASTM, ICBO or NER number. Member manufacturers should be using these designators by the time you're reading this book. By looking at the label, building inspectors can verify that the builder is using the right product, and builders can make sure that the steel they ordered is correct.

Code Approval

As I said earlier, you may not need to have your plans reviewed and house inspected, but chances are you will. Most states have adopted one of the model building codes, with or without amendments. These are:

- The *National Building Code* (BOCA) — mostly used in the Northeast
- The *Standard Building Code* (SBCCI) — mostly used in the Southeast
- The *Uniform Building Code* (ICBO) — used in the West

These codes have now largely merged their residential codes into a single document for the *International Residential Code (IRC)*, published in the year 2000. AISI's submittal of steel framing in the IRC will help all residential steel framers into the next century.

But what guidelines do you as a builder use today? If you don't live in a state that has adopted the *Prescriptive Method*, check with your local code official to see what they require. Show them a copy of the *Prescriptive Method* and see if they'll allow you to use that document as a basis for your span and strength requirements. If they want to wait and see it approved in the code first, they'll probably ask that you hire an engineer to provide a full set of plans.

Bring your code officials in early in the building process. Make it clear that you want to work with them and need their assistance. It would be a waste to spend a lot of time and money on steel and engineering only to find out that the code officials are resistant to steel framing. At the time of this publication, NASFA has a seminar that they can provide to code officials who need training on cold-formed steel. For more information, call (202) 785-2022.

In most of the jurisdictions we've worked in, we found that plan examiners and building inspectors are willing to work with steel frame builders. However, their biggest complaint has been the lack of a standard that they could follow. With the inclusion of the *Prescriptive Method* in the building code, they're going to start feeling much more comfortable with steel.

Steel Fire and Sound Ratings

If you're building attached homes, there's one more design issue related to steel framing that you may have questions about. How do fire and sound ratings compare to the ratings for wood framing? The United States Gypsum Company (USG) has tested fire and sound ratings for many different wall assemblies using USG products and ASTM standards for testing. The results are published in USG's *Construction Selector* (United States Gypsum Company, Chicago, IL. Publication No. SA100/3-99 (1-800-874-4968). Web site: www.usg.com.

Other resources that list fire ratings for cold-formed steel are The Gypsum Association, Underwriters Laboratories, Inc., Factory Mutual and Intertek Testing Services. The Gypsum Association produces a *Fire Resistance Design Manual*. A good resource that summarizes all of these resources is the LGSEA Tech Note 420, *Fire Rated Assemblies of Cold-Formed Steel Construction*. This Tech Note summarizes steel rated assemblies for UL, The Gypsum Association, Factory Mutual and HUD tests from 1-hour to 4-hour walls. Assemblies include loadbearing and nonbearing walls, floors, ceilings and roof/ceilings. You can order a copy of this Tech Note by calling LGSEA at (202) 785-2022.

Fire Ratings

Fire ratings are expressed in terms of hours. Steel studs are listed in USG's *Construction Selector* in several different configurations with fire ratings from 1 hour up to 4 hours. Fire rating refers to the length of time it takes a fire to burn through a wall. A 1-hour fire rating can be achieved for both loadbearing and nonbearing steel walls from 5/8-inch drywall on both sides of the stud wall with no insulation in the cavity. Or, the same rating may be achieved with 1/2-inch drywall on both sides with 1 1/2-inch Thermafiber sound attenuation fire blankets (SAFB) on both sides (see the *Construction Selector* for details).

Similar fire ratings are achieved for wood wall studs. While the whole assembly contributes to the fire rating, it's important to note that the fire rating is achieved mainly by the thickness of the drywall material covering the wall studs. See Figure 2-5.

Fire Blocking

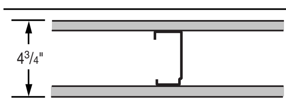
Fire blocking can be a confusing topic because most provisions in the building codes were based on using wood or other combustible materials in the wall cavity. The intent of fire blocking is to prevent the unnecessary horizontal and vertical spread of fire from combustible concealed spaces to other combustible framing members.

No fire blocking should be required for steel-framed walls using gypsum board on both sides, or with gypsum board on one side and stucco or other noncombustible material on the other side. Those walls are considered noncombustible. For steel-framed walls that use plywood or OSB on one side, fire blocking may be required, according to your local building code. Most steel framers use a layer of gypsum wallboard on the track or stud to provide the necessary fire blocking.

Fires in Steel Houses

Because steel-framed houses are relatively new on the residential scene, there's not a lot of documented data available on fires in steel houses. However, one did occur in 1996 in Brentwood, California that has been studied intensively.

The owners of that steel-framed home left for the evening, leaving a gas burner on in their kitchen. The gas burner melted the plastic knobs on the microwave oven located above the gas range — which then ignited the cabinetry. The flames climbed up into the ceiling but were unable to spread because the wall studs and trusses were made out of steel. The fire smoldered for several hours, producing enough heat to melt most of the plastic found in the home, but it didn't spread. The owners returned home later that night to a house full of smoke and immediately called the fire department. While there was extensive smoke and heat damage to the home, there was no structural damage. The firemen caused the only damage to the exterior of the house when they cut a hole in the roof to vent the smoke and heat out of the house.

Fire-rated construction		Acoustical performance		Folder reference	
Detail & physical data	Description & test no.	STC	Description & test no.		
Non-Combustible Wall Systems — Gypsum Drywall or Veneer Plaster Steel Stud Partition (Load-Bearing) — 1 Hour Rating					
4 3/4"  wt. 6	Load-bearing Steel Stud — 5/8" SHEETROCK Brand gypsum panels, FIRECODE core — 3 1/2" 20 ga steel studs 24" o.c. — panels screw att — joints fin — **UL Des U423 or U425** — rating also applies with IMPERIAL Brand gypsum base, FIRECODE core, and veneer finish surface	40 41	**USG-810519** Based on 2" SAFB in cavity — **USG-810518**	SA923	**33**

Courtesy: United States Gypsum Company, Chicago, IL

Figure 2-5
One-hour rated wall

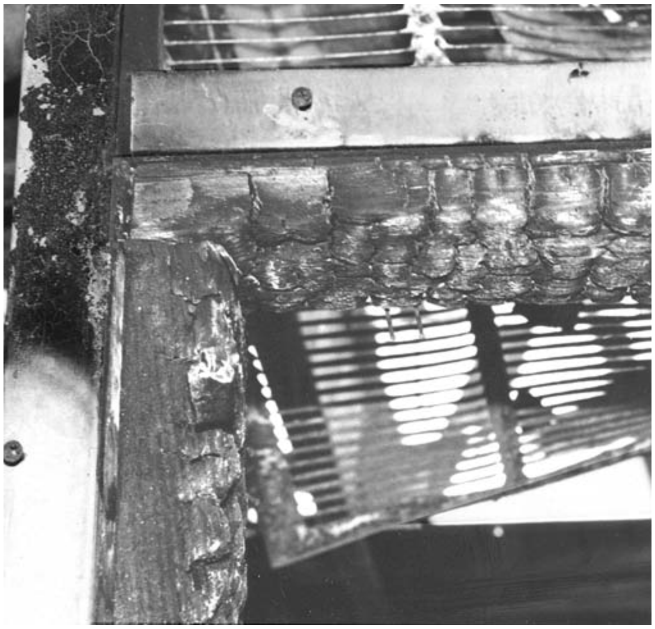


Figure 2-6
Results of fire in steel-framed house

The firemen reported that had the walls and trusses been made from combustible materials, the house would have burned to the ground. Other similar experiences are now being documented, illustrating how well steel-framed houses perform in fires. See Figure 2-6.

Sound Ratings

Sound tests were also conducted by USG. The measurement for these tests is STCs (sound transmission classes) as per ASTM test procedures.

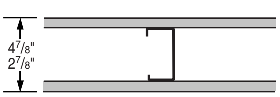
The sound transmission level recommendation from the HUD Minimum Property Standards is 45 STCs for partitions separating living units from other living units. Twenty-five STCs represents normal speech that can be understood quite clearly. At 45 STCs you must strain to hear loud speech. At a rating of 50 STCs, loud speech is not audible.

A steel stud wall with 5/8-inch drywall on each side and 3-inch SAFB in the cavity has a rating of 49 STCs (Figure 2-7). A similarly-constructed wood wall has a rating of 46 STCs. Both walls were constructed with studs at 24 inches on center.

Sound transmission is very similar through insulated wood and steel walls. Steel walls are slightly less soundproof if left uninsulated.

It's important to make a partition as airtight as possible for it to effectively reduce the transmission of sound. Use acoustical sealant to seal the perimeter of partition walls where sound transmission reduction is important. For more information, refer to USG's *Construction Selector.*

Non-Combustible Wall Systems — Gypsum Drywall or Veneer Plaster
Steel Stud Partition (Non- Load-Bearing) — 1 Hour Rating



Fire-rated construction: Detail & physical data	Fire-rated construction: Description & test no.	Acoustical performance: STC	Acoustical performance: Description & test no.	Folder reference	
wt. 6	Steel Stud — 5/8" SHEETROCK Brand gypsum panels, FIRECODE core or IMPERIAL Brand Abuse-Resistant gypsum base, FIRECODE core — 3 5/8" 25 ga steel studs 24" o.c. — panels screw att — joints fin — perimeter caulked — **UL Des U419 or U465** — rating also applies with IMPERIAL Brand gypsum base, FIRECODE core, and veneer finish surface	40 49 51	**USG-860808** Based on 3" SAFB in cavity panels — **SA-870717** Based on FIRECODE C core panels and 3" SAFB 25" wide, creased to fit cavity — **TL-90-166**	SA700 SA707 SA923	**1**
wt. 5	Steel Stud — 5/8" SHEETROCK Brand gypsum panels, FIRECODE core — 1 5/8" 25 ga steel studs 24" o.c. — single layer panels vert appl & screw att 12" o.c. — joints fin — perimeter caulked — **U of C 7-31-62**	38	**USG-860809**	SA923	**2**

Courtesy: United States Gypsum Company, Chicago, IL

Figure 2-7
49 STC wall

Chapter 3

Designing the Steel-Framed House

As I mentioned in the last chapter, using the *Prescriptive Method* you can design and spec a steel-framed house just as easily as a wood-framed one. In this chapter, as an example, we'll design a simple one-story house located in Salem, Oregon. We could use any location, but I've chosen Salem to demonstrate a home in a high seismic zone with substantial snow loads.

Figure 3-1 shows the floor plan and Figure 3-2 shows the front elevation of the house we're going to build. It's a basic 26- by 40-foot house with a gable roof and an attached garage. We'll build this house over a crawl-space foundation, with two pony walls running the length of the house. A pony wall is an intermediate support in the foundation of the house. We'll explain this more in Chapter 9. Here are the physical dimensions for our house:

Building type:	One-story house with crawl space
Building width:	26 feet
Floor span between the pony walls:	8 feet 8 inches
Building length:	40 feet
Wall height:	8 feet
Wall stud spacing:	24 inches on center
Floor joist spacing:	24 inches on center
Roof framing:	Pre-engineered steel trusses
Roof slope:	5:12
Overhang:	2 feet

Before we can begin to spec the steel members, we need some specific information about the climate and geography for the Salem, Oregon area. This information will affect our design loads. We'll need to know the seismic zone the house is located in, as well as the wind and snow loads for the region. The maps in Figures 3-3 and 3-4 are printed in the *Uniform Building Code* (1997). Please note, however, that your local building code may not use these maps. *Always* check it out before you make any design decisions.

Checking the Seismic Map in Figure 3-3 for Salem, Oregon shows that the Seismic Zone is 3. Checking with the local code officials in Oregon will verify that Seismic Zone 3 should be used for our design example.

Figure 3-4 shows the basic wind speed in that region to be 80 mph, and we'll assume an exposure of C for open terrain. We'd use Exposure B for hilly terrain, and D for coastal regions. A snow load map of the area tells us the load is about 20 psf. This should also be verified by the local code officials.

The building codes in most areas specify 40 psf for a first floor live load, and 10 psf dead load. We'll use these values when we use the tables in the *Prescriptive Method*. It's important to get this kind of information up front, because you'll need it to select member sizes in the tables.

Here's a summary of our climatic and geographic design criteria:

Roof snow load:	20 psf
Wind pressure:	80 mph, Exposure C
Seismic zone:	3
Floor live load:	40 psf
Floor dead load:	10 psf

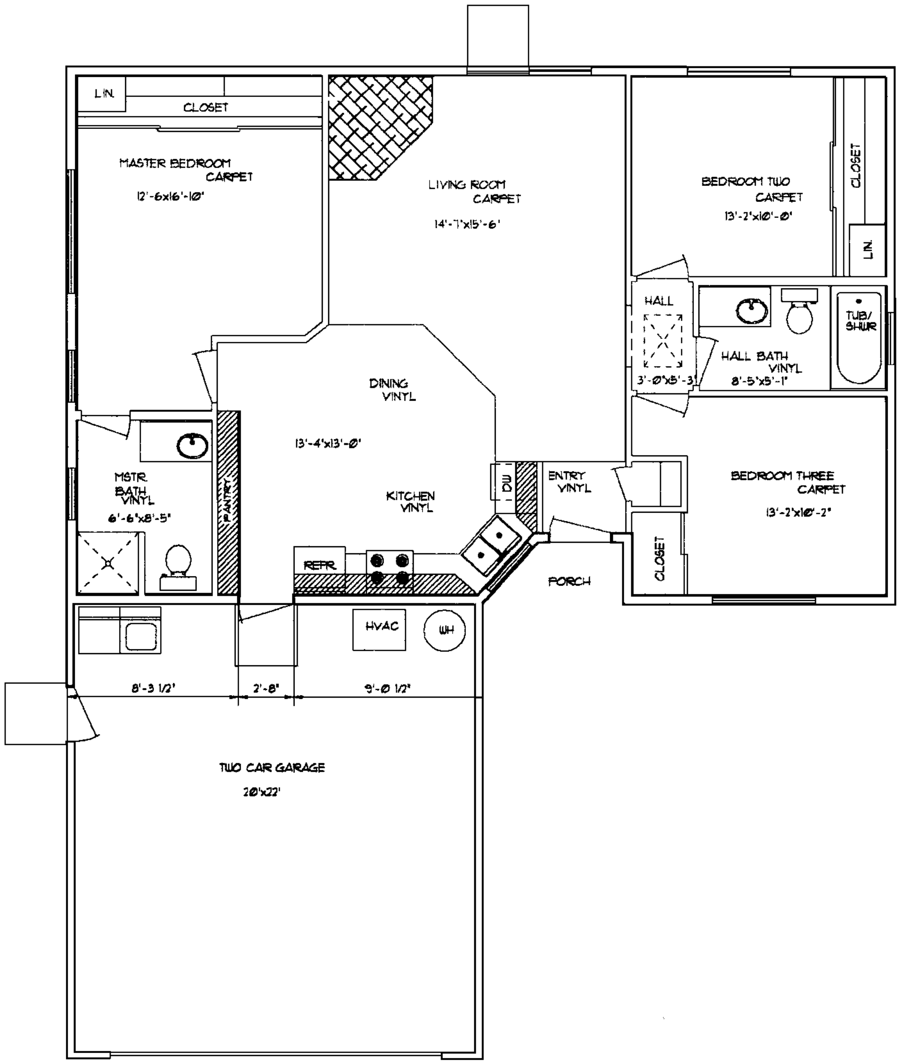


Figure 3-1
Floor plan for design example

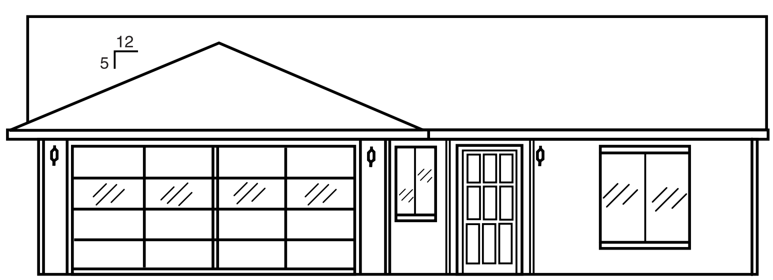
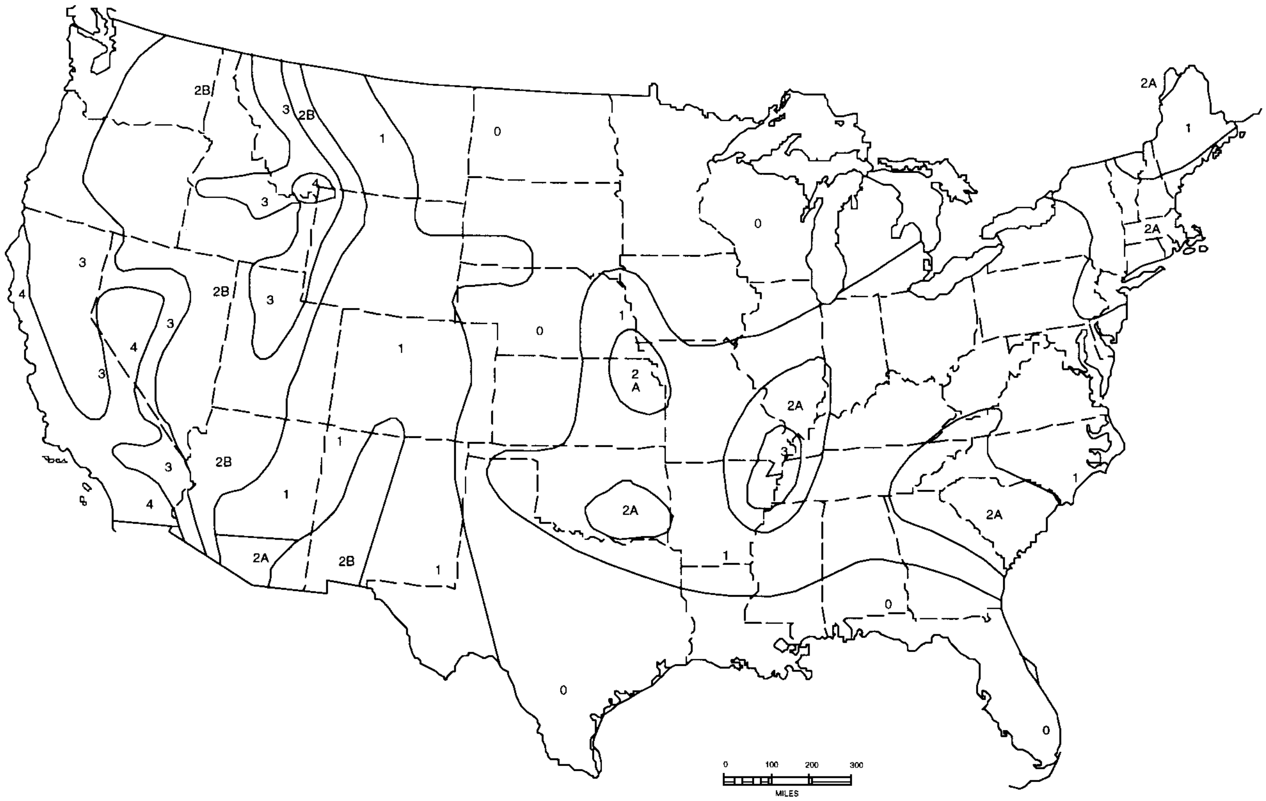
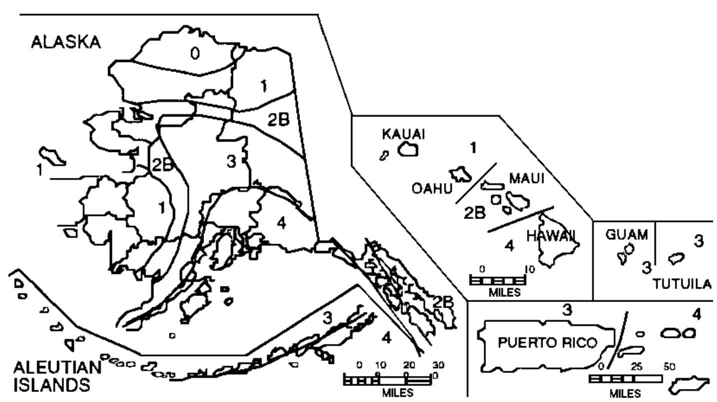


Figure 3-2
Front elevation for design example



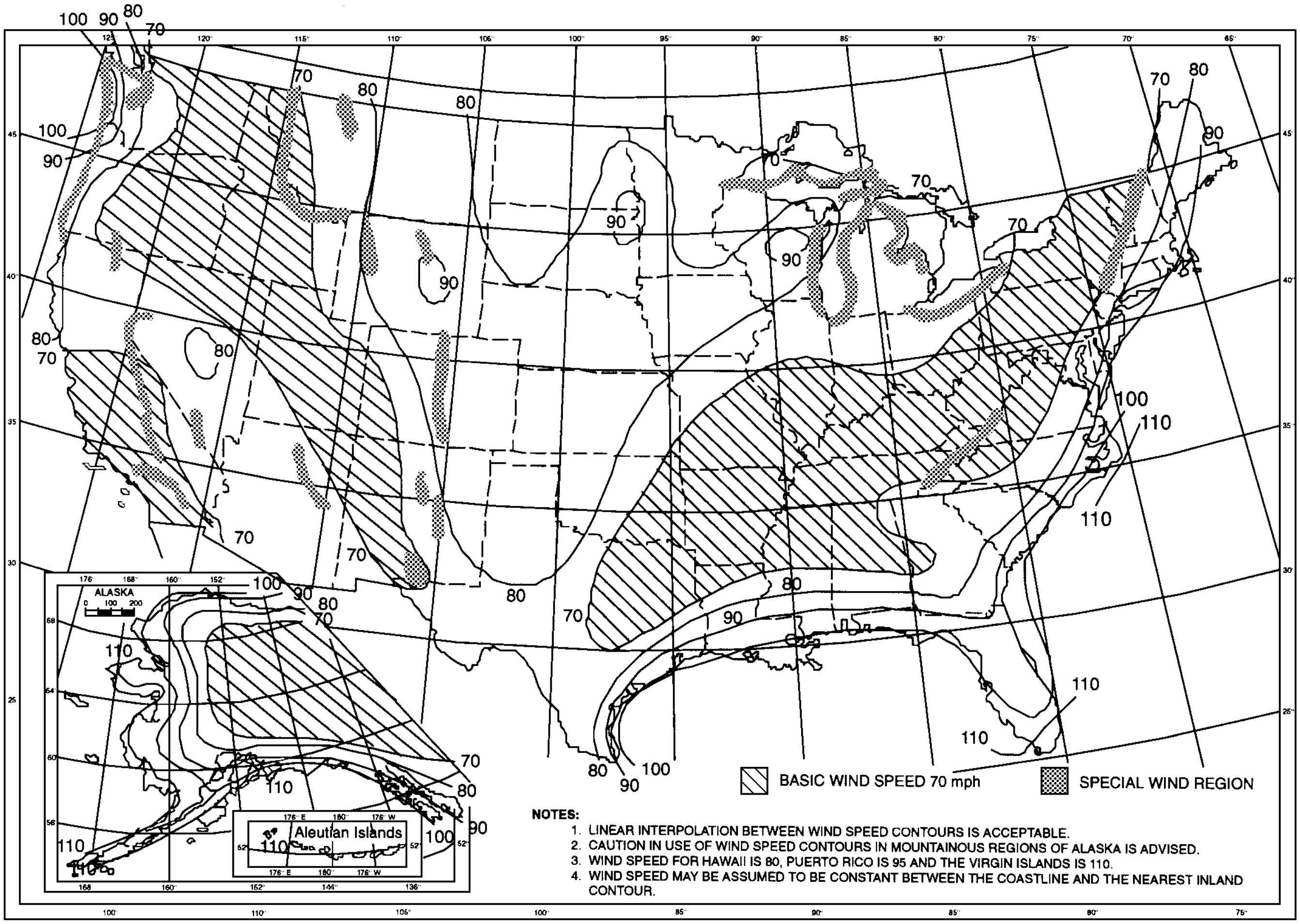
A Contiguous 48 states



B Hawaii, Alaska, and Puerto Rico

Courtesy: Uniform Building Code, ©1997, ICBO

Figure 3-3
Seismic zones



Courtesy: Uniform Building Code, ©1997, ICBO

Figure 3-4
Wind speed map

Sizing the Steel Members

Now that we've defined the physical dimensions of our house, and the climatic and geographic design criteria, we're ready to size the steel members. The *Prescriptive Method* doesn't list every possible physical dimension for a house. Where your dimensions for length and width differ from those listed in a table, use the next higher dimension.

Floor Joists (Appendix A, Table 5.4)

For the floor joists we'll use a continuous member running from one end of the house to the other, supported by two pony walls. Continuous joists run the full length or width of the house without a splice or lap. To check the spans, go to the floor joist table for multiple spans. If we were lapping the joists over the pony walls, we'd use the single span numbers (Table 5.3) instead. Since we're using continuous joists, we'll check the column for 40 psf live load in Table 5.4. We're looking for a joist that will span 8'8". It shows we can select from the following steel floor joists:

2 × 6 × 43 = 9'10"

2 × 8 × 43 = 10'8"

2 × 10 × 43 = 10'2"

Let's choose the 2 × 8 × 43 joist. The 2 x 6 would meet the span, but the 2 × 8 joist will work better and will provide, in this case, a stiffer floor. The deflection criterion in the table is L/480. This is typically stiffer than a wood floor joist, where the deflection criterion is usually L/360.

Subflooring

Check your local building code to make sure you're using the correct subflooring material. In most building codes, a minimum of 11/16-inch structural floor sheathing is required for 24-inch spacing.

Wall Studs (Appendix A, Table 6.2)

Now let's take a look at the walls. Here's one of the questions I've encountered most in training seminars: "What is the equivalent steel stud size to replace a wood 2 × 4?" As you'll see, the answer to that question isn't simple. With wood studs, a 2 x 4 is a 2 × 4, and in most cases creates a far stronger wall than you need. You're paying to build walls which can withstand loads the building will probably never experience. But because steel stud sizes vary in thickness, we can use the minimum size necessary to satisfy the particular building loads. If the building owner isn't going to store a herd of elephants upstairs, there's really no need to build the walls as though he were.

For our house, we'll use 8-foot walls with a building width of 26 feet. Using the column listing a 28-foot building width (because there isn't a 26-foot column) and our design criteria, the *Prescriptive Method* shows us that the thickness of the stud should be 33 mils. This is the typical wall stud size for most one-story homes. Thicknesses vary depending on house width, snow load, and wind exposure.

If this were a two-story house, the second story studs would be the same size and you'd find the studs for the first story in Table 6.3. For this example, if we had two stories we'd use a 54 mil stud on the first floor. But for walls using 1/2-inch gypsum on the inside, and 7/16-inch structural sheathing on the outside (typical of most homes), there's enough bracing of the wall to use a smaller stud size. Check footnote 5 of the table. In our case, we'd use the next thinner stud size, 43 mil.

You'll also find the size and number of screws required to attach floor and wall sections in the subsequent tables in the *Prescriptive Method*. It also shows details for wall corners and track splicing to help guide you in building the house and to aid the inspector who'll be checking your work.

Headers (Appendix A, Table 6.15a)

Our next step is to size the headers for this house. A header is made up of two 2 × 8 shapes, configured in either a box shape or back to back. As we'll explore later (in the section on cut lists in Chapter 8), it's important to keep as simple as possible the cut list that you'll give to the manufacturer. This makes it easier for the manufacturer to cut the material, and for you to sort it out. For simplicity's sake, it may be to your advantage to look at all the wall openings up to 8 feet wide and make the headers out of the same size C-shapes. For an 8-foot span, 30 psf ground snow load, and a 28-foot building width, two 2 × 8 × 54 mil headers will do the trick for spans up to 8'3". You could go through and size all the other openings for different header sizes. However, if you did, your cut list would get complicated and you'd have to order and stock different-sized material. You don't want to keep any more sizes than necessary on the job site. That's important, because it's not easy to tell the material thickness unless you check the stamp on the stud or joist, or measure it with a micrometer. We'll discuss header details more thoroughly in Chapter 11, including a newer, more cost-effective, L-header.

The garage header is longer than any of the headers in the tables. So for our sample house, we need to have the garage header designed by an engineer. In this case it will consist of two 2 × 10 × 54 mil C-shapes.

King Studs (Appendix A, Table 6.18)

At each end of the header, we must install at least one king (full height) and one jack stud (under the header to the floor). Now we need to determine the number of king and trimmer (jack) studs. The tables show that for openings up to 3'6", you only need one king and one trimmer (jack) stud at each end of the header. For openings up to 8'0", we need two king studs and one trimmer (jack). Use the same thickness for these studs as for the wall studs.

Shear Walls (Appendix A, Table 6.20)

For shear walls, the *Prescriptive Method* allows you to use either oriented strand board (OSB) or plywood. Since we're using 24-inch spacings, we need 7/16-inch OSB or 15/32-inch plywood, both APA (American Plywood Association) rated. The table prescribes the minimum percent length of wall your house has to be sheathed in order to use plywood or OSB as your sheathing material. This means that a certain percent of each wall needs to be sheathed, not counting window and door openings. This helps keep the walls from racking.

The tables are based on roof pitch, which contributes to the wind load. Because a 5:12 pitch isn't listed in the table, we'll need to use the next higher pitch, which is 6:12. A minimum of 40 percent of the endwall and 30 percent of the sidewall must be covered, and without window and door openings. For our example, this would be 10'5" for the endwalls and 12'0" for the sidewalls.

NASFA is currently working to develop data for sheet steel shear walls. For the latest in new methods and materials, check their Web site at www.steelframingalliance.com.

X-Bracing

Currently, the *Prescriptive Method* doesn't specify X-bracing as a way to provide shear strength to a wall in place of plywood or OSB. You can use X-bracing, but it'll probably just add to the cost. For starters, you'll have to rely on the assistance of an engineer to design the anchors and screws at the end of the X-bracing, as well as the size of the straps. X-braces are also more labor intensive to install. You'll pay more for the fasteners you use to install siding and insulation directly to steel rather than to OSB or plywood. Unless you prefer using X-braces, wood or steel sheathing is usually more economical.

Anchors and Hold-Downs (Appendix A, Table 5.1)

Use 1/2-inch anchor bolts, 4 feet on center, with eight No. 8 screws (as shown in Figure 5.4 of the *Prescriptive Method*) to anchor the floor joist track or end joist to the foundation.

Roof Trusses

We'll use pre-engineered steel trusses for the roof framing in our example. That way, all the engineering and assembly will be performed by the manufacturer. We can get quotes from different manufacturers. Many wood truss manufacturers now also provide steel trusses (Alpine and Mitek are examples). Or, if you prefer, you can cut and stack the roof using steel roof rafters and ceiling joists. You can select these member sizes using the tables in the roofing section of the *Prescriptive Method*. We'll cover rafter framing in more detail in Chapter 13.

Hold-Downs (Appendix A, Table 8.14)

Regardless of the roof framing method you decide on, you *must* anchor it to the wall framing. The hold-downs for our design house should be rated for 100 pounds per foot.

Summary

Let's summarize the members we've selected for this house:

Floor joists:	2 × 8 × 43 at 24 inches on center
Subflooring:	23/32-inch TNG APA plywood (satisfies the 11/16-inch requirement)
Wall studs:	2 × 4 × 33 at 24 inches on center
Headers:	Two 2 × 8 × 54 up to 8'0" span
Garage header:	Two 2 × 10 × 54 (by engineer)
Trimmer studs:	One 2 × 4 × 33 up to 8'0" header span

King studs:	One 2 × 4 × 33 up to 3'6" header span Two 2 × 4 × 33 up to 8'0" header span
Wall sheathing:	7/16-inch OSB; full height of side walls and end walls
Anchors:	1/2-inch anchor bolts, 4 feet on center
Roof trusses:	Engineered
Hold-downs:	100 lbs./ft.

Planning for Plumbing, Electrical, & HVAC

You need to preplan your plumbing, electrical and HVAC just as you would with a conventionally-framed home. Run the lines for all your mechanical services to avoid interrupting structural framing members. This simplifies the planning of mechanical risers such as ducts, vents, and plumbing stacks that have to pass through the structure.

On your plans, have plumbing facilities for the kitchen, laundry, bathrooms, and water heater clustered together as closely as possible to minimize piping runs. In two-story homes, stack bathrooms and plumbing facilities vertically. With alignment framing, you can establish a clear vertical path without interrupting structural members. Try not to locate plumbing in exterior walls — it can interfere with their structural and insulation properties.

The electrical layout needs especially careful design. Generally, you should put the service panel close to the kitchen or utility area to minimize the length of heavy wiring runs.

Place heating and cooling equipment in a central location on the floor plan to ensure good air distribution and minimize duct runs. You may need vertical or horizontal chases for ducts, flues, or returns. Make sure these are incorporated in the plan to avoid complications with the structure or other utilities.

Above all, before you start work, find a plumber, electrician and HVAC installer who will work with you. Find out if they've worked with steel framing before. If not, they may want to charge more for the "fear of the unknown" factor. You may need to educate them on how to work with steel, or perhaps find another subcontractor in the field who has some experience with it. Their cost shouldn't be much more than what they charge for wood framing. Many builders have been able to lower their subcontractor costs through competitive bidding. You'll find more information on what your subcontractors need to know in Chapter 20.

Steel Framing Design

Congratulations! You've just walked through the steel framing design for a typical house — without having to spend big money on engineering costs. Bear in mind, though, that in some parts of the country, you'll still need the services of an engineer to check the member sizes, as well as the hold-down, sheathing requirements, and continuous load paths. However, this would also be required for a wood-framed house.

With the adoption of the *Prescriptive Method* in many areas, steel framing is now pretty much on an even playing field with wood framing in the building codes. Portions of the *Prescriptive Method* are being used in the *International Residential Code* adopted in 2000. Builders now have a guide to use for selecting stud, joist, and rafter sizes. Engineers have a standard to base their engineering on. Manufacturers have a guide to what materials to stock, and building inspectors have a standard to check to see that homes are being built properly.

Chapter 4

Light Gauge Steel

Before a steel stud or joist makes its way to your job site, it may be helpful if you understand how the material is produced. I encourage you to visit a stud manufacturing plant in your area. You'll not only become familiar with the process involved, you'll also understand how the manufacturers operate and how best to order material from them.

There are several different steps involved in producing a steel stud. We'll start with the molten steel itself.

Production of Molten Steel

There are two methods for producing molten steel, the integrated process and the electric furnace process:

- In the *integrated process*, limestone and coal are used to refine iron ore into molten iron in a blast furnace. The limestone removes the impurities from the iron. The molten iron is then combined with steel scrap to produce molten steel.
- With the *electric furnace process*, steel scrap is melted in an electric arc furnace to produce molten steel.

The electric furnace method consumes less energy and uses more recycled steel, which saves natural resources. And the steel produced is equal in quality, from a structural standpoint, to the steel produced by the integrated process. No matter which process is used, the steel product that's produced has a minimum of 25 percent recycled content. Industry-wide, its recycled content averages 64 percent. Steel is the most recycled product on the planet. The steel studs you use in your house may have once been an old refrigerator or car.

Sheet Steel

In most cases, the molten steel is poured into molds to make large rectangular shapes called *slabs*. The slabs are passed through a series of heavy rollers which roll the material into thin sheets of specified thicknesses. The sheets are then sent through a hot-dipped galvanizing process. This applies a zinc coating to protect the steel from rust. (For more information on corrosion protection, see Chapter 2.) Then the sheets are rolled into coils that weigh about 10 tons each. See Figure 4-1.

Figure 4-1
Steel coils

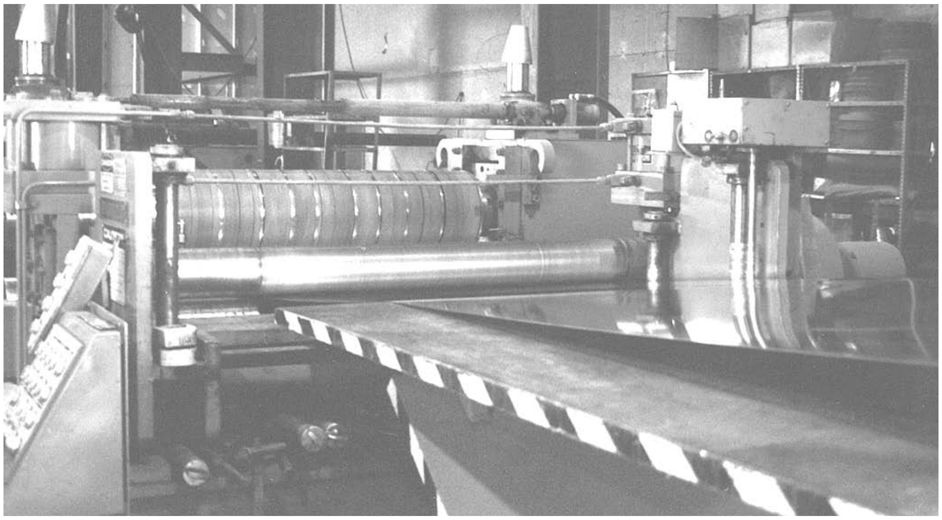


Figure 4-2
Slitter

Roll-Forming

The roll-forming manufacturer orders coils from the steel mills. The roll-former specifies the steel according to thickness, coating weight, and type of steel. After the coil arrives at the roll-forming facility, it's run through a *slitter* (Figure 4-2) to cut the sheet product into various strips or "ribbons" of steel. These ribbons are cut in the exact widths necessary to roll-form the different shapes.

Next, the steel ribbons are brought to the roll-forming machine (Figure 4-3). The ribbons are fed into the machine on a spool and the steel is put through a series of roll-forming dies that form the sheet into the desired shapes, like C's, track and hat channels. Modern roll-forming equipment is computerized, and the operator keys in the number and the length of the steel sections to be formed. The dies are set to roll the specific size and shape required, such as a $3^1/_2$- or $5^1/_2$-inch wall stud, 8 feet long.

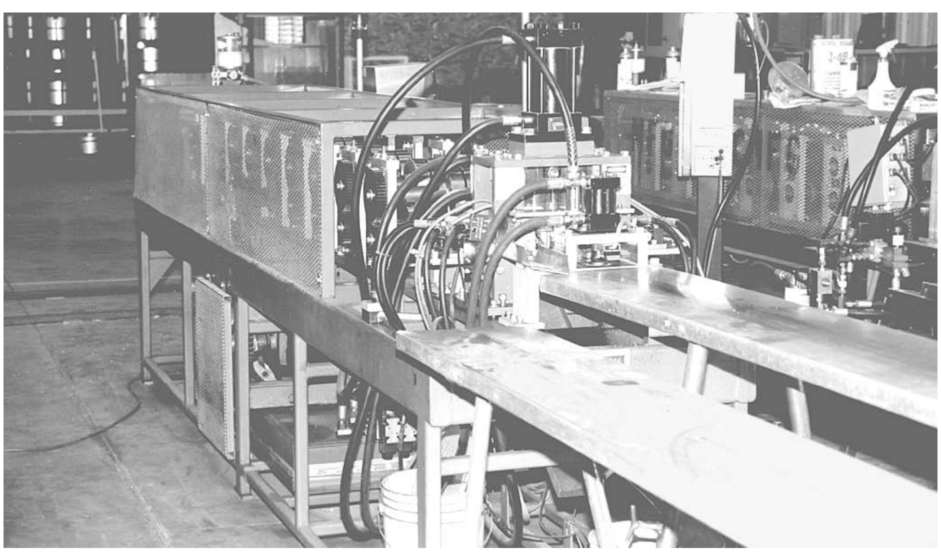


Figure 4-3
Roll-forming machine

Most roll-formers mark their product with an imprint or stamp, as shown in Figure 4-4, to identify the steel. This makes the steel easy to identify, especially if you're not used to distinguishing between the different thicknesses. Some manufacturers also use a color code to indicate gauge.

Figure 4-4
Stud markings

Purchasing from Manufacturers and Distributors

Some steel builders order steel directly from roll-forming manufacturers. It's important to recognize that until recently, most roll-formers have been only supplying commercial jobs. Commercial projects often use standard lengths, in large quantities. That means the roll-formers are able to roll these shapes quickly in a production setting.

Because of the relatively smaller quantities you'll require, the roll-former may have to slow down his equipment to roll your steel. Take the time to meet with your roll-former to discuss his capabilities and his willingness to roll your steel. He may even have some suggestions on how you can simplify your cut list to help reduce costs.

If you purchase your steel directly from a roll-former, have them package and label your steel according to the way you've written your cut list. Whenever possible, your truss parts should be kept together, wall studs in another bundle, and header material in yet another bundle. See Figure 4-5. This makes it easier for you to stage material at the job site.

You may also want to have your manufacturer cut much of the material to length, which will save you time in the field. Figure 4-6 shows lengths of precut material. This will probably be an additional cost, but the time saved may make it worth it.

Figure 4-5
Marking steel packages

Figure 4-6
Cut-to-length steel product

Most roll-formers, however, don't sell directly to contractors, so you'll need to buy from distributors and dealers the same way lumber is sold through lumberyards. Many lumber suppliers are also beginning to stock steel studs.

Once the *Prescriptive Method* is widely distributed, lumber suppliers will be able to recommend steel stud and joist sizes in much the same way they do for lumber today. It usually takes one to three weeks to get your steel back from the roll-former after you turn in your cut list. Having the material in stock at a distributor will certainly save time. Some distributors may only carry stock lengths of material, so you'll have to make more cuts in the field. Other distributors will work with you to provide cut-to-length product. Explore all your options, price them out, and decide which works best for you.

Ordering Material and Shipping

Once you're ready to place your order, provide a clean copy of your cut list to your manufacturer or distributor. The manufacturer will take your cut list and translate it into a work order for the plant. If you're ordering from a distributor, find out whether you'll have to purchase stock lengths or if they'll cut the steel for you. If you must purchase stock lengths, you might need to look at the lengths in your cut list and adjust your order.

Finally, agree on a delivery date for your steel. The manufacturer or distributor will deliver the steel to your job site on a flatbed truck. Typically, you'll need to provide a forklift to off-load the steel. See Figure 4-7. If you'll use the material right away, you don't have to protect the steel from the elements. If you won't be using it within three or four months, keep it dry to protect it. That way, the zinc coating won't be used up before you finish building the home.

Figure 4-7
Off-loading steel trusses with a forklift

Chapter 5

Steel Framing Tools

One of the myths about steel framing is that you have to spend a lot of money buying new tools. That's not necessarily true, because you may already have the basic tools you need to get started. Let's look at the tools you'll need to frame with steel.

Fastening Tools

Steel framing members can be fastened together with screws, nails (or pins), by welding, or by clinching. The most popular method by far is to fasten with screws.

Screwguns

Because the screw is the most common fastener used in steel framing today, the electric screwdriver or "screwgun" is the primary tool on the job site. See Figure 5-1. You'll need a screwgun to connect the steel members to each other as well as to attach plywood and drywall to the steel.

You may say, "I have one of those in my tool box." Maybe you do, but chances are you have an electric drill instead. Electric drills (sometimes called drill motors) aren't really designed to install screws, and they don't properly hold bit tips. Typically, they don't run at variable speeds and may not run at the correct rpm to do the job you need. Also, using a drill, the screw will spin as soon as you squeeze the trigger. With screwguns, the screw will only spin when pressure is applied to fasten the screw. This allows you to place a screw on the bit tip with the gun still running. For speed on the job site, you'll find this a valuable feature.

Always use industrial-grade screwguns. You probably won't find them at a home center. The ones sold at the home centers are typically light-duty models, suitable for the homeowner to use on the occasional do-it-yourself job. You'll find professional-quality screwguns at a tool or drywall distributor. These industrial-strength screwguns are usually 5-6 amps minimum and the clutch housing is metal, for durability. A 0-2,500 rpm gun is best for framing. The faster ones tend to burn screws before they penetrate the steel.

The first time you hold a screwgun, it may feel awkward. Notice how the back of the screwgun is contoured to fit your hand. Screwgun manufacturers design their tools so that they're comfortable to hold and use. In order to drive a screw effectively, you need to apply pressure through your arm, through the screwgun, and into the screw. You can't hold a screwgun down on the handle as you would a handgun. If you do, it'll be unstable and you won't be able to apply the right amount of pressure. You need to grip the gun high on the handle. When you hold the screwgun correctly, as shown in Figure 5-2, you can use your third or fourth finger as the trigger finger and your other fingers will fit around the housing.

A balance of finesse and pressure is necessary to get the drill point of the screw to penetrate the steel layers. Start the screw spinning *slowly* to allow the drill point to cut through the steel. Some first-time framers make the mistake of starting the screw at full

Figure 5-1
Screwgun

speed. This is too fast for the drill point to cut the steel. The result is the screw will simply spin against the steel and not penetrate it. If you're persistent, the screw will overheat and could even get hot enough to melt. Once the drill point goes through, you can increase the speed of the screwgun until the screw is firmly seated. If set properly, the screwgun will "cam out." We'll explain that in the section called Adjustable Clutch Screwguns, just a few paragraphs on.

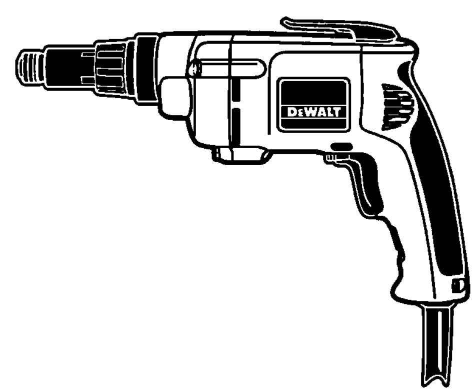
Figure 5-2
Holding a screwgun

Some trainees complain that it's difficult to rapidly feed or feather screws onto the tip of the screwgun. This slows them down. You can move rapidly if you keep a few screws in your hand and a good supply in your pouch. While installing one screw, have your free hand busy preparing the next one. Then, once you install one screw, you can immediately move on to the next one. It takes a while to get used to this and get into a rhythm. Most drywallers have it down to a science. Later in this chapter, we'll take a look at collated attachments that automatically feed screws into the bit tip using plastic strips. They may be able to speed up your production.

In our training sessions it usually takes the first-time users a few minutes to get used to working with a screwgun. By the afternoon of the first day, however, they're pretty efficient with it, and getting better at feathering screws.

Adjustable Clutch Screwguns

The screwgun that works best for steel-to-steel connections is the adjustable clutch screwgun (Figure 5-3). A common problem in screwing steel members together is over-torquing the screw after it's seated. This can cause the threads of the screw to strip the hole, so the screw spins around freely. When that happens, the connection won't achieve the proper design strength for pull-out. The adjustable clutch



Courtesy: DeWalt Industrial Tool Company

Figure 5-3
Adjustable clutch screwgun

screwgun really helps the beginner avoid this situation. An adjustment on the screwgun allows you to set it to stop turning after a certain torque is applied to the screw. This is called "camming out." Experienced framers know how to back off drywall screwguns to prevent stripping, but it takes time to develop that skill. An adjustable clutch screwgun is the best thing for an inexperienced steel framer to use until he or she develops a *feel* for the job.

Your adjustable clutch screwgun should be variable speed, with a speed range of 0-2,500 rpm. (An operating speed of 1,800 rpm is recommended for $^1/_4$-inch-diameter screws.) It should also have a reverse switch. The reverse switch comes in handy when you need to back screws out of temporary bracing.

Another good feature of the adjustable clutch screwgun is a quick-change bit chuck. You just lift up the chuck to remove the bit tip holder when changing between hex and Phillips tips.

Figure 5-4
Drywall screwgun with nose piece

Drywall Screwguns

While the adjustable clutch screwgun works well for framing with steel, it wasn't designed to attach plywood or gypboard to steel. For this application, you'll need a drywall screwgun. Make sure your drywall screwgun is also industrial strength, with 5 amps minimum. It should have a faster variable speed, capable of reaching up to 4,000 rpm for 18- and 27-mil material (0-2,500 rpm is suitable for 33-mil material steel and thicker). Make sure that it's reversible and that it has a removable, depth-setting nose piece like the one shown in Figure 5-4 for sheathing and gypboard. The nose piece will control the depth of the screw, and keep it from going through the plywood or gypboard. You can void the warranty on gypboard if you break the skin.

Experienced drywallers leave their screwguns running. This helps them screw gypboard faster and also keeps the tool cooler. One nice feature about a drywall screwgun is that the bit tip doesn't spin until pressure is applied. This allows you to place a screw on the tip while the screwgun is running.

Drywall screwguns aren't recommended for steel-to-steel connections, especially the 0-4,000 rpm models. They don't have an adjustable clutch to prevent screws from stripping, and they often burn up screws because they spin too fast.

Cordless Screwguns

A cordless screwgun can be a real asset on the job site. They're especially handy for reaching difficult spots where you have only a few screws to install and it's a hassle to run an extension cord. If you've ever had to untangle an extension cord while framing, you'll appreciate a cordless model. However, cordless models tend to be more expensive and the battery may not last all day. If you like using a cordless screwgun for all your work, keep a spare battery and charger handy. That way, while you're using one battery, the other can be recharging. Cordless models work very well for tasks such as setting trusses, interior framing, siding and trim work.

Bit Tip Holders

The majority of the screws used in steel framing have a hex or Phillips head, so you'll need to carry both these types of bit tip holders in your pouch. The No. 2 Phillips bit tip works well in a magnetic bit tip holder. For the hex-head screws, a $^5/_{16}$-inch magnetic hex driver works best. Get a 2-inch bit tip holder to help you get into those hard-to-reach places. You may even want to pick up a longer, 6-inch hex driver for really tough spots. Figure 5-5 shows a Phillips bit tip, bit tip holder, $^5/_{16}$-inch hex driver and a 6-inch hex driver.

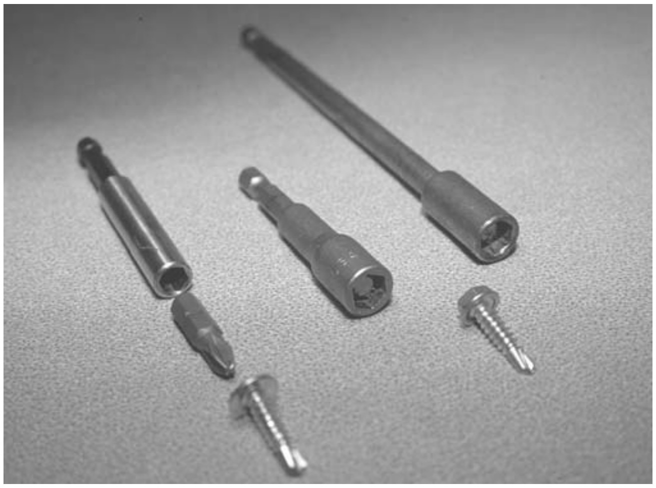


Figure 5-5
Phillips bit tip holder, Phillips bit tip, hex drivers

Figure 5-6
Collated attachment

Figure 5-7
Stand-up attachment

Collated Attachments

We've already begun to see improvements to screwguns with collated attachments. These attachments help speed production, like nail guns do in carpentry. If you plan to rely on collated attachments, it's important that you first have good basic screwgun skills to rely on, in case you drop and break your collated attachment. Once you learn to work with a screwgun, you can easily step up to the fancier tools as finances permit. Remember, many of the new collated attachments have only been on the market a short time and not all of the bugs have been worked out of them. Make sure that the manufacturer will stand behind any equipment you buy. Figure 5-6 shows a collated attachment on a screwgun.

Quick Drive and *John Wagner and Associates (Grabber)* are two manufacturers of attachments that work well with steel framing. Their new systems, *Super Drive* and *Quick Drive*, show real promise in saving framing time because you don't have to feather screws.

Another tool that's helpful when you're screwing down subflooring is a stand-up attachment for your screwgun. This will save your back and make your subflooring application easier. One such attachment by Grabber is shown in Figure 5-7.

Nail Guns

Advancements have also been made with pin fasteners (or nails), and there are now pneumatic nail guns available for attaching sheathing and subflooring.

These really speed up the application of plywood or OSB, since it takes less time to drive a pin than it does to install a screw. Figure 5-8 shows a nail gun in use. However, pins don't necessarily eliminate screws. If you're working in an area with cyclic windloads or special seismic conditions, you'll usually need to screw the perimeter and nail the field. Often, these two types of fasteners complement each other very well, but you're going to need an air compressor for the nail gun.

If you want to nail your subflooring, work closely with the manufacturer for the correct installation. Otherwise, you may be busy responding to callbacks for squeaky floors.

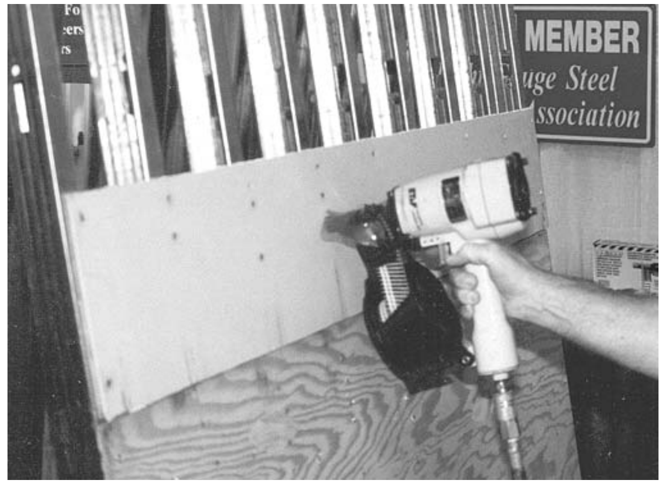


Figure 5-8
Nail gun

Clinching and Welding

Portable clinching tools are now available to press-form two or more layers of steel together. They're relatively new on the market, and some, like Attexor, have code approval. Companies like Attexor are making these tools smaller and more portable.

Welding is another method for fastening cold-formed steel. You can use MIG welders as long as certified welders make the weld and use touch-up paint to repair the galvanized coating.

Cutting Steel

Steel can be cut during production or in the field. With production cutting, the manufacturer or distributor uses a hydraulic shear or other device to make the cuts. See Figure 5-9. You can make field cuts using electric shears, aviation snips, a chop saw, a circular saw, or a portable hydraulic shear.

We briefly discussed production cutting in Chapter 3. Having your manufacturer or distributor cut the steel for you, using your cut list, can save you time. There's not yet an easy, cost-effective and clean method to do field cutting. One option that's available is a portable hydraulic shear. They cost about $200, but it may be worth the cost if you have many cuts to make.

A chop saw uses an abrasive blade that cuts quickly, but they make a lot of noise and create a lot of flying hot metal chips. Chop saws are very effective for making square cuts. They can cut a bundle of drywall studs at one time, but the resulting cut will have a rough edge with sharp burrs left on the steel. The burrs may rust, but the cut will be protected by the galvanized coating on the steel. You'll only need to coat the raw edge if it will be exposed to moisture. Figure 5-10 shows a chop saw in use.

Electric shears that can cut up to 68-mil material are also available. They were originally designed to cut sheet metal. Once you get the hang of using them, they can be very useful on the job site. See Figure 5-11. Some steel framers actually prefer these shears to using a chop saw. They may have a struggle when going around the tight radii on the

Figure 5-9
Manufacturer shear

Figure 5-10
Chop saw

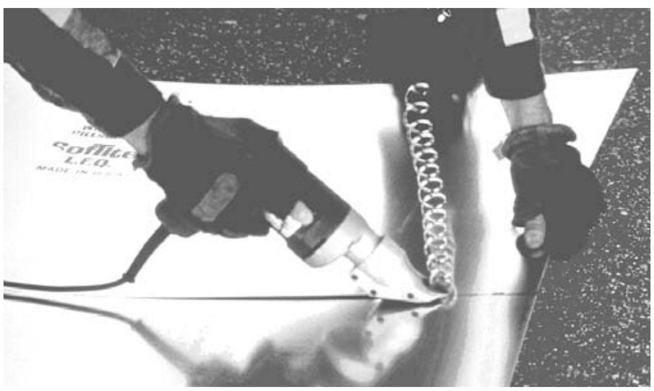


Figure 5-11
Electric shears

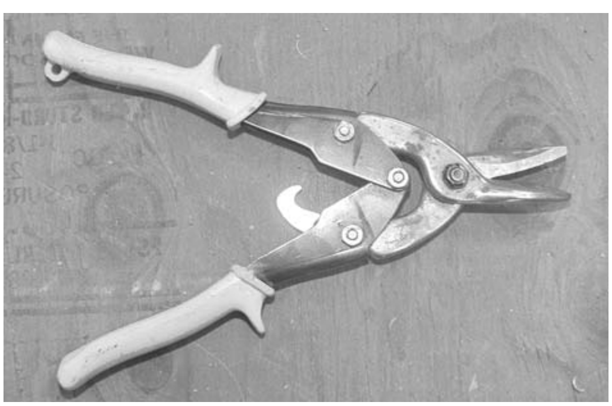


Figure 5-12
Aviation snips

flanges of a stud or joist, but electric shears make a smooth cut and don't leave burrs behind. The drawback is that the blades are expensive. Cordless models will soon be on the market. Electric nibblers are also available for cutting steel.

Aviation snips, like those shown in Figure 5-12, are useful when cutting and coping steel. An experienced steel framer can cut up to 43-mil material with these snips, but you might want to use them for 33 mil or less when starting out, until your hand gets stronger. Aviation snips come in three different types, for right-handed, left-handed, and straight cuts. If you're right-handed, buy the red-handled snips that make left cuts. If you're left-handed, buy the green-handled snips that make right cuts. The yellow-handled snips make straight cuts. You'll probably need two pair of snips per person: one yellow-handled and one green- or red-handled.

You can also use circular saws to cut steel. Residential contractors like the portability of the circular saw. Short-toothed blades, installed backwards, have been used by some contractors. They cut effectively, but they're very noisy to use. Carbide tipped blades cut quickly and they're not as noisy. They cost between $40 and $50, depending on the manufacturer.

Another method of cutting available for steel is a plasma cutter. Plasma cutters produce an electric arc that melts through steel. They cost around $1,000 or more, depending on the model, but they cut very quickly. They're popular with plumbers because of the speed of their cuts. I recommend plasma cutters over hole punches or drills because they save time. That's assuming they're in the hands of a competent person — one who knows where to cut the steel without destroying the structural properties. Figure 5-13 shows a worker using a plasma cutter.

As you can see, all of the cutting methods have their advantages and disadvantages. We're looking forward to new technology which will overcome the disadvantages. Metal circular saws that run quieter than a chop saw and catch all the metal shavings have been developed in Japan. When it's widely available, this type of technology will really help in cutting rafter tails, soffit framing, or just about anywhere that you need to make a field cut. Unfortunately, there are still problems with the cost and durability of blades.

Figure 5-13
Plasma cutter

Figure 5-14
Locking C-clamps

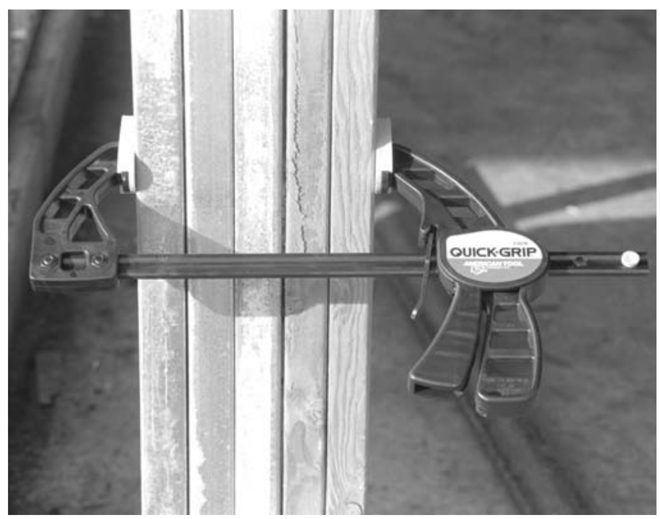


Figure 5-15
Bar clamps

Clamps

Locking C-clamps come in very handy when you're framing with steel. They act like an extra hand, temporarily holding framing members together. There are a variety of clamps available, with different jaw depths and throat openings, for use in almost any situation. When you're screwing two layers of steel together, there's a tendency for the screw, once it penetrates the first layer, to push the second layer *away* rather than screwing through it. A locking C-clamp like the one in Figure 5-14 helps prevent this "jacking," and allows the screw to drill through the second layer without resistance. The time you take to put a clamp on is time well spent. You won't waste time backing out a screw that didn't penetrate the second layer. The most commonly-used Vise-Grip clamps are the 6R, 11R, and the 18R sizes.

Another useful tool is a bar clamp. The Quick-Grip Bar Clamp has recently been improved to increase its jaw depth to $5^{1}/_{2}$ inches. This works really well with steel framing. You can use bar clamps to hold headers in position when you're placing them in a wall or other applications, as shown in Figure 5-15.

Bending Steel

On some projects, you'll need to bend flat stock to use as fascia, ridge cap or some other application. To bend steel, you'll either need to send it to a sheet metal shop or buy a brake press of your own. This decision depends on how serious you are about being a steel framer. If you use details that call for a lot of bent steel, you might want to make the investment. A 10-foot brake press works well for most job applications. You can easily spend \$3,000 to \$5,000 on a brake press. Compare this with paying a sheet metal shop every time you need to bend steel. Figure 5-16 shows a framer using a brake press on the job.

Figure 5-16
Brake press

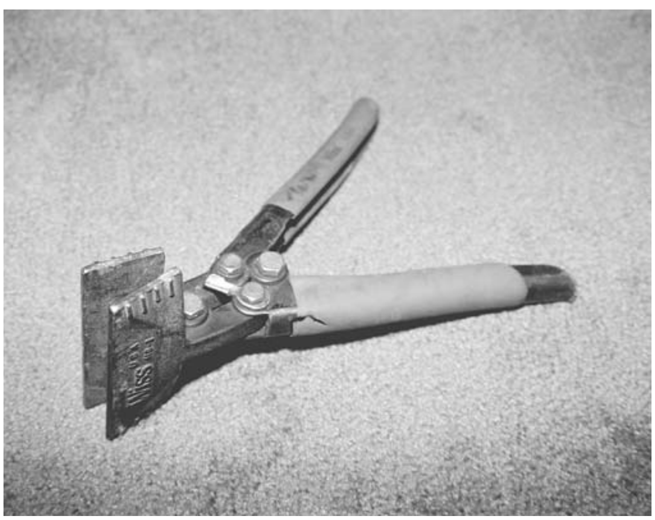


Figure 5-17
Hand seamers

For small bends, a pair of hand seamers (Figure 5-17) will do the job. Sometimes nicknamed *duck-billed pliers*, this tool has a 3-inch (or 6-inch) flat jaw. You can use it to bend the web or flange for the sills around window and door openings.

Miscellaneous Tools

There are several other tools you may want to have around. A magnetic level works really well with steel framing (just don't forget to take it off the wall stud before closing your wall!). You'll also need speed squares for marking right-angle cuts on studs and joists, felt tip markers for marking the steel, a pair of bull-nose pliers for removing stubborn screws, a hammer or drywall ax for tapping or positioning steel, and, of course, a tape measure, preferably a 30 footer.

You'll need a comfortable tool belt with enough pouches for the two or three different kinds of screws that you're going to need. Once you hang a few of the tools like clamps and a drywall ax on your belt, you may also want to buy a pair of suspenders to keep your belt (and your pants) up!

Figure 5-18 summarizes the tools you'll need to get started framing with steel.

It's really encouraging to see many of the tool manufacturers coming out to job sites, to work with steel and test their tools' performance. Many of them have already made improvements to their tools. Companies like Black & Decker, DeWalt, American Tool, John Wagner & Associates, Compass, ET&F, Attexor, Senco and others have participated in training sessions, and seen firsthand how their tools perform. Because of their interest, we can expect to see even more improvements to screwguns, saws, clamps, shears, clinches and more, in the near future.

Fastening Tools

DeWalt 268 SR, Versa Clutch Screwdriver — with 6.5-amp motor, 0 - 2,500 rpm variable speed reversible, 1/4" quick-change bit chuck, metal gear housing, adjustable torque control for framing.

DeWalt 276 Drywall Screwdriver — with 6.5-amp motor, 0 - 2,500 rpm variable speed, reversible, with depth-locating nosepiece for sheathing and gypboard installation, metal gear housing. (Or DW 274 for thin steel.)

DeWalt 979K Cordless Drywall Screwdriver — with 1/4" quick-change bit chuck, 1 hour charger and extra battery.

Magnetic Bit Tip Holder and No. 2 Phillips Bit Tips

5/16-inch Magnetic Hex Driver, 2" and 6" long.

Vise-Grip 6R Locking C-Clamps with regular tips — two pair, one pair of 11R's, and one pair of 18R's for clamping steel together while fastening.

Quick-Grip 53016 Bar Clamp — clamping headers in wall sections while fastening.

Cutting Tools

Prosnip Aviation Snips (Left Cut [101] for right-handed framers, Right Cut [102] for left-handed framers) — for cutting up to 43-mil material and making cuts for coping track.

DeWalt 14-Gauge Swivel Head Electric Shear — cuts up to 68-mil material, including C-sections and flat material.

DeWalt 14-inch Chop Saw — good for cutting multiple sections simultaneously, especially bundles of gypboard studs.

Unibit Step Drill Bit, 1" — for drilling holes in studs in track for anchor bolts, etc.

Caddy Hole Punch, 1 1/4" — punching holes for the installation of electrical and plumbing systems.

Miscellaneous Tools

Wiss 3 1/2" and 5" Hand Seamers — bending and coping track.

Bull Nose Pliers — removing screws.

Magnetic Level — frees hands during wall leveling.

Felt Marker — makes clear marks for layout and cuts (black and red).

Tape Measure

Speed Square

Utility Knife

Drywall Ax

50-foot Grounded Extension Cords

Carpenters' Pencils

Figure 5-18
Sample list of steel framing tools

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Chapter 6

Steel Framing Fasteners

A lot of attention is currently focused on the fastening process for steel framing. Whether you look at screws, pins, welds or clinches, critics say that it either costs more or takes more time than nailing wood members together. New tools and fastening techniques are being developed all the time, but for now you have to use what's available and try to simplify your methods to keep your costs down. As a steel framer, you know that it may cost $400 more to use screws, but you may be able to absorb that cost in the savings you get in the cost of the steel package. Let's take a look at the fastening systems available today.

Screw Basics

Imagine a set of plans for steel framing with so many different types of connections and screw sizes that you'd need a half-dozen different types of screws to do the job. Don't laugh — it's been done before. But it doesn't have to be that way. The key to fasteners in steel framing is keeping them simple. The fewer screws, the better. How many pouches do you want to carry on your tool belt anyway?

In wood construction, the connection relies on the friction of the nail in the wood to provide pull-out strength. For steel fastened with screws, the connection is developed by the shear capacity of the screw. Holes are not predrilled in steel framing. Screws must be able to make their own holes before they engage. These "tapping" screws conform to the specifications SAE J78 and ASTM B633, screw industry standards.

Let's look at the different parts of a screw and the function of each part. Then, when we talk about an application, you'll have a better understanding of *why* we recommend a certain type of screw. Or if you have a unique application, you may be able to select one on your own.

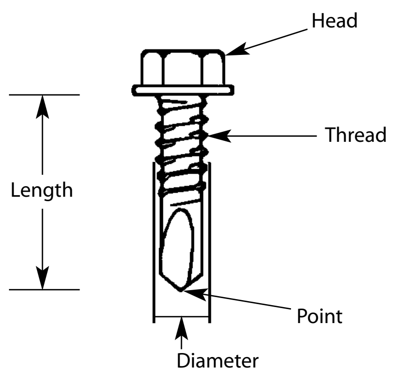
A typical screw has a head, drive type, thread, diameter, point, length, and plating. Figure 6-1 shows the different parts of a screw.

Head Styles

We use several different styles of screw heads in steel framing. The most common head styles are pan, round washer, modified truss, hex washer, truss, oval, flat, pancake, and wafer (Figure 6-2). The head of the screw locks the screw into place and prevents it from sinking through the layers of material. The head also contains the drive type required to install the screw. In order to choose the right head style to use, you must look at the application.

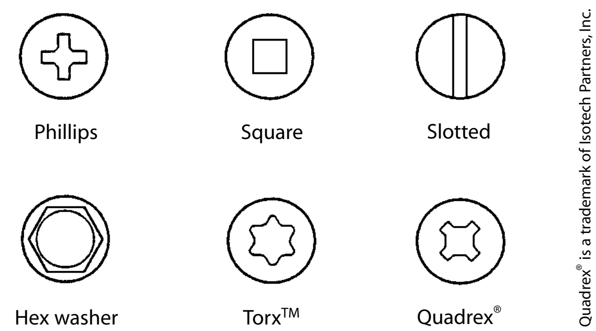
For steel-to-steel connections, the hex washer is most popular. When you're applying sheathing or gypboard, the modified truss or pancake head styles are preferred. They have a low profile that prevents blow-outs or bumps from occurring in the gypboard at the screw locations.

When you attach plywood, OSB or cabinets to steel, you need a fastener that's flush with the surface of the wood. Flat, bugle, and wafer head screws are excellent for this application. For installing baseboard and other trim, use the small trim head screw.



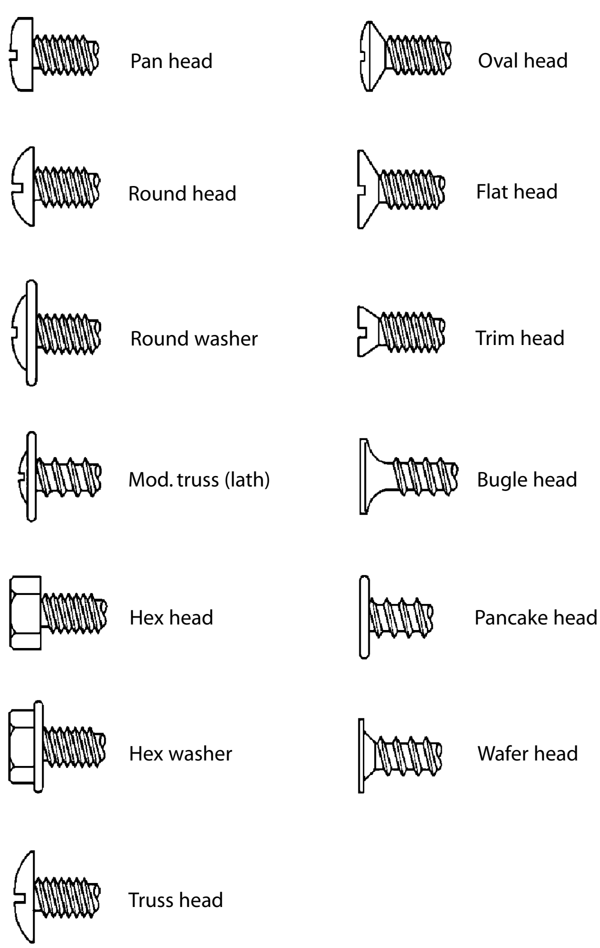
Courtesy: Light Gauge Steel Engineers Association

Figure 6-1
Parts of a screw



Courtesy: Light Gauge Steel Engineers Association

Figure 6-3
Drive types



Courtesy: Light Gauge Steel Engineers Association

Figure 6-2
Head types

Drive Types

The drive type of the screw determines what kind of bit tip you need to drive the screw. Figure 6-3 shows six different drive types. The bit tip needs to turn the fastener quickly, fit securely, and release quickly once the screw is driven. The most common drive types are the Phillips and hex washer drives. As with any recessed slot, you need to be concerned with the bit tip remaining in the head of the screw. If the bit tip comes out of the holder, it's an annoying waste of your time.

The hex head is the best system because it provides the most positive connection between the driver and the head of the screw. This positive connection makes it easier for the screw to penetrate the steel. Since the screw won't fall out of the driver as easily as a Phillips head screw, you should try to use a hex head screw in as many locations as possible. Unfortunately, the hex head protrudes above the steel quite a bit, so it's not good for some applications. For example, you'll get "blow-outs" at the screw locations when you apply gypboard over hex screws. So if you're going to cover the screw with gypboard or plywood, you'll need to use another head style. Modified truss or pancake head screws have low profiles. Either would be a good choice for these applications.

Threads

For optimum cutting, use coarse-thread screws for light gauge steel. For thicker steel (cold- or hot-formed), you may need to use screws with finer threads, and reduce the rpm on your screwgun.

Diameter

The diameter of a screw is measured from the outside of the threads on one side to the outside of the threads on the other (Figure 6-1). The screw size itself is a number designation that correlates to the diameter of the screw. For most connections, a No. 8 screw (with a nominal diameter of 0.164 inches) provides enough fastening strength. Figure 6-4 shows typical screw diameters.

Screw Number	Screw Diameter (inches)
6	0.138
8	0.164
10	0.190

Figure 6-4
Screw diameters

Point Types

In steel framing, the point of the screw you choose is very important. You always use a tapping screw because of its ability to "tap" its own threads when you're driving it into the material. There are two types of tapping screws used in steel framing: self-drilling and self-piercing screws.

The self-drilling screw shown in Figure 6-5 drills through the layers of steel before any threads engage. If the drill point is too short, the first layer of steel will climb (or jack up) the threads while the drill point attempts to cut through the subsequent layers. Usually the screw will bind or break off, producing not only a bad connection, but also a frustrated framer. You can order screws with different point styles. The higher the number, the longer the drill point. For basic steel-to-steel connections, a No. 2 point style is adequate. For thicker layers of steel, you'll need a longer point style or maybe even a thicker diameter screw, plus a longer point style. Table 2.6 in the *Prescriptive Method* shows recommended screw sizes.

Figure 6-5
Self-drilling screw

Figure 6-6 shows a self-piercing screw. It doesn't have a drill point, but it does have the ability to tap threads into 18 and 27 mil steel. It's usually used to attach plywood or gypboard to thin layers of steel. Self-piercing screws have sharp points that can penetrate the thin layers.

Figure 6-6
Self-piercing screw

Length

You measure the length of a screw from the bearing surface of the fastener to the end of the point (refer back to Figure 6-1). Pay particular attention to length when you're ordering screws. You need to make sure that the drill point and three exposed threads will be able to penetrate beyond the thickness of the material you're fastening. This will ensure that the screw has developed its design strength in the connection. For most steel-to-steel connections, $^{1}/_{2}$-inch or $^{3}/_{4}$-inch screws are acceptable.

Plating

Different screw manufacturers use different types of platings to protect their screws from corrosion. Self-drilling screws are typically zinc plated, although manufacturers have developed many specialty platings that they can also apply to screws. The common standard for self-drilling screws is compliance with a 96-hour salt spray test. This is adequate for normal construction practices, where you close your walls within a few months after they're framed. Typically, screws have a thinner layer of zinc than the steel studs and joists, and they'll rust first if left exposed to moisture.

If you're framing or paneling a house where the walls are going to remain exposed to the weather for longer than a normal construction schedule, you may want to spray your screws with a rust-inhibiting paint to prevent corrosion. Also, thicker layers of steel can cause the screws to heat up during their installation, breaking down the metallic coating. If you penetrate three to four layers of steel, especially when using 54-mil steel or thicker, you may also want to coat the screws if the panels will be exposed to the elements for a long period of time in a damp environment. Remember, once the screws in the wall panels are dried inside the wall cavity, the corrosion will stop. Steel and zinc need water for corrosion to occur.

Framing, Sheathing and Gypboard Screws

Given all this information, what screws do you need to use? You have several choices, depending on your application. The next three sections will provide you with suggestions for the framing, sheathing, and gypboard screws you might want to use.

Framing Screws

In framing, there are two screws that do just about everything (Figure 6-7). For areas where you have gypboard and sheathing, use a minimum No. 8, $^1/_2$-inch low-profile (modified truss or pancake), self-drilling screw. For all other areas up to three layers of 33-mil material, use No. 10, $^3/_4$-inch hex-washer head, self-drilling screws. If you run into areas where you have more layers of steel, you may need a few No. 12 screws, but that should be rare.

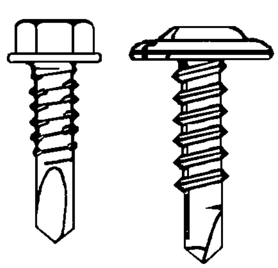


Figure 6-7
Two framing screws

Sheathing Screws

You need a different type of screw for attaching sheathing. With exterior sheathing, whether you use plywood or OSB, you'll need to use a screw that can do three jobs. It must drill through the wood, then the steel, and finally the threads must pull the plywood tight to the steel. The size and type of screw you use will depend on the thickness of the plywood and the steel. A minimum No. 8 self-piercing screw will do the job if the plywood is $^1/_2$ inch or less and the steel less than 33 mils. Be careful that the plywood doesn't climb the screw. It must be pulled tight against the steel. Otherwise, the sheathing material won't provide the proper shear strength for the wall.

For thicker steel and plywood, select a No. 8 self-drilling screw with a drill point that's at least as long as the plywood is thick. This will allow the screw to penetrate the steel without the plywood climbing the threads. After the drill point penetrates the steel, the threads engage and pull the plywood tight up to the steel. The screw diameter you need will depend on the thickness of steel you're penetrating. Check Table 2.6 of the *Prescriptive Method* for recommended screw diameters.

An additional option is the No. 10 laminator-type gypboard screw. It may save you a lot of time when you're attaching plywood or OSB to steel, as long as the steel isn't more than 43 mils thick. Its coarse threads and self-piercing point penetrate the plywood and steel quickly, and an experienced framer won't have any difficulty getting the plywood to draw tightly to the steel. If you're not used to working with a screwgun, however, you may want to stay with the self-drilling screws.

No matter what screw you select for installing sheathing, make sure it has a head that will be flush with the plywood. Use a flat, bugle or wafer head screw. Also, be sure to use a depth-setting nosepiece on a drywall screwgun. If you over-drill the screw through the plywood layers, it will reduce the effectiveness of the connection and void any warranty on the plywood.

Gypboard Screws

For attaching gypboard to steel framing, a No. 6 self-piercing (sharp point), bugle head screw (sometimes called a drywall screw) works well. Use a depth-setting nosepiece to avoid screwing straight through the gypboard. If the steel is thicker than 33 mils, you may need to switch over to a self-drilling screw.

Foam Insulation Fasteners

In colder climates, or where builders don't use plywood or OSB, foam insulation is often used. It can increase the R-value of the wall, and also provides a backer for stucco. If you use foam over structural sheathing, simply use roofing nails or staples to hold the foam in place. Where you install foam directly over the steel, you can use a minimum No. 6 self-drilling, low-profile screw, such as a modified truss, pancake or wafer head. The screw has to be long enough to penetrate the foam and leave three exposed threads through the steel. Use a plastic washer to keep the screw or nail head from penetrating the foam. You can buy screws with plastic washers already in place.

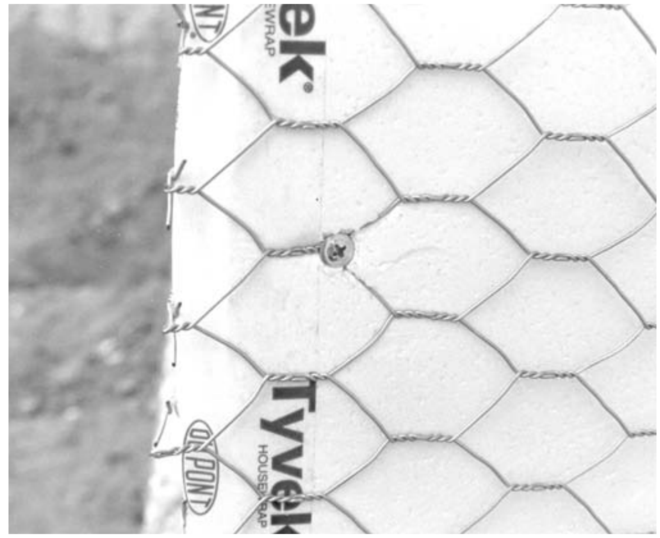


Figure 6-8
Attaching lath to foam

Stucco Lath Attachment

If you're using stucco, you'll need to attach the metal lath or chicken wire to the wall before plastering. With structural sheathing, simply nail or staple the lath to the sheathing. With foam insulation, use a minimum No. 8 drill-point screw to drill through the foam backing and into the steel. This isn't an easy task, as the screw has a tendency to flop over. And the longer the screw, the more unstable it is. Figure 6-8 shows lath attached to foam insulation with screws.

Siding Attachment

Different types of siding require different fasteners. For wood siding over structural sheathing, you may be able to nail to the sheathing, depending on the manufacturer's recommendations. For attaching siding to steel, you'll need a minimum No. 8 self-piercing, bugle head screw. Use self-drilling and larger diameter screws for steel thicker than two layers of 33 mil. For cement composite siding, such as Hardie Board, you may need to use a screw with wings that will slightly over-bore the hole to prevent the board from "jacking." The wings break off when they hit the steel and the screw pulls the siding tight to the steel. Some bugle head screws come with nibs on the underside of the head. These help countersink the screw into the siding without stripping the threads in the steel.

Figure 6-9 gives a summary of the screws you can use, and the possible applications for each screw. Once you know your siding and the thickness you need to penetrate, you'll be able to identify the type of screw you'll need to complete your steel frame.

Drive Pins and Nails

Companies like Aerosmith, ET&F, ITW Paslode, Bostich and Senco have been working closely with steel framers to develop pin fasteners and staples for steel applications. Pneumatic nail guns, like those used in wood framing, greatly increase productivity at the job site. You can apply plywood or OSB sheathing using 1- to $1^1/_2$-inch pneumatic pins. These are easily identified by the spiral grooves on the pins. The grooves help draw the pin tight when it's driven into the steel.

Pins have been tested and proven for shear strength for wall and roof sheathing applications (Figure 6-10). In order for the pins to work effectively, the plywood must be held tightly against the steel before the pin is driven. The pin itself won't pull the plywood tight. Roof sheathing is easier to install with pins than wall sheathing, because the installer usually stands on the plywood, adding his weight and pressure to the application. When

Application	Fastener
Steel to steel, nonbearing (less than 33 mils)	No. 6 minimum, self-piercing, low-profile[1] screws
Steel to steel, loadbearing	No. 8 minimum, self-drilling, low-profile[1] screws where gypboard and sheathing are installed, hex washer-head screws elsewhere
X-bracing	No. 8 minimum, self-drilling, low-profile[1] screws
Gypboard	No. 6 minimum, self-piercing screws for 33 mil and thinner. Self-drilling bugle-head screws for 33 mil and thicker
Interior trim	No. 6 trim-head screws, or finishing nails and adhesive. For wood blocking: finishing nails
Foam insulation	Roofing nails for structural sheathing, or No. 6 minimum, self-drilling, low-profile[1] screws (use washers for screws)
Structural sheathing (OSB, plywood)	No. 8 minimum, self-drilling, bugle-head screws, or pneumatic pins
Stucco lath	Roofing nails to lath for structural sheathing, or No. 8 minimum, self-drilling, low-profile[1] screws for steel
Siding: hardboard, fiber cement, or panel	No. 8 minimum, self-drilling, bugle-head screws for steel, coated drywall screws for structural sheathing
Vinyl siding	Staples for structural sheathing or No. 8 minimum self-drilling, low-profile screws or pneumatic pins.
Brick ties	No. 8 minimum self-drilling, hex washer-head screws
[1] Low-profile: modified truss or pancake head	

Figure 6-9
Recommended fasteners for residential steel framing

Figure 6-10
Pneumatic pins

installing wall sheathing, it's a good idea to either tack the sheet up with screws or screw the perimeter first, and then use the pins on the field.

Discuss subflooring installations with your manufacturer. You want to avoid the risk of floor squeaks. Improper fasteners and improperly-applied adhesives can both contribute to squeaky floors. If adhesives are applied too thickly or too far ahead of the subfloor application, you'll have problems. If you apply adhesive too far ahead, it dries prematurely and holds the wood away from the steel. A thick application has the same results. When this occurs, the nail simply can't draw the wood up to the steel tightly, and your floor will squeak.

Trim Attachments

When installing interior trim, you have a few options. A No. 6 minimum, sharp-point finish or trim head screw works well in hardwood trim that's been predrilled. If you prefer to use nails, install wood blocking inside the bottom track for base trim. Some builders install trim by gluing and pin nailing with a pneumatic nail gun.

For exterior trim, select a fastener the same way you would for siding, based on steel thickness, wall thickness, and thickness of trim. A minimum No. 8 self-piercing or self-drilling, bugle head screw usually does the trick.

Roof Fascia

If you want to install a wood fascia over the steel, attach the wood to the steel with a minimum No. 8 self-drilling screw of a length to match the thickness of the material you're putting together, plus the drill point and three exposed threads. If your metal backing is 33 mil, attach the wood trim with self-piercing screws.

Welding and Clinching

What about welding? The majority of steel framers don't weld light gauge steel together. But welding is being performed by some truss manufacturers, international companies, and smaller custom home builders. Field welding presents additional steps that you may or may not be willing to take. First, your welds usually need to be performed by certified welders. And second, the galvanized coating on the steel is destroyed during the welding process, so you'll need to apply a rustproof coating to touch up.

Welding is more suitable for panelized operations, where you can maintain quality in a shop setting. Welding is also practical when you use thicker steel, or welding to hot-formed members. Code officials will probably be more inclined to pass you through the inspection process in a controlled environment such as a panelization shop.

Clinching

The clinching method of fastening steel together has gained acceptance in Australia. Clinching companies have obtained ICBO approval in the U.S. Good test results in shear and pull-out have come from this type of fastening system. Clinching requires no screws or pins, only a pneumatic tool that press-joins the pieces of steel together (Figure 6-11). This method works well in a controlled panelization environment where you can run air lines overhead. Using this system, you don't have to feather a screw with your fingertips or drop a screw. However, if you fasten a stud in the wrong place, you'll have to drill out the connection. For this reason you want to be accurate in putting the walls together. Don't spend your time on rework.

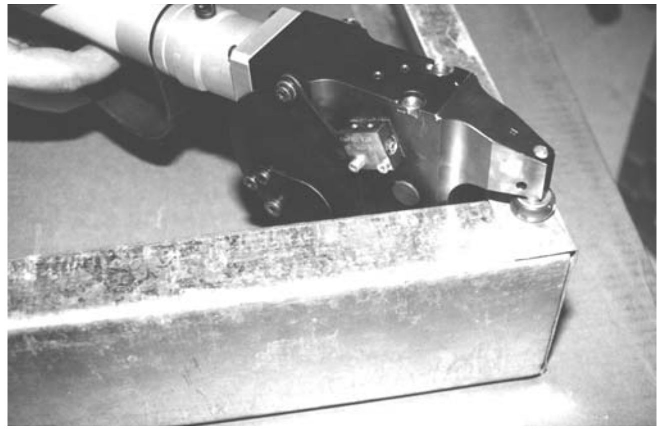


Figure 6-11
Clinching steel

In the field, you'll still need to rely on your basic screwgun to reconnect the stud. You'll also need it when you have multiple layers of steel. So, even if you decide to try clinching, don't part with your screwgun just yet.

Anchors

As with wood framed construction, you'll need to anchor your steel frame to the foundation. The anchors you'll need to use depend on where you live and what type of foundation you're building on. The size and spacing of the anchors are determined by the load conditions on the house. For example, the higher the wind and seismic loads, the larger the required anchors. We'll discuss foundation anchoring methods in more detail in Chapter 9.

Chapter 7

Types of Construction

There are three basic methods you can use for framing a steel house:

- Stick framing
- Panelization
- Pre-engineered construction

Each of these methods is different from the other, and each one is used today. No matter which method you prefer to use, your first step is to select a cost-effective design.

As we discussed in Chapter 2, it's important to select a design that's easy to build. Wood stick framing has been standardized to the point where, for the typical affordable home, you don't even think about the design. This comes with years of experience using a material that you're very familiar with.

Working with steel is a little more complicated. With steel, not only do you have a cross-sectional width and depth, for example 2 × 4, 2 × 6, 2 × 8, but you also have a material thickness to consider. By varying the thickness of the steel, we can design members that match or exceed the carrying capacity of the same size wood members. Because there are so many different thicknesses of steel members, there are a variety of ways to design a steel house. And, because residential steel framing is still in its infancy, many builders and engineers are trying different framing details.

The advent of the *Prescriptive Method* has brought about more standardized details, but as long as the steel industry is manufacturing framing materials in a variety of shapes and sizes, there'll continue to be many different ways to frame a steel house. Variety can be good *and* bad. It can be good because it leaves more flexibility in design; it's bad when it confuses the builder and makes it more difficult to standardize.

Whatever you select for your design, keep *ease of construction* foremost in your mind. The bottom line is the number of manhours you spend framing the house. Become familiar with the details you'll be using when you're selecting the design. Whether you select the details yourself or you hire an engineer to do it for you, I can't emphasize enough how important your involvement is from the very beginning of the project. You can apply a good, cost-effective design to any framing method, whether it's stick framing, panelization, or pre-engineered construction.

Stick Framing

The most popular method (and the one that's most easily embraced by wood framers) is stick-built construction. You'll find the layout and framing of a stick-built steel house is almost identical to that of wood. You simply substitute steel members for wood members, using either a standard 16- or 24-inch layout. As with wood framing, there are different ways to stick frame, but the basic layout and methods are the same. Some steel framers assemble wall studs on the floor, as shown in Figure 7-1; others use a table and panelize in the field. While others, with limited crew sizes, string line the top track and snap studs in place. Most of the methods we talk about for walls, floors, or trusses in this book are combinations of stick-built framing and panelization.

Figure 7-1
Stick-built construction

Panelization

Even if you're a stick builder, chances are you'll choose to panelize your walls or trusses to a certain degree. Steel members lend themselves readily to panelization because of their straightness and their relatively light weight. With panelization, you lay out and build the walls and trusses on a jig table. You can panelize in the field or you can do it in a controlled panelization area and then transport the walls and trusses to the job site.

You can manufacture an entire subdivision of steel-framed houses more cost-effectively if you frame them in a panelization area. If you build tables to accommodate different wall and truss sizes, you can reuse them and reduce the time it takes to assemble the different sections. You can use assembly-line methods to quickly assemble walls and trusses. To make your work more comfortable, you can cover your outdoor panelization area or you can locate it inside to get out of the weather. This keeps your crew busy even on a rainy day.

A good roll-forming manufacturer, back at the plant, can cut his studs to within $^3/_{16}$ inch tolerance. When ordering studs, specify that the $^3/_{16}$ inch be held on the short side rather than having them long. Using these close tolerances will help you keep a straight wall in the jig table each time. When framing walls, it's important that you fit each stud tightly in the track member to allow the stud to take the axial or downward load from above. Doing this helps you produce perfectly straight walls, resulting in a well-built home.

Panelization Tables

Panelization tables and fixtures need only be as sophisticated as your budget allows. Figure 7-2 shows a typical panel table. You can build a simple

Figure 7-2
Panelization table

jig table for walls and trusses all out of C-shapes and use the table in the field. You can build a structural steel table out of hot-formed steel and leave it in a permanent panelization building. Or you can invest in sophisticated hydraulic and automatic screwgun tables like the ones in Figure 7-3 that simulate automobile assembly lines. If you choose to panelize, select a type of table that fits your budget and helps you meet your schedule.

Figure 7-3
Panel table inside plant

Truss Jigs

You can easily make jig tables like the one in Figure 7-4 to build your trusses as well. The table can be as simple as plywood on the floor, or you can make an elevated table with adjustable stops. The nice thing about setting a jig for trusses is that once you've built the jig and set the stops, you can easily build trusses over and over again to the exact layout. This will produce a really straight roof. Have you ever noticed poorly-constructed roofs, especially noticeable when the sun hits it at the right angle?

Panelization also helps you keep good quality control. It provides you with the opportunity to check over the frame and make sure all the connections have been made properly before you move it into place. That's good practice, whether you're

Figure 7-4
Truss jig

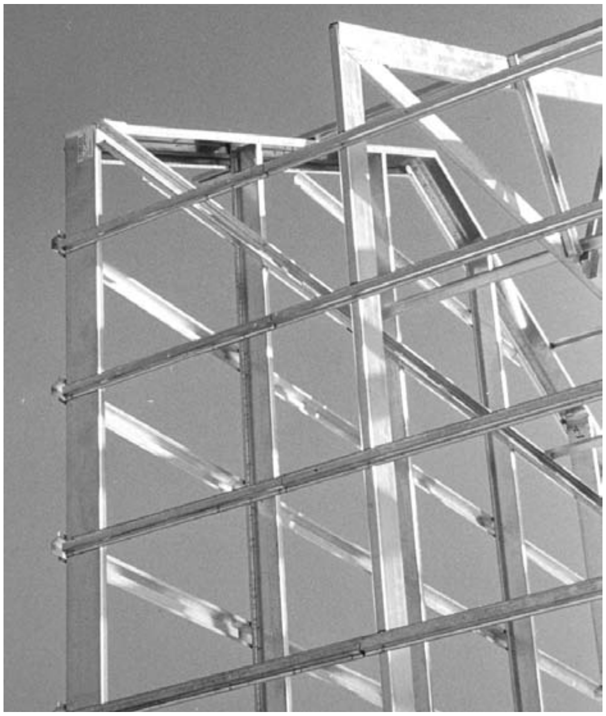


Figure 7-5
Rigid frame design

building a wall or a truss. All the screws must be according to the drawings or building code. You also need to check to be sure the steel doesn't separate where you apply the screws.

Pre-Engineered Buildings

Pre-engineered steel framing typically increases the size of the load-carrying steel members and allows you to spread them farther apart. You can use members made from C-shapes that are 68 to 118 mils thick, or from structural I-beams. Sometimes, pre-engineered houses mimic commercial construction practices, using purlins and girts to hold up the sheathing and drywall. This is necessary because the studs or columns can be anywhere from 4 to 16 feet apart. Many of the pre-engineered designs resemble post and beam construction. Figure 7-5 shows one such pre-engineered design, with wall studs and roof rafters 4 feet on center.

A number of proprietary pre-engineered systems have been developed. Companies like Tri-Steel and Advanced Steel Framing, for instance, use proprietary pre-engineered framing on 4-foot or 8-foot centers. These companies spend a lot of time and money in up-front engineering to design a steel frame. Sometimes they'll offer a collection of different houses or kits for sale so they don't have to re-engineer each new house design. Some of these companies make arrangements with local dealers to help represent their product.

Cost Impact

Stick-built framing may save you on material costs, but it often requires more manhours to build up structural members than the other methods. However, it's the most popular type of residential steel framing used today, and has been standardized in the *Prescriptive Method* for code approval.

Panelization reduces job site costs by assembling members on worktables, in an area protected from the weather, with workers performing repetitive tasks. You can install these systems quickly in the field.

Pre-engineered buildings usually involve more up-front engineering costs and sometimes, higher material costs. These designs are typically used for custom homes and upscale construction where high quality takes precedence over cost.

When choosing the method you want to frame with, examine all the up-front costs:

- Engineering
- Steel and freight
- Training of crews
- Support for framing details
- On-site panelization
- Equipment costs for the erection of larger members (for pre-engineered systems)
- Plan check and framing inspection
- Royalty or franchise fees

If you examine these costs closely, you can make a better decision about which framing method is right for you.

Chapter 8

Before Construction Begins

While steel stick-built framing is very similar to wood framing, it'll cost you time and money if you don't plan ahead on your steel project. That's why I've devoted the first nine chapters of this book to all the things you should consider before you pick up your screwgun and drive that first screw into a steel member.

How Will You Cut the Steel?

How are you planning to cut the steel on your project? After reading the discussion on cutting tools in Chapter 5, are you planning to use a chop saw, or to work with your roll-former or distributor and have him cut most of your steel? Residential construction involves cutting some steel members into lengths that are less than 3 feet long. That could be a problem for some roll-formers whose machinery isn't designed to cut such small lengths.

If your roll-former can do it, find out if he'll charge you more, or if it's standard procedure. Compare any additional roll-forming costs to the time you'll need to have a man running a chop saw to cut the steel for your project. Don't forget to include the cost for the number of chop saw blades it'll take to keep the chop saw running. With serious cutting, you can go through one blade in less than half an hour. Compare the two figures to determine which is more economical for you. Also check out the tool list and cutting methods in Chapter 5.

Simplification

With steel framing, simple means faster and using less labor. You can simplify every aspect of residential steel framing. It doesn't take long, using a C-shaped stud or joist, to get into some elaborate detail work. While steel stick-built framing imitates wood, it isn't the same thing. Hollow C-shapes add a new set of problems to rafter and soffit details. Even header details take on a new dimension. While many of the details in this book will help you, you may come up with some of your own details that are even simpler and work better for you. Remember — keep an open mind, and keep it simple.

That goes for your cut list, too. A cut list is simply a material take-off for your steel-framed house, written in the format of a bill-of-material for your supplier or roll-former. When planning your cut list, the simpler the better. If you're asking your roll-former to go out of his way to cut the steel for you, you want to be reasonable and not present him with a four-page cut list. Keep it short. Keep your wall steel in one group and your truss material in another. The simpler you make your cut list, the more willing the roll-former or distributor will be to cut the steel for you.

Your Cut List

The backbone of every well-executed steel framing project is a well-prepared cut list. For wood framing, lumber yards can take a set of plans and provide a material take-off for you. Since steel framing is new in the residential market, not every distributor will be able to help you. You'll most likely need to come up with your own cut list to order material. If you're experienced in wood framing, you should have a good feel for taking off quantities and ordering material.

Steel framing has a distinct advantage over wood framing in that manufacturers aren't limited to stock lengths of material. Studs, track, and joist material

Figure 8-1
Truckload of steel

can be cut to any length to satisfy the needs of a job. The only limitation is what can be physically transported down the highway (usually that's no longer than 40 feet). Figure 8-1 shows a truckload of steel being transported to the job site. Manufacturers should be able to deliver a product cut to within $^3/_{16}$ inch of your specifications.

Figure 8-2 is an example of a cut list. It's for the 1,020 square-foot sample house we designed in Chapter 3 (refer back to the floor plan in Figure 3-1). Before you decide to skip on to the next chapter because you think cut lists aren't fun, allow me to give you a bit of advice.

Once you're at the point of making a cut list, the design and engineering are complete. All you need to do is count the number of members you need and list their respective lengths. True, it's not an exciting task. In fact, it would be much easier to let someone else do it. However, the first time you run short of wall studs, or discover that the person who wrote the cut list forgot to order gusset material for the trusses, you'll wish that you'd taken the time to make that cut list yourself! Until steel studs are available in all distribution outlets, it may take longer to order more steel studs than it would to reorder wood studs. That said, let's walk through the steps to see how we generated this cut list.

Floors

Our house is 26 feet wide by 40 feet long. The floor joists we designed in Chapter 3 were 2 × 8 × 43 for the 26-foot width. For this foundation, we'll run the floor joists inside the foundation and anchor the joists to the stem wall with mushroom spikes. This is the recessed floor joist method (Figure 8-3). The distance from inside foundation to inside foundation is 26 feet minus the 8 inches on each side for the foundation walls (26'0" − 8" − 8" = 24'8"). We need to leave a $^1/_8$-inch gap on each end of the floor joist. This will keep the floor joists from rubbing against the rim joist and causing a squeak in the floor. We'll order the floor joists 24'7$^3/_4$" long to allow for this gap.

For our 40-foot foundation, with the floor joists 2 feet on center, we'll need to order 21 floor joists, plus 1 extra in case of damage. That's a total of 22 joists, as shown in Figure 8-2. The rim track must be the same thickness as the floor joists. If we order the track in 10-foot lengths, we'll need 8 pieces, plus 1 extra; 9 members total.

The material totals for the floor and rim joists are shown under numbers 1 and 2 in Figure 8-2. The ssbuilder's nomenclature (2 × 8) and the manufacturer's designator are both included to reduce confusion. The thickness of the materials is expressed in mils or decimal inches.

Walls

For the wall framing, we'll order the wall studs 8 feet high, 2 feet on center, and 33 mils thick. Some contractors like to order their wall studs 1 inch longer to accommodate a sheet of gypsum board, plus a gap at the bottom. For this example, we'll stick with 8-foot studs. The house perimeter is 132 feet (40 + 40 + 26 + 26), so we'll need 66 studs (132 ÷ 2 = 66). The garage walls are 22 feet long by 20 feet wide for a wall length of 64 feet (22 + 20 + 22). Again, we'll divide this length by 2 to find that we need 32 studs (64 ÷ 2 = 32) for the garage. That's a total of 98 studs for the house and garage. You can be precise and count the corner, compression, king studs and so on, or you can add a percentage to cover all material. In this example, we add about 20 percent for corner and compression studs. That'll bring our total up to 118, which we'll round up to an even 120 studs (see item 3 in Figure 8-2). This will cover compression, king studs and any temporary bracing we may need later.

Item No.	Quantity	Size	Manufacturer's Designator	Thickness (mil)	Length (ft-in)	Location
1.	22	2 x 8	800S162	43	24′ 7 3/4″	Floor joists
2.	9	2 x 8	800T162	43	10′ 0″	Floor joist track
Wall Framing						
3.	120	2 x 4	350S162	33	8′ 0″	Exterior wall
4.	50	2 x 4	350S162	33	7′ 4″	Exterior wall
5.	30	2 x 4	350T162	43	26′ 0″	Exterior wall
6.	8	2 x 8	800S162	54	4′ 0″	Header (no holes)
7.	4	2 x 8	800S162	54	7′ 0″	Header (no holes)
8.	2	2 x 8	800S162	54	9′ 0″	Header (no holes)
9.	2	2 x 10	1000S162	54	19′ 5 1/2″	Header (no holes)
10.	60	2 x 4	350S162	33	8′ 0″	Interior
11.	30	2 x 4	350T162	33	10′ 0″	Interior
12.	15	2 x 6	550S162	33	8′ 0″	Interior
13.	6	2 x 6	550T162	33	10′ 0″	Interior
Roof Framing						
14.	42	2 x 4.0	400S162	43	16′ 1″	Truss A (no holes)
15.	22	2 x 4.0	400S162	33	26′ 0″	Truss A (no holes)
16.	8	2 x 4.0	400S162	33	16′ 1″	Truss A (no holes)
17.	42	2 x 4.0	400S162	33	6′ 6″	Truss A (no holes)
18.	22	2 x 4.0	400S162	33	5′ 3″	Truss A (no holes)
19.	22	2 x 4.0	400S162	33	3′ 0″	Truss A (no holes)
20.	42	2 x 4.0	400S162	33	2′ 9″	Truss A (no holes)
21.	12	2 x 4.0	400S162	33	20′ 0″	Truss B (no holes)
22.	24	2 x 4.0	400S162	33	12′ 10″	Truss B (no holes)
23.	24	2 x 4.0	400S162	33	5′ 0″	Truss B (no holes)
24.	12	2 x 4.0	400S162	33	4′ 0″	Truss B (no holes)
25.	12	2 x 4.0	400S162	33	3′ 0″	Truss B (no holes)
26.	24	2 x 4.0	400S162	33	2′ 0″	Truss B (no holes)
27.	4	2 x 4.0	400S162	43	11′ 0″	Hip rafters (no holes)
28.	4	2 x 4.0	400S162	43	9′ 0″	Hip rafters (no holes)
29.	4	2 x 4.0	400S162	43	7′ 0″	Hip rafters (no holes)
30.	4	2 x 4.0	400S162	43	5′ 0″	Hip rafters (no holes)
31.	4	2 x 4.0	400S162	43	3′ 0″	Hip rafters (no holes)
32.	4	2 x 4.0	400T162	54	16′ 0″	Hip
33.	12	2 x 4.0	400S162	33	10′ 0″	Ceiling rafters
Miscellaneous						
34.	30		8.8 flat	33	10′ 0″	Fascia — hip, valley, ridge
35.	130		1 1/2 x 8 angle	43	1′ 0″	Gusset
36.	70		1 1/2 x 8 angle	43	3′ 0″	Gusset
37.	50		1 1/2 x 1 1/2 angle	33	10′ 0″	Bracing
38.	20	1 5/8 x 1 5/8	162S162	33	10′ 0″	Gable end studs
39.	10	1 5/8 x 1 5/8	162T162	33	10′ 0″	Gable end track
40.	4	2 1/2 x 1 5/8	250S162	33	12′ 0″	Gable end studs

Figure 8-2
Cut list for 1,020 SF house

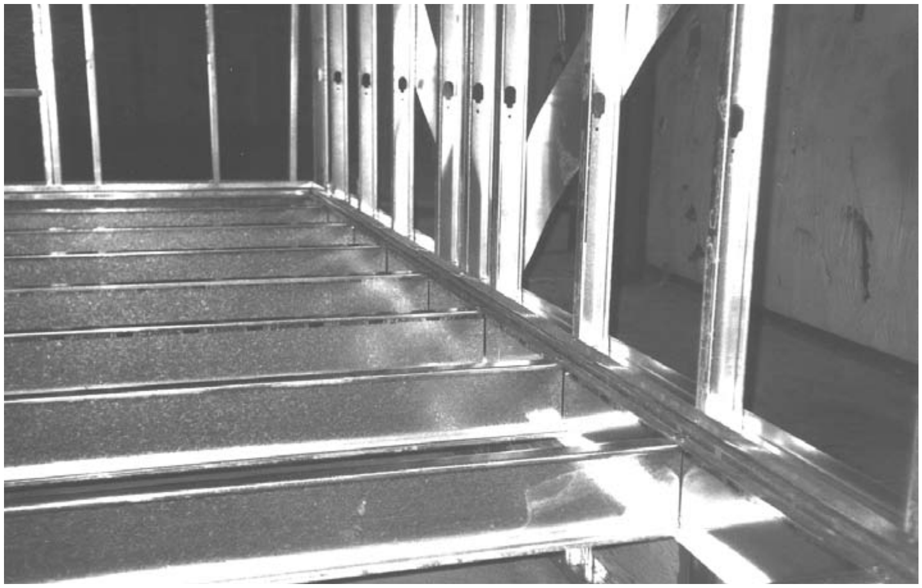


Figure 8-3
Recessed floor joists

We'll order all of our headers (except for the garage) 8 inches deep. We can order our wall trimmer studs 7'4" in length (8 inches less than full height framing for an 8-foot wall). To find out how many trimmer studs we should order, we count the number of window and door openings and multiply them by 4. We may not need two trimmer (jack) studs in each location, but this will give us some extra studs. We have eight header openings, so we'll need to order at least 32 ($8 \times 4 = 32$). The end walls don't have headers because we'll use a gabled end truss that's structural, and will carry the loads above. The interior doors also won't need headers. The garage header could take as many as four on each side, so we'll want to add a few more pieces to cover the garage header and any extra we may need. That'll bring our total to 50 (item 4 on the cut list).

You should order your loadbearing wall track in at least the same thickness as the wall studs. For our design example, we bumped the wall track to the next thicker material to stiffen the top track and make it a more comfortable walking top plate. We can panelize the walls the full width of the house, 26 feet. We'll order the track this long. For the 40-foot walls, we'll have to splice the track. The perimeter is 132 feet. Multiply this by 2 to have the proper quantity for the top and bottom track, or 264 feet. If we order 2 pieces (1 top and 1 bottom track) for each side width, and 4 pieces for each side length (2 top and 2 bottom), that'll give a total of 12 pieces of track; 6 pieces for the bottom track and 6 pieces for the top track. We'll need 8 more pieces for the garage walls and header, as well. We'll also need track for the window and door openings to use to build headers and sills. And we need to account for the interior pony wall if we frame them out of steel. You can do a precise take-off, or add a percentage. In this case, we add at least 25 percent to the order to cover the openings. In this cut list, that would be 24 times 1.25, or 30 pieces of track (item 5 on the cut list).

Headers

Back in Chapter 3, we designed all our headers to be $2 \times 8 \times 54$, with the exception of the garage. Therefore, we only need to figure how many openings we have, and order the correct length of the headers. For this house, we have four 3-foot openings, one 6-foot opening, and one 8-foot opening that require a header. The walls under the gable trusses won't require headers, because we'll use structural trusses on the end walls to carry the loads. The porch area will be supported by a 7'0" header along the house line. The window in the kitchen area won't need a header because that angle wall is nonbearing.

In order to standardize the headers, we add 12 inches to the width of each opening. This gives us room for two trimmer studs on each side, and also room for wood bucks if necessary. Each trimmer stud has a flange width of 1⅝ inches. Four trimmer studs are 6½ inches wide, and two wood bucks are 3 inches wide (6½ + 3 = 9½). If we allow 12 inches over rough openings, that will give us plenty of room to accommodate these 9½-inch dimensions. Sometimes you'll only need one trimmer stud; it's okay to leave a 1⅝-inch gap between the king and trimmer studs. Work off the centerline of the header to position any trimmers, wood bucks, or door jambs. The important thing is that we've simplified our cut list and our header details.

We have a total of four 3'0" openings. Therefore, we'll order eight 2 × 8 × 54 C-shapes, 4'0" long (two C-shapes are used to make one header). This is item 6 on the cut list. We'll order the rest of the header material listed in items 7 and 8 in the same way.

In Chapter 3, we decided to have the garage header designed by an engineer. We can order it to run the full width of the wall opening. We just need to reduce the 20-foot opening by 6½ inches to accommodate the width of two king studs on each side of the header. Therefore, we'll order our garage headers 19'5½" (item 9 on the cut list).

Interior Walls

You order interior wall framing in the same way as exterior wall framing. Divide the wall length by 2, because we're using 24-inch stud spacings, and add 20 percent for corner studs as we did before. We're ordering our wall track in 10-foot lengths. The quantities on the cut list are based on the length of wall multiplied by 2 (for top and bottom track), plus a 20 percent overage. We also need to order 2 × 6 stud and track material for plumbing walls. We're using 33-mil material for interior walls. For nonbearing walls, we could order 18-mil material. If you use 18-mil studs, we recommend 16-inch-on-center spacing (items 10-13 on Figure 8-2).

Roof Framing

In our design example, our trusses were pre-engineered. This means that we won't have to do a take-off for truss parts. Parts for Truss "A" and "B" are listed on the cut list in Figure 8-2. I'll come back to this later in the book when we cover how to do a take-off for trusses (Chapter 14). Remember, punchouts in truss members can accelerate failure in compression members. Order your truss members without holes.

One section of our roof is hip-framed. Our cut list includes material to frame the hip, which we'll cover in Chapter 15.

Miscellaneous

Our fascia material is listed under Miscellaneous items on the cut list. We'll look at fascia in Chapter 16. Depending on how you want your fascia to look, you can order track or flat stock that you can bend. For our sample house, we're ordering 30 pieces of 8.8-inch flat stock, 10 feet long. This is usually a standard width at the roll-former. We'll bend the steel in a brake press for the fascia (Figure 8-4). We're also ordering enough to cap our trusses at the ridges and for our valleys.

We're ordering gussets for the trusses and 1½- × 1½-inch angle to brace the trusses together. We'll cover gussets and gable end truss material (shown at the end of our cut list) in Chapter 14.

Estimating Costs

Once you have a detailed cut list, you can calculate how much the roll-former or supplier will charge for the steel. A roll-former buys his steel by the ton and sells it by the linear foot. Depending on the steel member you're ordering, the cost per linear foot will vary. Ask your roll-former for a price sheet so you can calculate the cost. Also ask the supplier or roll-former how much of a discount you can get for your order.

Figure 8-4
Fascia

While figuring your cut list, as we just did, will give you the exact cost for your steel framing package, sometimes it's helpful to have a rule-of-thumb method when you bid a project. Our rule-of-thumb method is based on weight rather than linear feet.

Rule-of-Thumb Estimate

For slab-on-grade homes, you can estimate the cost of the steel you need by multiplying the square footage of the house by 7 pounds per square foot. Then, multiply this number by $.50 per pound to get the approximate cost of steel. For crawl space or basement homes, use the same formula, but substitute 10 pounds per square foot instead of 7. This will give you a very conservative rule-of-thumb figure. When you do your itemized estimate, plug in the actual costs from your distributor to get the most accurate cost estimate.

If your rule-of-thumb figure is dramatically different from your itemized estimate, that's a warning. Double-check your work once more — just to be sure.

The example house is built on a crawl space, and the garage on a slab. So the conservative cost estimate for steel would be:

- 1,020 SF for the house area at 10 lbs/SF = 10,200 lbs.
- 440 SF for the garage area at 7 lbs/SF = 3,080 lbs.
- Total weight of steel for the house is 13,280 lbs (10,200 + 3,080) or 6.6 tons.
- 13,280 lbs at $.50/lb = $6,640 for the steel framing material necessary for the house.

Material Delivery

Ask your roll-former, distributor or lumberyard to bundle the material the way you have it called out on the cut list. Make sure that all of the "Truss A" parts are together, "Truss B" parts, etc. Have him label the steel with a felt-tipped marker as he bundles it. Most roll-formers will write the name of the project, the quantity, length, thickness, and size of the members on each bundle.

Forklift

Arrange to have a forklift at the job site to offload the steel. Roll-formers usually don't send one with the delivery, but distributors do. If you don't keep a forklift handy at the job site, make sure you coordinate its arrival with the delivery time to the site. You'll definitely not make friends with the truck driver if he has to wait for you to send out for a forklift, or if you take the time to offload the truck by hand.

Organize Your Steel

After you offload the truck, have the forklift operator stack the bundles in their order of use. Don't try to do this while you're offloading the truck; get that truck driver back on the road as soon as possible. When you do stack your bundles, don't bury your exterior wall studs behind your truss parts. Keep the bundles together and organized. This will help enormously when you start framing. If you're panelizing, take the bundles to the panelization area and stack them conveniently.

Above all, *don't* cut any of the steel bundles open until you're ready to use them. After the supplier went to all the effort to label and bundle your steel, the worst thing you can do is break open the bundles and then not be able to find the pieces you're looking for because the labels are buried in the pile of steel. Simple job site organization will save you a lot of time in the long run.

Chapter 9

Foundations and Anchoring

The three basic types of house foundations we use today are slab-on-grade, crawl-space, and basement foundations. The type and quality of the foundation influences the steel frame design, the anchor systems, and the straightness of the walls. In this chapter we'll introduce the different types of foundations and the anchors used in steel framing.

Concrete Tolerances

The quality of your foundation's concrete work has a direct impact on the time you'll have to spend leveling your bottom track. The bottom track of a steel-framed wall rests differently on a concrete foundation than a wood bottom plate does. Because the steel bottom track may want to bend to fit the contour of the slab, you should work closely with the concrete finishers to make sure they provide a flat surface for you to frame on. Any bumps that remain in the surface will have to be chipped down. If you still don't have a flat surface, you may need to stiffen the bottom track with a C-shape to span dips in the wall or slab.

Slabs-on-Grade

Slabs-on-grade, or concrete slabs at ground level, when placed properly, can be the least expensive foundation to build on. The slab eliminates the need for floor joists, and you can assemble the walls right on the slab. The time you spend with the concrete finishers making sure the slab is straight, square, and free of bumps or valleys will pay off in the end. You'll get straighter walls, and you'll have to spend less time trying to compensate for abnormalities in your foundation. Figure 9-1 shows a slab-on-grade foundation.

Crawl-Space Foundations

Crawl-space foundations, or stem walls that elevate the first floor 2 to 4 feet off the ground, can be made from concrete or post and beams. The design house (see Chapter 3) that we'll be referring to in the chapters coming up is to be built on a crawl-space foundation. Crawl spaces like the one shown in Figure 9-2 are popular in warm climates. They provide good air circulation, and serve where basements aren't practical. Once again, you need to pay close attention to the straightness of the wall.

Crawl-space foundations on the West Coast are built differently from those on the East Coast. While typical East Coast foundations may have a center girder or stem wall, West Coast foundations have several supporting girders, or pony walls. Typically, the pony walls break the joists into 8-foot spans. Figure 9-3 shows a typical pony wall.

Basement Foundations

Basement foundations (or areas 6 to 7 feet below ground with walls that hold back the soil) also work well with steel framing. They're usually constructed in colder climates where an underground or below-grade floor level is desired. It's important that the basement walls are level so the rim joists will sit level on top of the walls. As with slab-on-grade

Figure 9-1
Slab-on-grade

Figure 9-2
Crawl-space foundation

foundations, pay close attention to the concrete work as it's being laid. Figure 9-4 shows a basement foundation under construction.

Anchorage

The foundation of a house not only provides a starting point at which to begin framing, but also provides a point of anchorage so the house doesn't blow away in a storm or topple over in an earthquake. Whether you use a slab-on-grade, crawl-space, or basement foundation, you'll need to anchor your steel frame to the foundation properly. There are a variety of anchors available: anchor bolts, mudsill anchors, anchor straps, and mushroom spikes.

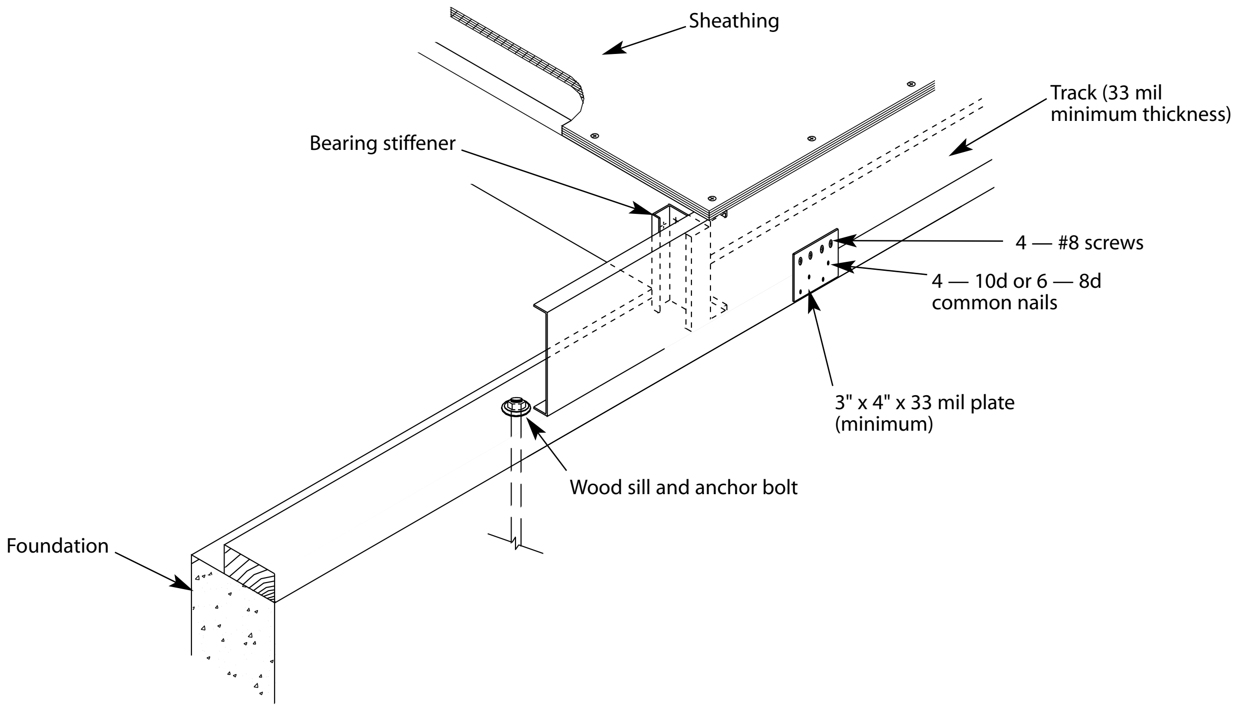
Anchor Bolts

The *Prescriptive Method* provides several details for anchoring steel-framed houses with anchor bolts. Figure 9-5 shows a steel-frame floor system anchored to a wood sill on top of a concrete foundation. Figure 9-6 is a detail without a sill plate. Anchor bolt sizes are provided in Table 5.1 of the *Prescriptive Method*.

Where there are no floor joists, as in a slab-on-grade house, you can use anchor bolts to anchor walls to the slab (Figure 9-7). Set embedded anchor bolts, such as J-bolts, or threaded rods with a nut and washer on the end, into the forms before the concrete

Figure 9-3
Pony wall

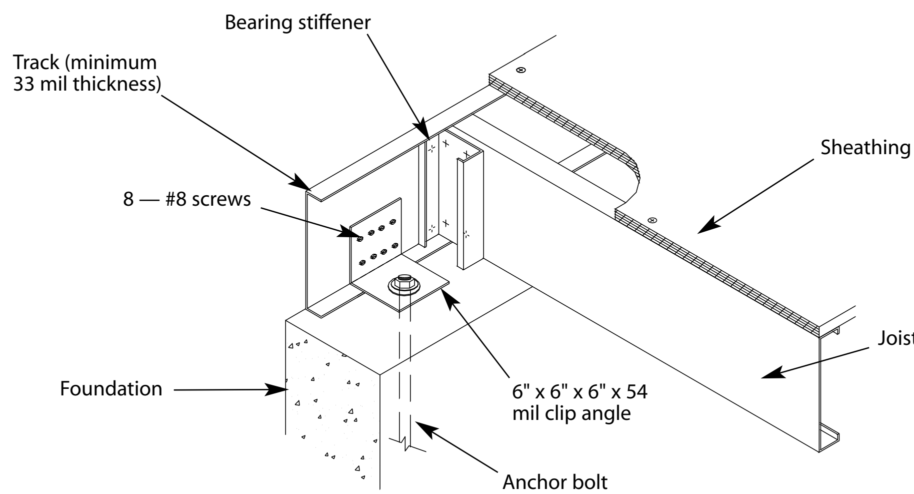
Figure 9-4
Basement foundation



Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing*, Second Edition

Figure 9-5

Floor to wood sill connection



Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing*, Second Edition

Figure 9-6

Floor to foundation connection

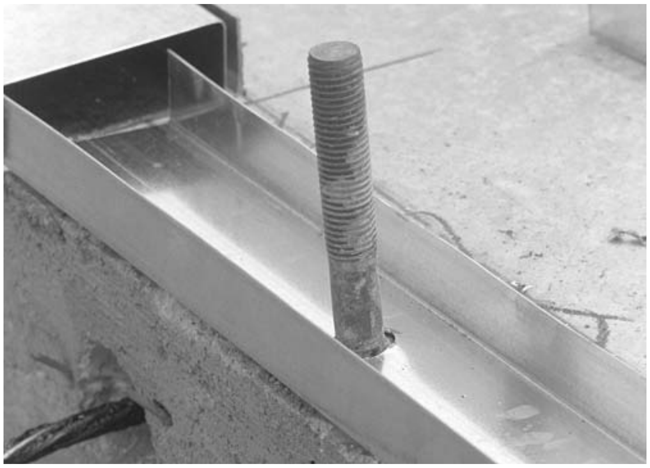


Figure 9-7
Anchor bolt

Figure 9-9
Sill anchor

is poured. It's a good idea to use a bracket to keep the bolt in place while the finishers pour concrete. You can cut brackets from steel angle or studs with holes punched in them. Attach the bracket to the formwork to hold the bolt in position.

Inevitably, one or two bolts will get knocked out of position. It's always good to go back and check the bolts. Every once in a while, you'll probably miss one. Fortunately, the bolts can be epoxied in. Some builders just prefer to wait until after the foundation is poured, and then they go back, drill the holes, and epoxy the bolts into place (Figure 9-8). Two companies, Simpson Strong-Tie and Hilti, make epoxy that works well.

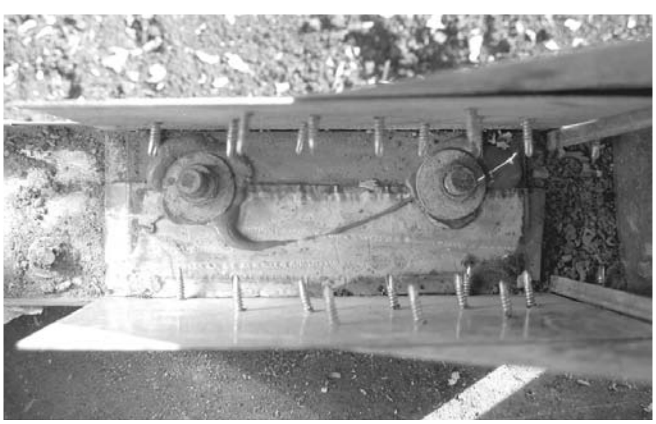


Figure 9-8
Epoxy bolts

Anchor Bolt Hold-Downs

An anchor bolt alone won't properly connect the steel track or stud to the foundation. You also need a hold-down bracket, plate, or washer to distribute the pullout over a larger area of steel. A sill anchor with a properly-distributed load can be as simple as a washer and nut over an anchor bolt and plate in a steel track (Figure 9-9). You can also use a steel plate, C-shaped stud, or even a piece of lumber in the bottom track to form a sill anchor.

Mudsill Anchors

You can also use mudsill anchors in the bottom track. Mudsill anchors are prefabricated pieces of steel. One end is embedded in concrete while the other folds over the top track, as shown in Figure 9-10. The straps bend over the C-shape.

Anchor Straps

In place of anchor bolts, you can use anchor straps embedded in the foundation to secure your framing. When the forms are removed, the straps are bent up so they can screw into a wall stud or structural sheathing (Figure 9-11). If they're going to be attached to wall studs, they shouldn't be attached to

Figure 9-10
Mudsill anchor

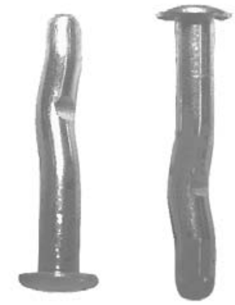


Figure 9-12
Mushroom spikes

cripple studs under windows. They don't transfer loads. Simpson Strong-Tie is one manufacturer of mudsill anchors and anchor straps.

Mushroom Spikes

Mushroom spikes (Figure 9-12) are expansion bolts that expand in predrilled concrete holes. You can use them to anchor steel to concrete when the concrete has already been poured and cured. If you use mushroom spikes to anchor the bottom track, to anchor a rim joist, or to hold an anchor strap in a high wind area, you won't have to worry about them until after the concrete is cured. RAWL is one manufacturer of this kind of anchor.

Powder-Actuated Fasteners

These are pins fired by a Hilti or similar gun (Figure 9-13). You can only use them to temporarily anchor exterior walls or to permanently anchor non-bearing walls. The head of the fastener isn't big or strong enough and the pullout value isn't high enough to withstand wind and seismic loads.

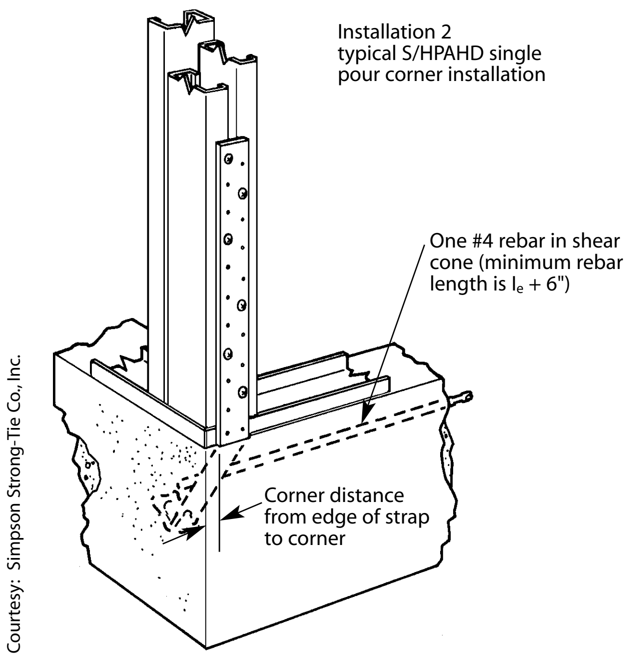


Figure 9-11
Anchor straps

Figure 9-13
Powder-actuated fasteners

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Chapter 10

Floor Joists — First Floor

After all this preparation, let's do some actual framing. If you only build slab-on-grade houses, and don't even want to know about building floor joists, you can probably skip this chapter and go straight to Chapter 11. In this chapter we'll concentrate on crawl space and basement homes where you need to set floor joists. In case you're new to this, floor joists are horizontal members that provide the support for the floor of the house. Floor joists must support the loads that typical occupants impose on homes. Most building codes use a live load of 40 pounds per square foot and a dead load of 10 pounds per square foot for the first-floor joists. In Chapter 3 we specified the correct size and spacing of the joists for our design house based on code requirements in the area we've selected. Once you've established this information, you're ready to set your joists on the foundation.

Girders and Bearing Walls

For most crawl space or basement foundations, an intermediate support consists of one or more interior girders, usually made of hot-rolled structural steel (I-beams). The *Residential Steel Beam and Column Load/Span Tables* (Publication NT 12-96 by NASFA) gives girder span sizes for typical spans. For crawl space foundations, intermediate supports may also consist of beams or interior bearing walls. The interior bearing walls may be made out of concrete or steel. If you use engineered drawings, they'll specify the floor beam sizes and direction, or the size of the bearing walls. If you're able to choose steel girders on your own, the NASFA publication just mentioned is a good reference for you. Once you have your intermediate supports (concrete or steel) in place and anchored to the foundation, you're ready to work on the floor joists. Figure 10-1 shows a hot-rolled girder.

Span Direction

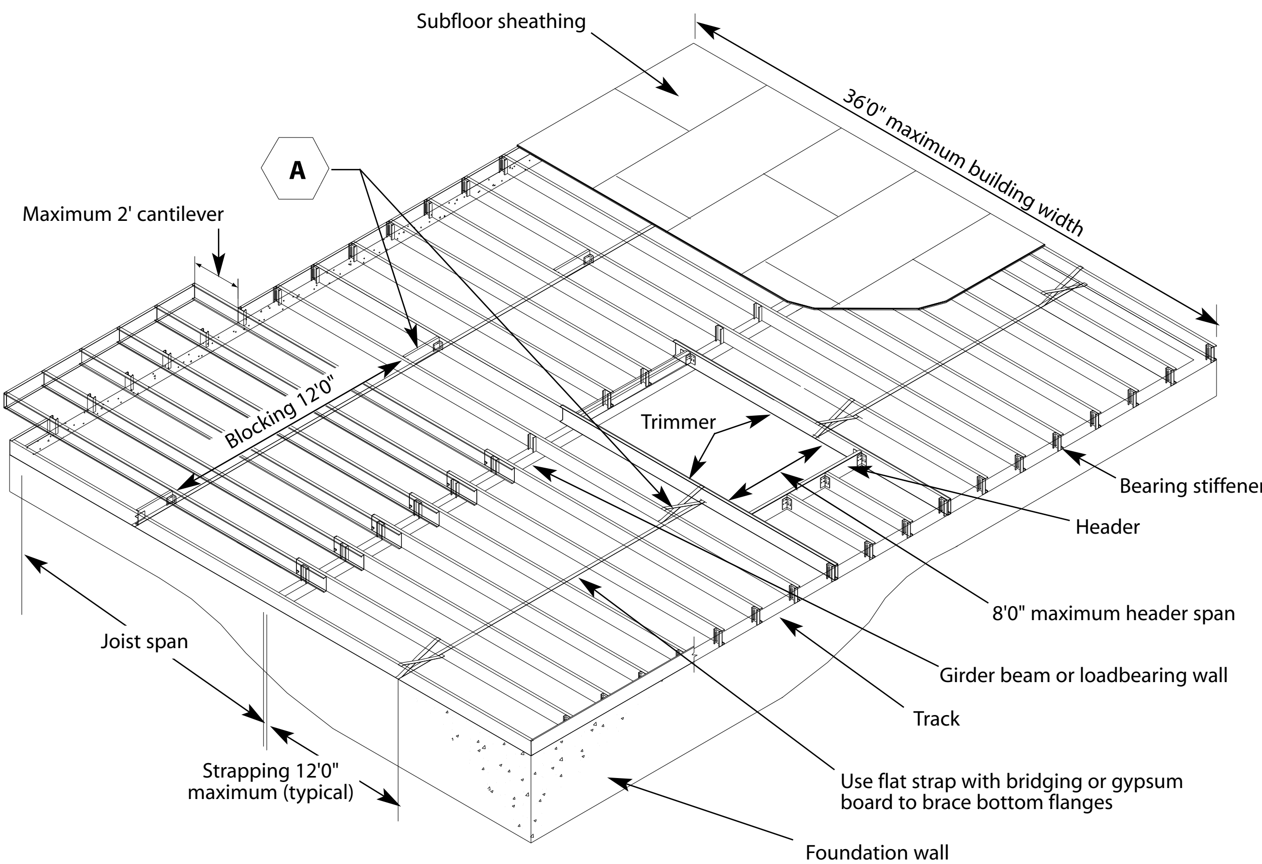
This may sound basic, but if you're following an engineered set of plans, make sure you know the direction the joists are supposed to run. Steel joists, like wood joists, are designed to carry a maximum load. If you span them longer than they were designed for, you may exceed their limits and create a bouncy floor. Check the plans to be sure.

Single Span vs. Multiple Span Joists

Single span joists run between two supports without any intermediate supports. Typically, they don't span more than 12 to 14 feet. You'll usually need to lap single span joists over a center girder to make the span from one side of the house to the other. Figures 10-2 and 10-3 illustrate lapped joists.

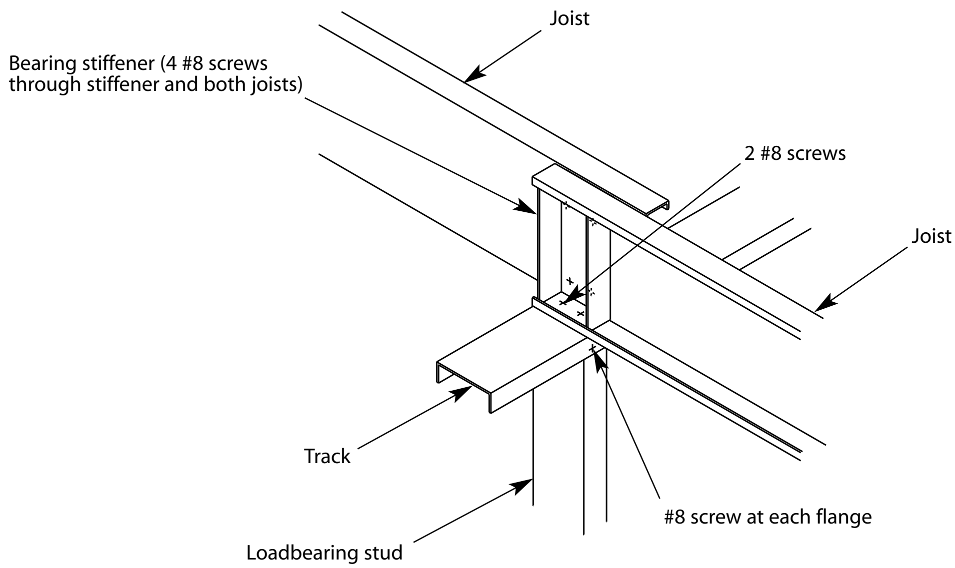
In contrast, multiple span joists run from one side of the house to the other, with one or more intermediate supports, like a beam or a bearing wall. Figure 10-4 shows continuous spanning joists. There's no lapping of the joists, just one continuous length. A single span joist only covers the distance of a single span (8 to 14 feet), so you need to lap two or three together (over one or two intermediate support points) to cover 26 feet. A multiple span joist can cover the entire 26-foot span of the house (because it's 26 feet long), but it needs intermediate supports. The maximum length of multiple and single span joists are in the joist tables in the *Prescriptive Method*.

Figure 10-1
Girder



Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing*, Second Edition

Figure 10-2
Steel floor construction



Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing*, Second Edition

Figure 10-3
Lapped joist supported on interior loadbearing wall

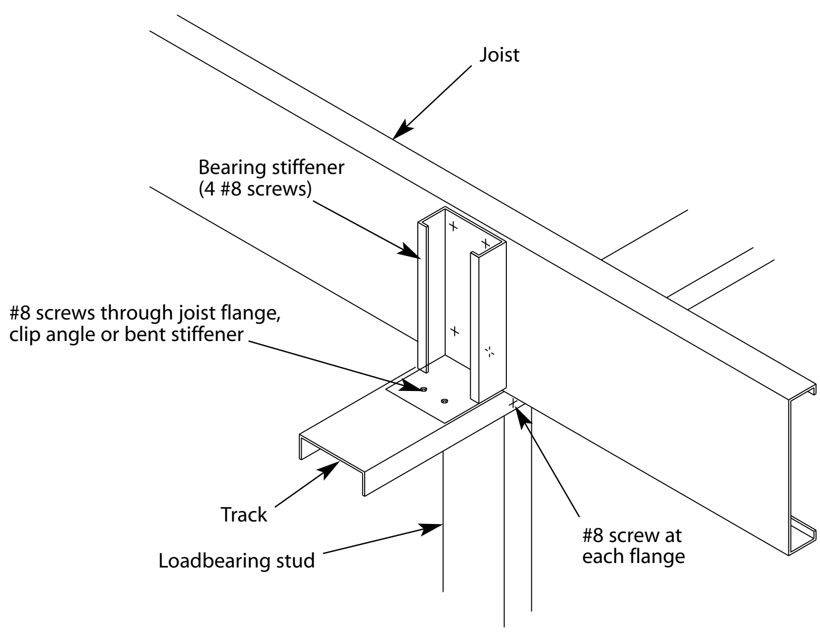


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Figure 10-4
Continuous span joist
supported on an interior loadbearing wall

There are separate span tables for single span and multiple span joists, so you need to know which type is designated by your plans and make sure you install them according to the appropriate table. Because of the way steel floor joists act under load and deflection, the spans may be higher or lower for multiple span joists. If you're working with an engineer, make sure you know what kind of joist he had in mind (single or multiple span) when he indicated the joist size on the drawing. If you selected the joist size, make sure you follow through with the correct joist size for the way you span your joists. If you use multiple span joists, also remember to install a web stiffener at the interior loadbearing wall, as shown in Figure 10-4.

For instance, a single span 2 × 8 × 43 joist spaced 24 inches on center will span 12'3" (from Table 5.3 of the *Prescriptive Method*). The same size joist in a multiple span will only span 10'8" (Table 5.4). In this case, the multiple span joist has a 1'7" shorter span than a single span joist. On the other hand, a single span 2 × 8 × 68 spaced 24 inches on center will only span 14'2" (Table 5.3), while the same size joist in a multiple span can handle 16'4" (Table 5.4). In this case the multiple span joist spans 2'2" more than the single span joist. See the summary table in Figure 10-5. It's critical that you check your span tables for these joists to make sure the floor will be built according to design.

Layout

In-line framing usually governs the layout of your steel joists. You must consider your roof truss or rafter layout. If you've preordered your trusses, your floor joists will be in the same location as your roof trusses. This is necessary to transfer all axial loads from the roof trusses, through the wall studs, through the floor joists and into your foundation.

Joist	Single span	Multiple span	Difference
2 x 8 x 43	12'3"	10'8"	−1'7"
2 x 8 x 68	14'2"	16'4"	+2'2"

Figure 10-5
Comparison of single and multiple spans

If you're not thrilled with in-line framing, I can offer you a couple of alternatives. One is to stiffen the top and bottom tracks in your wall to carry the trusses and floor joists between the wall studs. But check with your engineer first. The second method is to recess your floor joists down into the foundation, anchoring them to the side of the stem wall rather than having them resting on top. We'll discuss this method in more detail shortly.

Review the floor plan of the house carefully to check for openings. You'll need to double up joists around stair openings as well as any other openings called out on the plans. Look closely to see where the toilets and bathtubs are located. It's your responsibility to avoid placing floor joists where fixture drains are located. Scale the drains off the drawing so you know exactly where they are.

You need to lay out the location of each joist. Set your joist track on each end wall of the house. If you're setting the track directly on concrete, with no wood sill, use building paper and caulk to keep the steel separated from the concrete. This is to prevent corrosion in case water gets under the track.

Because we typically use in-line framing, the first and second joists on the layout aren't always 24 inches apart. Start with a floor joist at the end of the house and then come in to where your next truss is located above for the next joist, even if it's less than 24 inches from the first joist. After that, all your floor joists will be on layout.

Mark the rim track showing the joist layout, using a line with an "X" to show which side of the line the joist goes (usually on the side of the line away from layout.) See Figure 10-6. Continue down the length of the building, marking every 24 inches, with each line representing the web location of each new joist. If the joists span the entire width of the building (if they're continuous), repeat the layout on the opposite side as well as over any immediate supports. Put a double mark where two joists go — "XX" at floor openings for example.

For noncontinuous joists, one joist won't be on the same line as the other because they lap each other. You normally set the lapped joist back toward where layout was pulled from. Otherwise the distance between the first joists may be more than 24 inches on center. You don't want to create an overspan by setting the lapping joist on the other side.

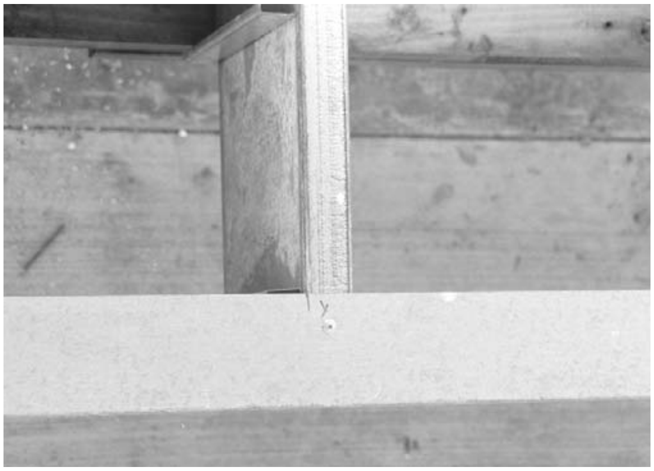

Figure 10-6
Joist layout

Setting Floor Joists

One good thing about steel joists is that you don't have to worry about a crown. Your joists should be perfectly straight to start with. First, you'll set the joist track on each end wall. Be sure you use building paper and caulk if you're setting the track directly on the concrete. Use Figure 5.4 or 5.5 of the *Prescriptive Method* as a guide for anchoring the joist track. Table 5.1 of the *Prescriptive Method* gives anchor bolt spacings and anchor connections. For instance, for our Salem house that has a wind pressure of 80 mph, Exposure C in a Seismic Zone 3, we use the second column — "Up to 100 A/B or 90 C or Seismic Zone 4." For the floor joist track or end joist to foundation detail shown in Figure 5.5, we would use a 1/2-inch diameter anchor bolt and clip angle spaced at 4 feet on center with eight #8 screws.

Set your joists, one at a time, inside the rim track. Keep the hard side (web side) of the joist on layout — and on the same side each time. You'll need to turn the joist at an angle to fit it in between the flanges of the rim track, and then twist the joist into position. It's easier to work with a partner, with one of you on each side of the joist, especially for floor joists that run clear span. Using a speed square, check to see if the end of the joist is perpendicular to the rim track. Also check to see that there's a 1/8-inch gap between the rim track and the end of the joist. Remember, you should have ordered your floor joists 1/4 inch shorter than the span to allow for this gap. (Refer back to Chapter 8.) Screw the joist into position with a minimum of two No. 8 screws in each flange. You'll need to use a low-profile head screw on the top flange to give you a smooth surface for applying the plywood subflooring.

Check the layout over your intermediate supports and screw the joists down into the wall or girder. For a bearing wall, fasten two No. 10 screws into the top track (see Figure 10-3 and Table 5.2 of the *Prescriptive Method*). For steel girders, you'll need a No. 12 drill point screw. For concrete, use 1/2-inch anchor bolts with clip angles. Work your way across the entire house, keeping the webs of the joists all on the same side. Figure 10-7 shows joists being fastened in place.

Cantilevered Joists

Cantilevered joists are joists that overhang a foundation or loadbearing wall. In the *Prescriptive Method*, floor overhangs are limited to 24 inches. You'll need to install bearing stiffeners at the bearing points and at the end of the cantilevered section (Figures 10-8 and 10-9). All punchouts in the cantilevered section of the joist have to be reinforced as shown in the illustrations. The *Prescriptive Method* states that cantilevers can support only one story. Any cantilever floor larger than 24 inches must be checked by an engineer.

You'll also need to cut blocking out of joist material to place between the joists over the foundation wall. Anchor the bottom flange of the track down into the concrete with 1/2-inch anchor bolts (for wind areas up to 90 mph). For seismic areas, consult with your engineer. When you cut your blocking pieces, cut a stud or track piece and screw it into the joist and blocking instead of making fancy cuts in the blocking for a joist with an open web. See Figure 10-8.

Recessed Floor Joists

One way to simplify the installation of your floor joists is to take the floor joists off the top of the foundation and recess them on the inside of the foundation wall. This is about like hanging wood floor joists using joist hangers. But instead of using joist hangers, you use rim track and anchor it to the foundation wall with two 1/4-inch mushroom spikes, 24 inches on center, as shown in Figure 10-10.

Figure 10-7
Setting joists

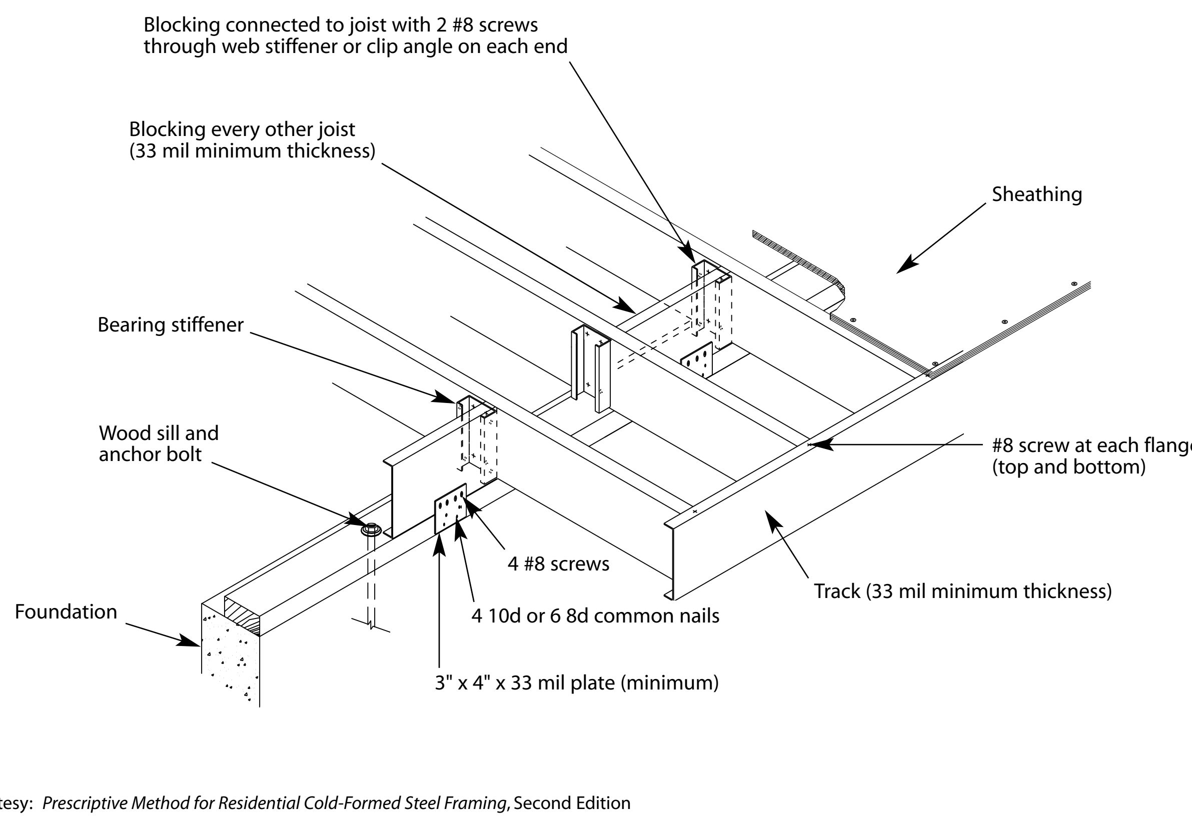

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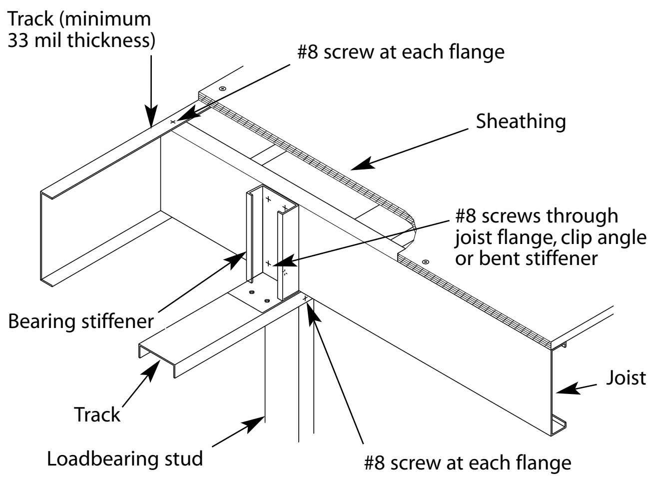
Figure 10-8
Cantilevered floor to wood sill connection



Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing,* Second Edition

Figure 10-9
Cantilevered floor to exterior loadbearing wall connection

With this installation method, you don't have to worry about lining up your floor joists with your wall and truss layout. And, because you're no longer bearing on the floor joists at the exterior walls, you don't need to install web stiffeners except over intermediate supports. However, you *will* need to make sure that your concrete finishers prepare a nice straight, level wall for the rim track.

This is the method used in our sample house and what our cut list is based on. If you're using 3/4-inch plywood subflooring, measure down 3/4 inch to set the top flange of the rim track. Set the rim track at the top of that mark. Tack it into the foundation with 1/4-inch mushroom spikes as mentioned. Tack the track in two or three places, then remember to come back later to install two spikes at each joist location.

Lay out the joists the same way you would if you were on top of the wall, only this time start the first joist on the inside of the wall. Then continue the layout across the floor, marking an X for each joist location. Fasten each joist to the track with a minimum No. 10 screw at the top and bottom.

Joist Bracing — The top flanges of the floor joists will be braced with floor sheathing (plywood or OSB). Make sure that if your joists are spaced 24 inches on center, your sheathing thickness meets code requirements in your area. (Refer back to Chapter 3 for information on selecting the subflooring.)

Floor joists with spans 12 feet or less don't require bracing on the bottom flange (except in Seismic Zones 3 and 4). If your joists are longer than 12 feet, the bottom flanges must be braced with gypsum board or steel strap. The steel strap can be 33 mil, 1 1/2 inches wide, installed without slack. Attach the strap to the bottom flange of each joist with one No. 8 screw.

Figure 10-10
Recessed floor joists

Blocking or Bridging — For joists spanning greater than 12 feet, you must install blocking or bridging. You can use strap material or manufactured straps like those made by Simpson Strong-Tie. You can also use joist, stud, or track material for blocking. Install the blocking or bridging between the joists at the ends of the steel straps, at a maximum spacing of 12 feet on center. Fasten the straps to the blocking with a minimum of two No. 8 screws (Figures 10-11 and 10-12).

Web Stiffeners — If you install floor joists and rim track on top of the foundation, you'll need to install web stiffeners wherever you have a loadbearing wall coming down on a joist. The web stiffener prevents the joist from crumpling. Remember, these joists aren't solid like wood joists. Simply cut stud or track material the same thickness as the floor joist, and screw it to the web of the floor joist on either the hard side or open side of the C. The *Prescriptive Method* calls for four No. 8 screws through the web of the stiffener into the web of the floor joist (Figure 10-13). For exterior walls, add the web stiffener at the end of the joist. Put two No. 8 screws through the rim track into the flange of the web stiffener. For interior bearing walls, you need the web stiffener at the wall location. You don't need to have any screws through the flanges.

With recessed floor joists, you won't need to install web stiffeners at the ends of the joists. However, if you have interior bearing walls, you'll need to install a web stiffener at each joist at the wall location.

For regular or recessed joists where you have an intermediate support with single span floor joists lapped together, you'll also need a web stiffener. Four No. 8 screws installed through the web stiffener is usually sufficient to hold the joists together. You may want to add additional screws for long laps (see Figure 10-4).

Joist Track Splices — You'll need track splices wherever one section of the joist track isn't long enough to extend the whole length of the wall. Use a minimum 6-inch section of joist material to splice the track together, with four No. 8 screws on each side of the splice to secure it (Figure 10-14).

Floor Openings

Frame floor openings with built-up header and trimmer joists. You can frame header joist spans less than 8 feet in length using the same size thickness as the floor joists. Make your headers using a double member consisting of a floor joist inside a track. Use 2 × 2-inch clip angles to fasten the headers to the

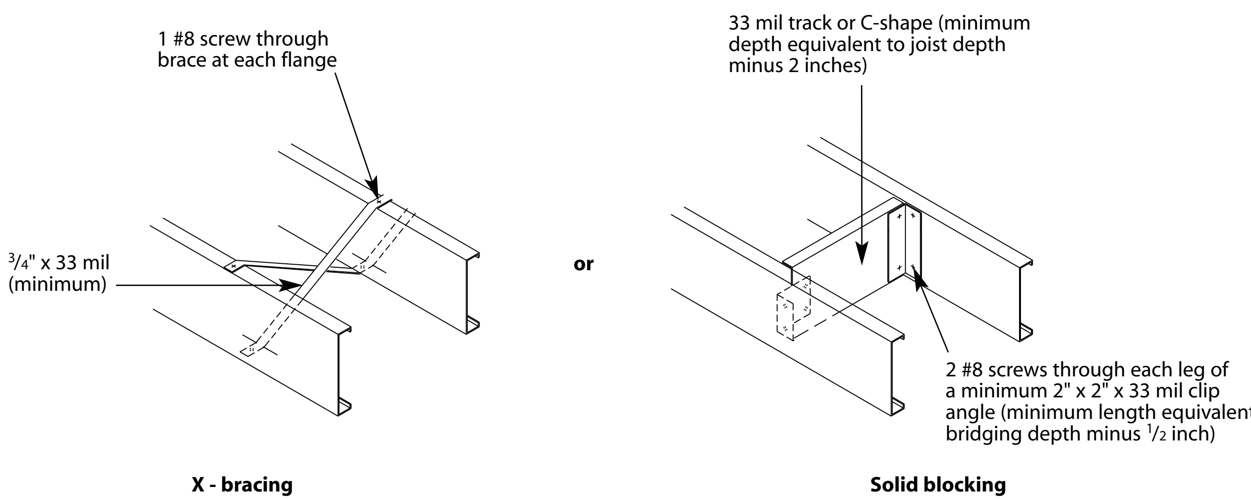


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Figure 10-11
Steel floor bridging options

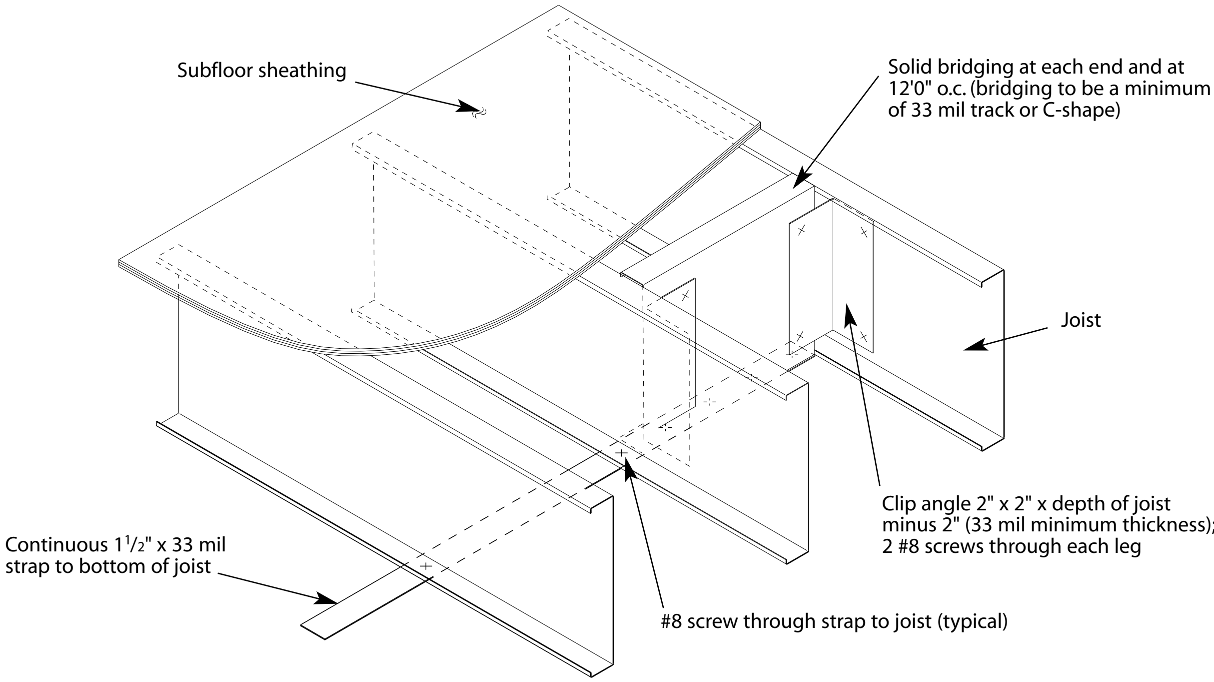

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Figure 10-12

Steel floor bracing

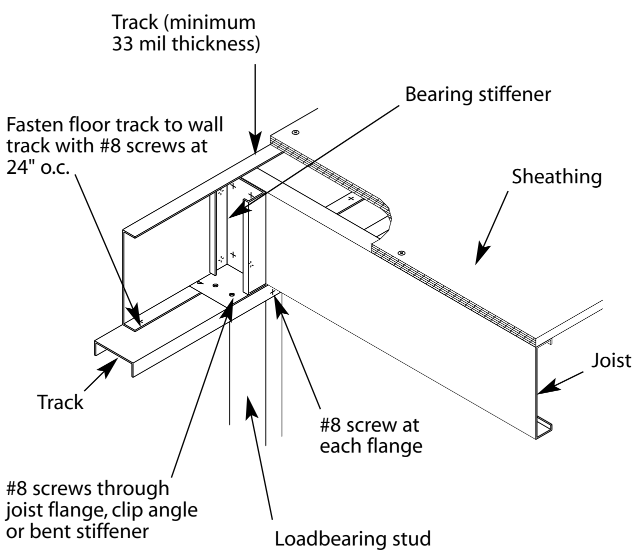

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Figure 10-13

Floor to exterior loadbearing wall connection

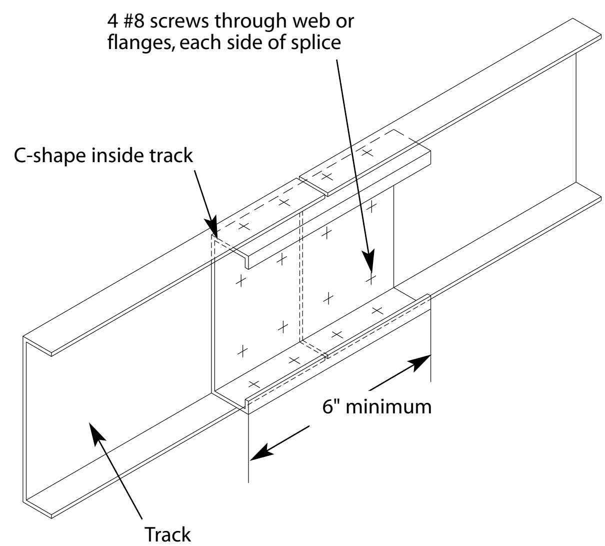

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Figure 10-14

Track splice

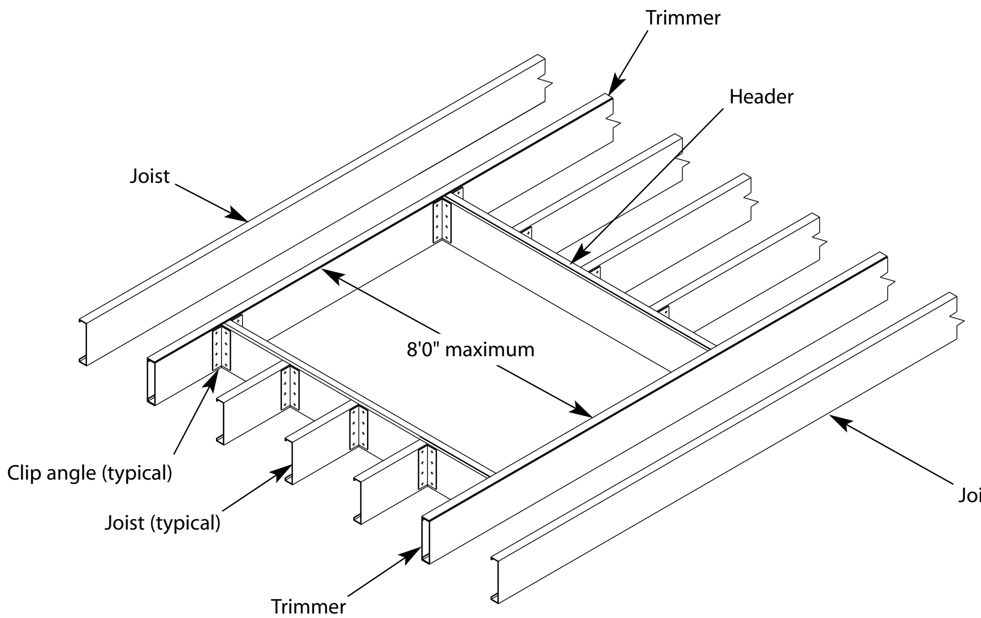

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Figure 10-15
Floor opening

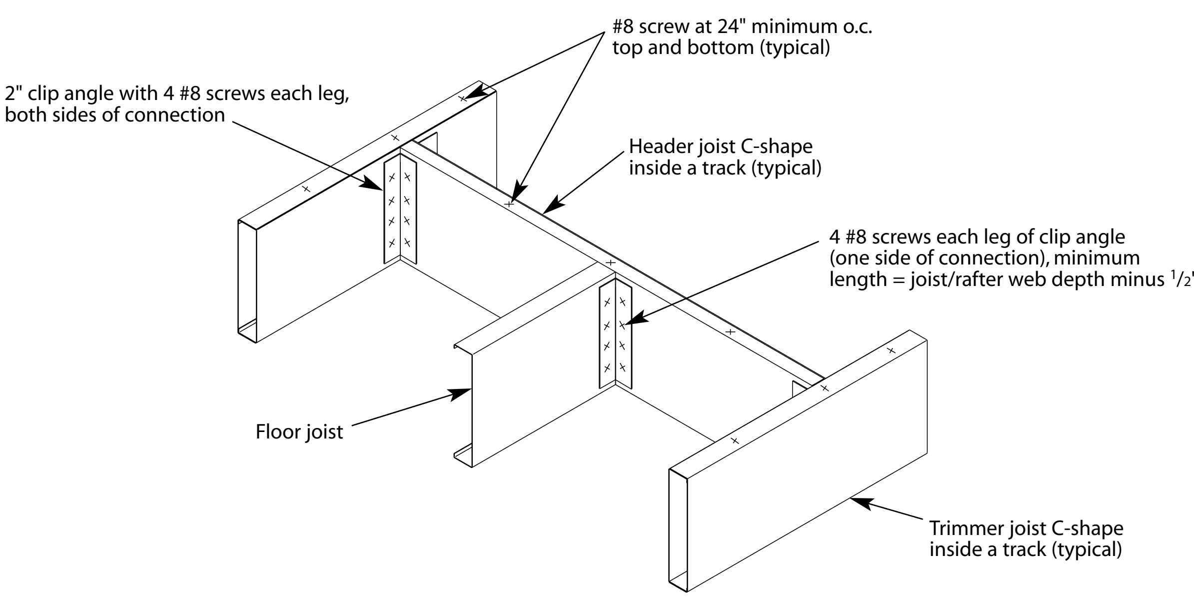

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Figure 10-16
Floor header to trimmer connection

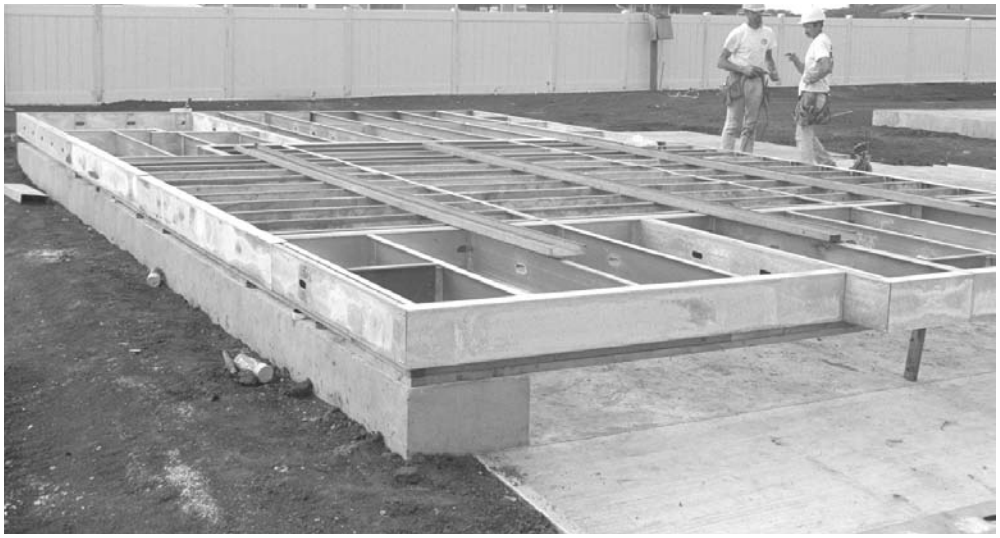

Figure 10-17
Panelizing floors

trimmer joists. You can also make trimmer joists with floor joists inside a track. Fasten four No. 8 screws in each leg of the clip angle to secure the header to the trimmer. (See Figures 10-15 and 10-16.)

Subflooring

Remember to select your subflooring material based on your local building code. When you use 24-inch spacing, you'll usually need to use $^{23}/_{32}$-inch TNG APA rated sheathing. This sheathing material also acts to brace your joists together to keep them from rolling. For floors outside of designated high wind and seismic areas, screw the floor down with a minimum of No. 8 screws, 6 inches on center at the edges, and 12 inches on center in the field. (See Table 5.2 of the *Prescriptive Method*.) Make sure you use a bugle head screw and a drywall screwgun with an adjustable depth setting nose piece. For securing floors inside high wind and seismic areas, consult your engineer.

Panelizing

Floor joists can also be panelized in the shop or in the field. You can assemble modules of floor sections 8 feet wide and up to 30 feet in length and transport them to the site. Make sure that you adequately brace the floor panels so they don't rack before you deliver them to the site. Figure 10-17 shows the second floor joists panelized on a floor slab, ready to be lifted into place on another house.

Floor Squeaks, Pongs and Vibrations

Steel floor joists, if designed and installed incorrectly, can make squeaks, pongs or produce nuisance vibrations. It's important that you know how these sounds are produced, and what you can do to prevent them.

Squeaks

Floor squeaks are caused by the rubbing of two materials together. It can be steel on steel, wood on steel, or plastic grommets on plastic-coated wire. No matter what's rubbing, they're all annoying. Make sure your floor joists are set back $^{1}/_{8}$ inch from the rim track to prevent steel rubbing against steel. Also make sure that your screws aren't stripped, and that the plywood or subflooring doesn't "jack" up the screw when you screw it down. Glue your floors down to the floor joists, being careful not to get too far ahead of yourself so the glue doesn't harden before you screw down the plywood. Finally, make sure any blocking or bridging is installed securely, without loose connections.

There are also foam pads or tape that you can use to help eliminate squeaks. Apply the tape to the top of the floor joists. Where wiring rubs against plastic grommets, use foam pipe insulation.

Pongs

Pongs are caused by the web of the joists flexing when a load is applied from above. The deeper the web and the thinner the joist, the higher the likelihood a pong will be produced. When the joist bounces back to its original shape, it produces a drumming effect or echo throughout the floor. You can do several things to prevent this. You can use joists that are thicker and less deep, but this might produce a bouncier floor. The best solution is usually to use shorter spans. Some new joists have reinforced holes that reduce the potential for floor pongs (check the NASFA Web site for details). Finally, insulate between the floor joists to reduce the echo effect.

Nuisance Vibration

Before steel floor joists are fully loaded with subflooring and carpet, the floor tends to be stiff. When walking across the floor, it may reverberate and send a vibration across the floor. The floor may not bounce, but it has a resonance and vibration that may be annoying. This usually goes away after the subflooring and carpeting are installed. Stiffening the floor with larger floor joists isn't always the solution. While that may take away the bounce, the vibrations may still occur. To help eliminate nuisance vibration, make sure the bracing and/or blocking is correctly installed, and let the floor assume the dead load of the subflooring and finished floor material.

Chapter 11

Wall Construction — Loadbearing Walls

The exterior walls of the house are loadbearing — they carry the weight of the structure itself and resist wind, seismic, and snow loads. With steel-framed walls, unless you use a structural top track, your layout is governed by in-line framing. The bearing studs must be aligned with the trusses, joists, or rafters above or below the wall. The top and bottom wall tracks must be of equal or greater thickness than your studs.

The tables in the *Prescriptive Method* make it easy for you to select a steel stud size to use in the walls. They handle wind speeds up to 110 mph, exposure C, and seismic conditions 0, 1, 2, 3, and 4. Ground snow loads up to 70 pounds per square foot are included (Table 1.1 of the *Prescriptive Method*). For any other conditions, you must ask an engineer to help you select the correct wall stud size.

Wall Assembly

You can build your walls flat on the slab (as shown in Figure 11-1), on your floor deck, or on a panel table. Wherever you build them, make sure that you have a level surface and two straight sides to frame up against — one at the end of the wall and one along the top or bottom track. This will help you build a perfectly straight wall and save time while you're plumbing and lining.

Decide which walls will run the full length of the house, from edge of foundation to edge of foundation. The other set of walls will also run along the edge of the foundation until they meet with the full-length walls. The intersecting walls will be $3^1/_2$ or $5^1/_2$ inches shorter than the full-length walls, depending on the size of the wall studs you're using.

Full-Length Walls vs. Short Sections

One advantage of steel framing is that you can frame walls up to 40 feet in length. This covers most single-family houses commonly built today. If you build a wall in one section, it will be perfectly straight and easier to erect. However, you'll usually need more than a five-man crew to lift a 40-foot wall. You must consider your available manpower at the job site when you're laying out your walls. If you don't have enough men to support the wall, it could twist as you lift it, damaging the top and bottom tracks.

It's perfectly acceptable to build shorter sections of wall and splice them together. You'll need to take care in making sure that each wall section is straight, however. You can splice track by inserting a 6-inch minimum length of stud material inside the track. Use four No. 8 screws on each side of the splice. (See Figure 11-2.) You can save material if you splice the walls at the header locations. The C-shapes that make up the header can also serve as a track splice.

The Layout

Cut your top and bottom track to the right length or take it from your inventory if it was on your cut-list. Position your top and bottom track members on the straight edge of your panel table or other layout area. Arrange them so the webs are against each other, and make sure they're tight against the edge of

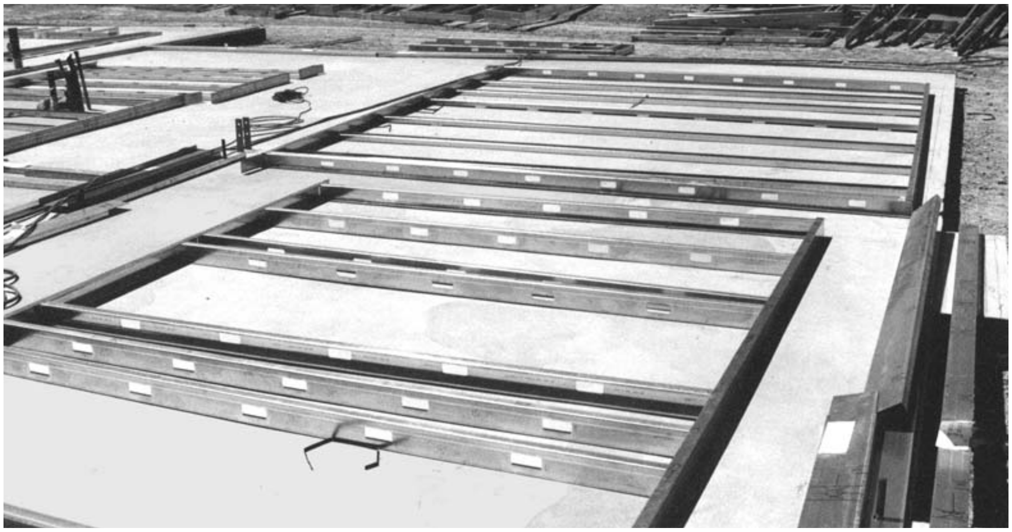

Figure 11-1
Use a level surface for wall layout

the end stop. You normally wouldn't have an end stop if you build your wall on a slab.

As with the floor joists, your wall stud layout is governed by the truss locations. Mark the flanges of the top and bottom track, starting with one end. Use a black felt-tip marker instead of a pencil so you can easily see the marks. For your full-length wall, add another stud 3 inches from the end to use as a backer for the shorter intersecting wall. Mark the track where the web of the stud will be located. Place an X on the side of the mark where the flanges should be located, as shown in Figure 11-3.

Next, measure in along the track to locate your next stud, which must align with the first truss above. It will be 24 inches or less from the edge of your wall. Once you've located this stud, you can use your tape measure and continue putting marks every 24 inches along the full length of the wall. Use a straight line to show the web locations, and an X to show the side of the line the stud flanges should be on.

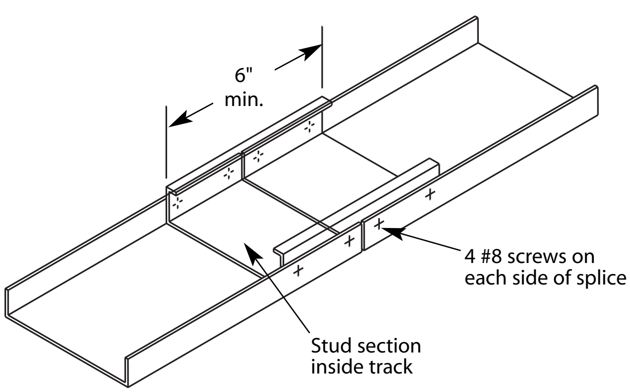

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Figure 11-2
Track splice

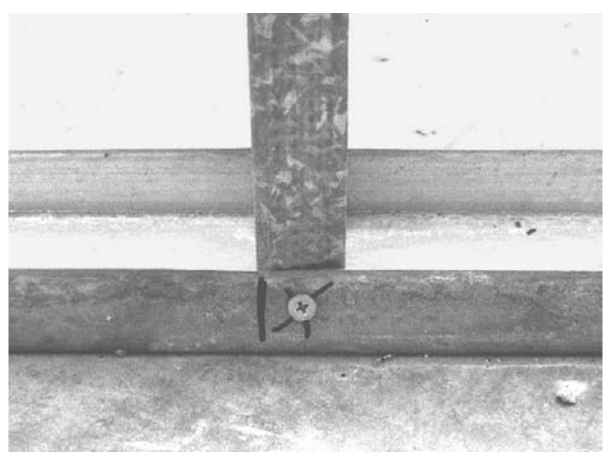

Figure 11-3
Mark the wall layout on the track

Now you need to locate all of your rough openings. Check your architectural drawings to find all the door and window locations. If the dimensions aren't given on the drawings, scale them off. Mark the center of the openings on the top and bottom tracks. It's helpful to use a red felt-tip marker so you can tell these marks apart from the layout marks.

Check the sizes of the windows and doors. It's best if there's a schedule on the drawing. However, even with a detailed schedule, sometimes the actual window sizes are different. If you know or you can find out what the window sizes are before you frame, you won't need to adjust the rough openings after you frame. That certainly saves time and effort.

Take the width of each window and door opening and add 12 inches. The 12 inches allows for two trimmer (or jack) studs on each side of the header and a wood buck on each side of the opening ($1^5/_8 + 1^5/_8 + 1^5/_8 + 1^5/_8 + 1^1/_2 + 1^1/_2 = 9^1/_2$, with $2^1/_2$ inches to spare). You should standardize this dimension so that all of your headers are cut the same. You may not need two king studs or wood bucks at every opening, but standardizing the length takes away an extra complication. Take this dimension and center that length on your tape measure over the red marks you put on the track (which signifies the center of the opening). Put a red mark on the track at each end of your tape (which is still centered and holding the dimension) to locate the king studs. Put an X on the side of the mark away from the window opening. Make sure you mark both the top and bottom tracks.

Installing Studs

Now that your layout is established on your top and bottom track, separate the track and install a wall stud at each end of the wall. Clamp the studs with locking C-clamps at each end. Tap the track on one end. Try to get the top and bottom of the studs as tight as possible to the web of the track. Remember, these are bearing walls. If there's a gap, then most of the load will be supported by the screw. It's much better to rely on the strength of the member rather than the strength of a screw. Keeping the studs tight in the track will also help keep the wall straight and level.

Once the end studs are tight into the track and perpendicular with the wall, screw one No. 8 screw (minimum size) through the flange of the track into the flange of the stud. If you're working on an elevated panel table, you may be able to install the screw on the other flange from underneath the table. If you don't have access to both flanges, then once all the studs and headers are in place, you'll need to flip the wall over to install all the screws located on the other side. In drywall framing, it's common for the drywaller to install only one screw on one side of the wall. But you can't do that. Because you're building bearing walls, you've got to install a screw on each side of the wall on each flange. That will keep the studs from twisting, and give the proper connection for in-line framing.

Continue twisting the studs into the track. Make sure that you install all the studs the same way. Align the punchouts so they'll provide straight runs for the plumbers and electricians. You also need to consider which way your studs are turned so everything matches on parallel bearing walls.

When you get to a rough opening with a red mark, install the king studs with the hard side of the stud facing the rough opening. If you have any stud markings in between the king studs, don't install studs in these locations. These markings are for the cripple locations, and you'll need them when you frame the rough opening. Continue down the length of the wall until all the studs are twisted in and screwed into place. The *Prescriptive Method* (paragraph 6.5) doesn't allow you to splice studs unless you have an approved design.

Box and Back-to-Back Headers

Two types of headers are commonly made from generic C-shapes. There's the box shape and the back-to-back configuration (see Figures 11-4 and 11-5). The header tables in the *Prescriptive Method* work for either method (Tables 6.15a — 17b).

If you need to use hold-down straps to anchor your trusses or rafters onto the wall, you might consider using the box header because it provides a flat surface to screw into. One disadvantage of using the box header, however, is that you need to insulate it before installing it in your wall. In contrast, the back-to-back header looks like an I-beam once it's assembled, and can be insulated at the same time you install your wall insulation.

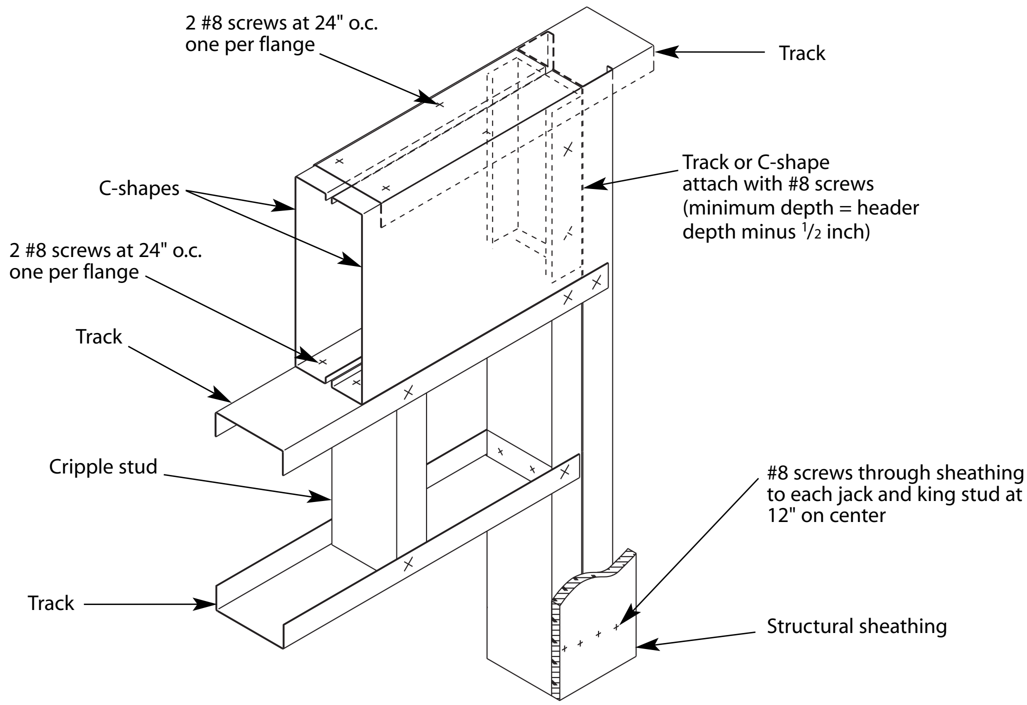

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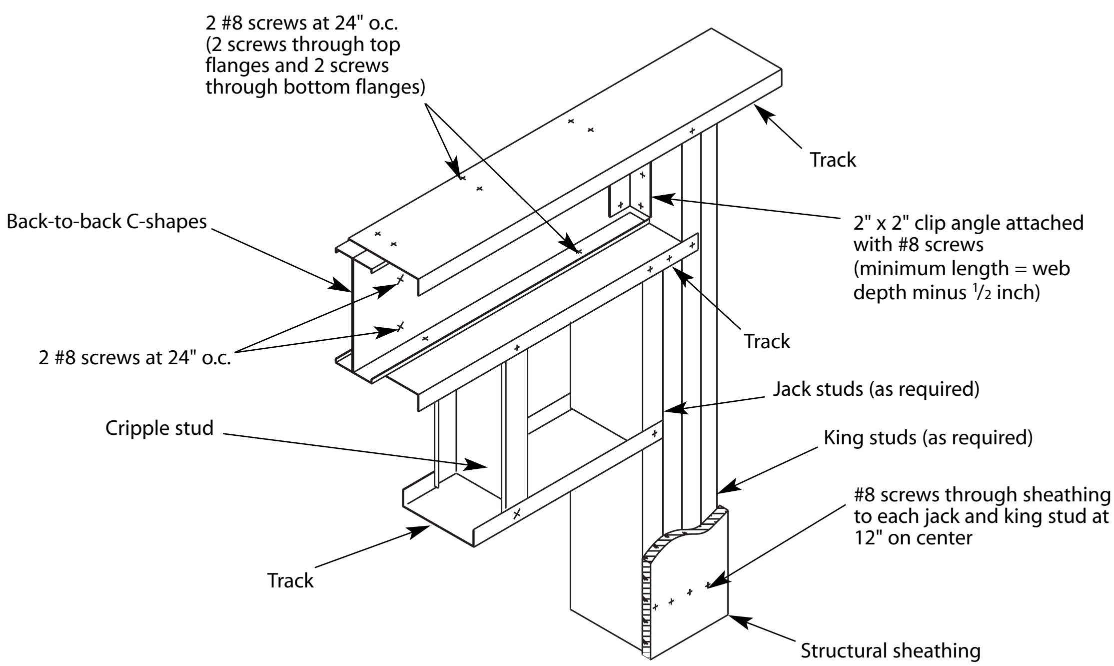
Figure 11-4

Box beam header detail



Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing*, Second Edition

Figure 11-5

Back-to-back header detail

The headers for the house in our design example are box headers. They're sized 12 inches over rough opening. That allows room for two trimmer (jack) studs on each side, and a wood buck.

To build a box header, locate the header material that you ordered for the first wall opening. Measure a section of $3^1/_2$-inch wall track 2 inches longer than the length of the header. Clip the radius back 1 inch on the track at each end and bend the web down toward the flanges with your hand seamer. Be sure to make a straight, clean bend to keep the wall opening straight. This piece becomes the header track for the bottom of your header.

It's hard to keep the C-shape material for the header straight — it tends to twist during assembly. And crooked or twisted headers in a wall always cause problems. Sometimes it helps if you build a small header jig that keeps the header pieces straight. You can build a header jig out of C-shapes with the exact dimensions of the wall opening. Then screw it to your table. Clamping the header pieces to this jig will keep the header members straight while you assemble the header track and stiffeners.

Clamp the header C-shapes to the jig and screw the web of the header track to the flanges of the header pieces with two No. 8 screws 24 inches on center (Figure 11-4). Cut web stiffeners from $3^1/_2$-inch stud material and install them in each end of the header with the hard side of the stiffener facing out. Screw four No. 8 screws through the web of the header pieces into the stiffener flanges on each side. Insulate the header with fiberglass insulation before you install it in the wall.

Loosen one of the king studs in your wall opening and install the header, track side down, into the top track. This is usually a tight fit. Start on one end and clamp it with the bar clamp. Apply pressure, working from one side of the header to the other using the clamp to push the header tightly into the top track.

Reposition the king stud that you loosened and screw it back in place. Screw the top of the king stud into the header stiffener with a minimum of four No. 8 screws on each side. Screw the header to the top track with two No. 8 screws at 24 inches on center. Figure 11-6 shows a box header being screwed into place.

Figure 11-6
Installing a box header in a wall

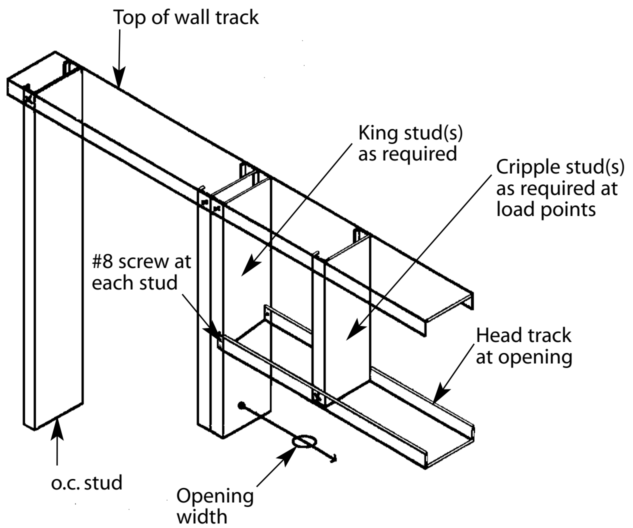
L-Headers

If you want to save on labor costs for fabricating headers, you may want to use an L-header. The L-header consists of one or two angle pieces that fit over the top track. The L-header saves labor because the L-shape itself spans the opening for the header. There's no special fabricating for the box shape, and you use fewer screws. Figures 11-7 and 11-8 show how you use an L-header.

The prescriptive requirements for the use of the L-header are given in the new *L-Shaped Header Field Guide*. It contains a complete set of tables showing loads and spans. Figure 11-9, on the next page, is from this publication. Call 1-800-79-STEEL to order a copy.

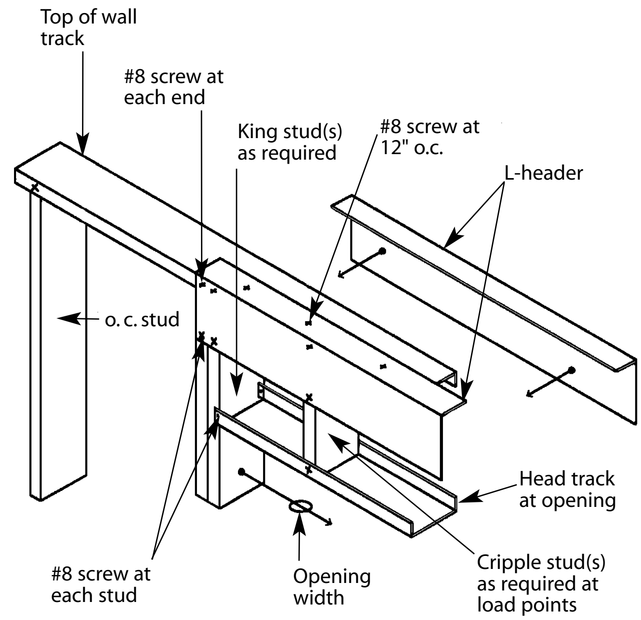
Trimmers

Check Table 6.18 in the *Prescriptive Method* to determine how many trimmer (jack) studs you'll need to install. It will depend on how large an opening you have. If you need two trimmer studs, the 12 inches over rough opening that we're using in our design house will accommodate this with $2^1/_2$ inches to spare. If you need only one trimmer stud, put it on the inside of the rough opening. If you're using wood bucks, leave $1^1/_2$ inches on each side. The trimmer



Courtesy: North American Steel Framing Alliance

Figure 11-7
Framing a rough opening



Courtesy: North American Steel Framing Alliance

Figure 11-8
L-header (detail)

Double L-Header Span Table — Headers Supporting Roof and Ceiling Only 24-Foot-Wide Building[1,2]							
Double L-Header Designation	Ground Snow Load (psf)						
	16	20	30	40	50	60	70
2-600L150-43	4'10"	4'8"	4'4"	4'0"	3'8"	3'5"	3'2"
2-600L150-54	5'6"	5'4"	4'10"	4'6"	4'2"	3'10"	3'8"
2-600L150-68	6'3"	6'1"	5'7"	5'1"	4'9"	4'5"	4'2"
2-800L150-43	6'4"	6'2"	5'4"	5'2"	4'9"	4'5"	4'2"
2-800L150-54	7'3"	6'11"	6'8"	5'11"	5'5"	5'1"	4'9"
2-800L150-68	8'2"	7'11"	7'3"	6'8"	6'2"	5'9"	5'5"
2-1000L150-43	7'0"	6'9"	6'2"	5'9"	5'3"	4'11"	4'7"
2-1000L150-54	8'11"	8'7"	7'0"	6'6"	6'0"	5'7"	5'3"
2-1000L150-68	10'1"	9'8"	8'11"	7'4"	6'9"	6'4"	5'11"

[1] Building width is measured in the direction of horizontal framing members supported by the header.
[2] Design assumptions: Roof and ceiling dead load = 12 psf; Attic live load = 10 psf; 2 foot roof overhang

Courtesy: North American Steel Framing Alliance

Figure 11-9
Allowable loads for L-header

studs for our design house are precut 8 inches shorter than your wall studs to fit under the 8-inch headers. Keep the hard side of the trimmer stud facing the rough opening.

Framing the Opening

Check the window openings on the drawing to determine the height of the window. Locate the position of the top of the window in the wall. Measure down from the top plate and mark your trimmer studs at the top of the windows. Leave an extra $1^1/_2$ inches if you use wood bucks. Make another mark on your trimmer studs at the bottom of your window. Also leave $1^1/_2$ inches at the bottom if you use wood bucks. Cut two track pieces to fit in between the trimmer studs to make up your head and sill pieces. Cut these pieces 2 inches longer than the width of the opening so you can clip the flanges 1 inch on each side. Bend the web down toward the flanges.

Set these head and sill pieces in the opening, keeping the hard side of the track towards the opening. Screw the tab at the flange of each piece into the trimmer studs with one No. 8 screw. Don't forget to also screw the bent web into the trimmer studs with two No. 8 screws. Figure 11-10 shows a close view of a sill screwed into place.

Cut cripple studs to fit between the header track and head pieces, as well as between the sill piece and bottom track. Keep the cripples on the 24-inch wall layout. That will make installing your gypboard and sheathing easier. Screw the cripple studs in place with a No. 8 screw at each track on each side.

Obviously, door openings don't require a bottom sill. However, let your bottom wall track run continuously at the bottom of the door opening to hold the wall together temporarily. You may want to cut the web of the track at each end of the opening to make it easier to remove after the wall is in place. But only cut the track out after the wall is plumb, level, and permanently braced. Figure 11-11 shows a finished framed opening.

Bracing

There are several types of wall bracing. Intermediate steel bracing, shear wall bracing, X-bracing, and temporary bracing all have different applications. Let's look at how to use each type.

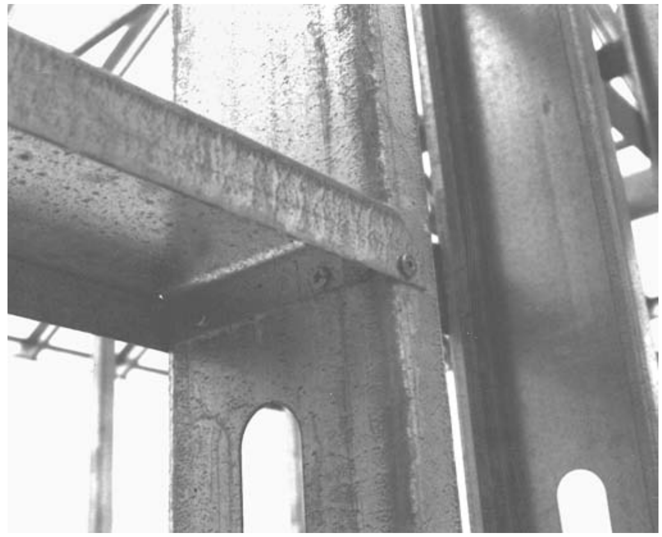
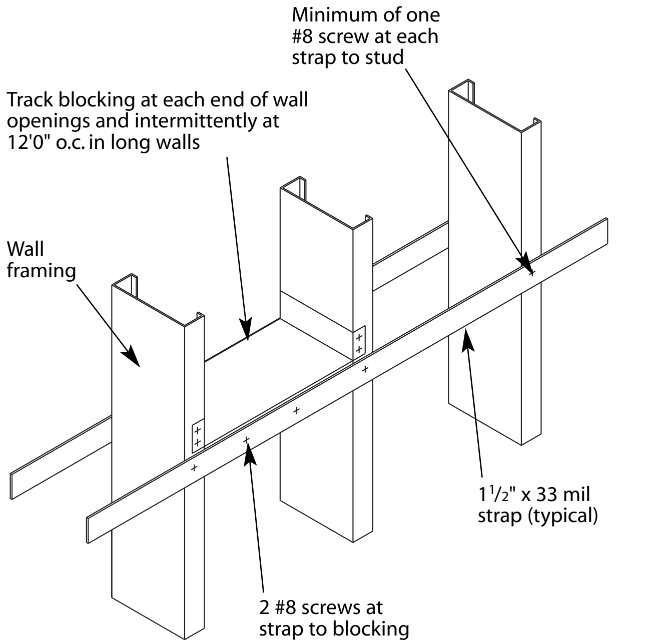


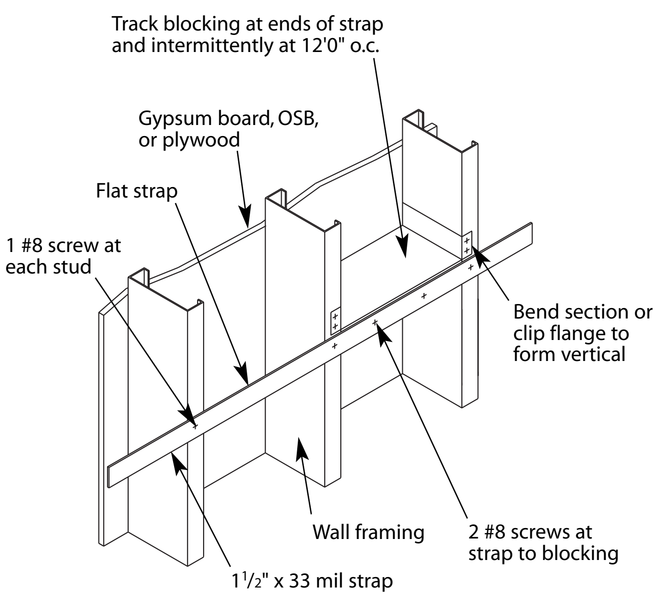
Figure 11-10
Sill installed in window opening

Figure 11-11
Finished opening



Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing*, Second Edition

Figure 11-12
Stud bracing with strapping only



Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing*, Second Edition

Figure 11-13
Stud bracing with strapping and sheathing material

Intermediate Stud Bracing

You should use intermediate stud bracing when you won't be applying gypboard or structural sheathing to both sides of bearing walls, such as on unfinished garage walls. See Figures 11-12 and 11-13.

Install ½-inch gypboard on bearing walls using minimum size No. 6 screws, spaced 12 inches on center. For structural sheathing, use No. 8 screws, 6 inches around the perimeter and 12 inches in the field (on intermediate supports). For walls higher than 10 feet, consult with your engineer to determine the possible need for stud bracing, regardless of whether or not you use structural sheathing.

Wall Bracing (Shear)

You must brace the loadbearing walls of a house to protect them from shear forces and prevent them from racking. Shear bracing keeps the house from leaning or falling over when subjected to force. You can use either structural sheathing or X-bracing as shear wall bracing.

Structural Sheathing

Type II plywood or OSB will keep a wall from racking, as long as the wall doesn't contain an excessive number of openings. The openings can't exceed the percentages found in Table 6.20 of the *Prescriptive Method*. Under the *Prescriptive Method*, shear walls using these materials are limited to wind speeds of 100 mph, Exposure B or less, and Seismic Zones 0, 1, and 2. If you use plywood, then it must cover the full height of the wall, from the top track to the bottom track. Table 6.14 of the *Prescriptive Method* recommends using No. 8 screws 6 inches on center along the edges and 12 inches in the field.

For effective bracing, install your structural sheathing with the long dimension parallel to the stud framing (vertical orientation). Attach the plywood to the wall while panelizing or after the wall is plumb and level. Make sure you fasten the sheathing firmly to the steel frame. Draw the plywood up tight against the wall with No. 8 self-drilling screws. Finish attaching the plywood with screws or pneumatic pins. Instructions for installing structural sheathing are in paragraph 6.8.2 of the *Prescriptive Method*. Figure 11-14 shows structural sheathing in place.

Figure 11-14
Structural sheathing

X-Bracing

You can use X-bracing to obtain shear strength on walls where you're not using structural sheathing. X-braces are diagonal steel straps that you attach to walls with screws. They're most commonly used on stucco walls or in termite-prone areas.

You'll need to have your engineer design the X-bracing. Ask the engineer to develop an effective and easy-to-install X-brace design. There are two common types: narrow-strap X-bracing with gusset plates or wide-band X-bracing. With the narrow-strap X-bracing, you need gusset plates (steel plates about 12 inches square) at the end of each diagonal, as shown in Figure 11-15. The steel plates might make your walls thicker. That can cause difficulties in shooting pins or applying screws when you install your siding material.

If this is a problem for you, ask your engineer to design a wider band of steel, sometimes 8 or 12 inches wide, with a thinner material thickness (as thin as 33-mil) for your X-bracing. (See Figure 11-16.) This will minimize the thickness of the layers of steel, making it easier to attach the fasteners for your siding. Another advantage to the wider strap is that you won't need the gusset plates at the ends of the diagonals because with this bracing, all the screws are located in the end of the strap. Your engineer should try to design your X-braces with fewer screws in the ends because a large number of screws will slow

Figure 11-15
Gusset plate X-bracing

Figure 11-16
Wide-band X-bracing

Figure 11-17
Temporary panel bracing

down your framing progress. Be sure you check the straps after they're attached to make sure they're installed with the correct number of fasteners.

Installing the X-Brace on the Panel Table — If you use X-bracing, you can either cut the strap and tack it to the wall during panelization or install the strap after the wall is already in place. If you're installing the X-brace on the panel table, then you need to measure the diagonal section that requires strapping and cut the strap slightly longer than required. Tack the strap on each end and in the center with one No. 8 screw in each location. Don't tighten the straps until the walls are plumbed and aligned. We'll discuss how to complete X-brace installation in the section on Wall Erection, coming up shortly.

Temporary Bracing

There are two types of temporary bracing: temporary bracing of panelized walls and temporary bracing of erected walls.

Panelized Walls

After you've constructed a straight wall on a panel table, you don't want to rack or bend the wall while removing it from the table. You can prevent racking the wall by installing plywood or temporary bracing.

Before you take the wall off the table, check for squareness by diagonally measuring the panel. Adjust it if necessary. Lay extra studs or truss material across the wall diagonally, as shown in Figure 11-17. Screw the bracing to the wall studs, especially at door openings where the bottom track is weak. Leave the bracing on the wall until it's installed and permanently braced. These precautions will help you make straight walls that are ready for installation.

Erected Walls

Paragraph 6.4 of the *Prescriptive Method* requires that you provide adequate temporary bracing to resist construction loads until your permanent bracing can be installed. Extra studs ordered on your cutlist will provide temporary bracing material. The studs should be long enough so that you can anchor the ends of the braces to stakes driven into the ground. Figure 11-18 shows temporary wall bracing in place.

Figure 11-18
Temporary wall bracing

Wall Erection

Depending on the type of anchors in your foundation, you may have to measure their location and provide holes in the bottom track of your wall panels so they'll fit over the anchor bolts. If you're using something like strap anchors, this won't be necessary.

When you're ready to erect your walls, place temporary bracing material near the foundation. Position extension cords, screwguns, and ladders where they're easily available for use. Make sure you have enough workers on hand to arrange and tilt the walls into position so that you won't twist or bend the top and bottom tracks. If you don't have a sill plate, caulk your concrete foundation with weatherproof caulking material or a foam sill sealer where the wall will rest on the concrete.

Bring the first wall panel over and set the bottom track on the foundation. Position it over the anchor bolt locations and tilt the wall up. Leaving the wall tilting slightly outward, take your temporary brace material and clamp it to a stud in the wall. Make sure that the brace stud doesn't lap past the inside face of the wall. This could cause injuries or simply get in your way. Secure the brace to the stud with a No. 10 hex head screw before removing the clamps. Install a brace every 8 to 12 feet along the wall panel. To hold it in place, screw the bottom of each brace stud into a stake driven into the ground.

Now stand the next wall section up in position and repeat this procedure. Once you have each wall standing, plumb the walls and screw the corners together with No. 10 screws. Adjust the bracing to align the walls. Leave the bracing and bottom track in the door openings in place until all of your permanent bracing is installed.

Anchor your walls as soon as possible after you've plumbed and leveled them. How you anchor your walls will depend on the type of foundation you have. Refer back to the guidelines in Chapter 9 for wall anchorage.

Completing the X-Bracing

Once all your walls are in place, plumb, and level, you'll need to complete the installation of your shear wall plywood or X-bracing. Plywood installation is pretty basic, so we'll concentrate on X-bracing. Follow the plans the engineer provided for shear wall locations, strap sizes, and number of fasteners.

Compression studs are usually required at the end of all X-bracing. Compression studs are made up of two wall studs positioned back to back to support loads in the X-braced panel. It's usually better to install compression studs while the wall is still on the panel table. But if you forgot to put them in, you can install them before completing your X-brace straps. Check with the engineering details to see how many screws are required to screw the two studs together.

Remember, a loose strap is useless! Once a shear load is applied to a wall, the wall will start to move if there's any slack in the strap. You must pull the strap tight to take out all the slack. Do this by putting only one screw in the middle of one end of the strap. Then take a No. 8 C-clamp and install tabs on each end of the clamp (sometimes called a *strap stretcher*). Screw one tab into the other end of the strap, and the other tab into the rim joist, foundation or bottom track (see Figure 11-19). Adjust the clamp and keep tightening the strap until all the slack has been taken out. Then secure the clamp end of the strap onto the bottom track with a No. 8 screw. Remove the clamp and complete the installation by fastening the number of No. 8 screws required by the design through the strap into the studs and top and bottom tracks.

Repeat this procedure for all your straps. Don't remove the temporary bracing until all your permanent bracing is in place.

Interior Loadbearing Walls

Occasionally you'll frame a house that has interior loadbearing or shear walls. Interior bearing walls usually break up a span for the floor joists. They can also increase the shear capacity of a home when the exterior walls can't achieve all the shear strength necessary to work against wind or seismic loads.

Closely follow the engineering recommendations for the size of the studs, location of any compression studs, and size and connections for X-bracing. Once

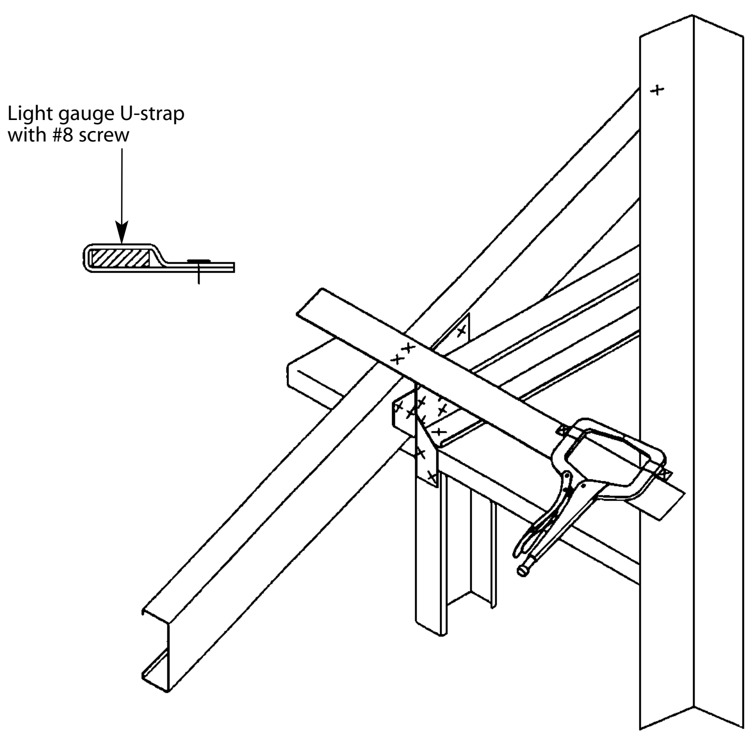


Figure 11-19
Strap stretcher

again, either plywood or X-bracing may be required. Plywood is recommended if you need backing material, as you would for cabinets on a kitchen wall. Otherwise, you can install X-bracing as described above.

Framing Walls in Place

Some builders choose to frame walls in place, especially if they're using a one- or two-man crew. If you choose this method, cut your track for the full length of the wall. Mark the top and bottom track for layout. Anchor the bottom track in place, and secure the studs in each end of the track. Use a string line and level to position all the rest of the studs in the wall. Install your headers, X-bracing, or plywood after the wall is standing.

Balloon Framing

For two-story homes, you may choose to use balloon framing. In other words, use a full-length stud that extends up through both stories (Figure 11-20). This type of framing falls into the category of a pre-engineered structure (see Chapter 7). There are no tables in the *Prescriptive Method* to help you select balloon frame stud sizes. So if you decide to balloon frame, you must work closely with your engineer to size the members and develop good details.

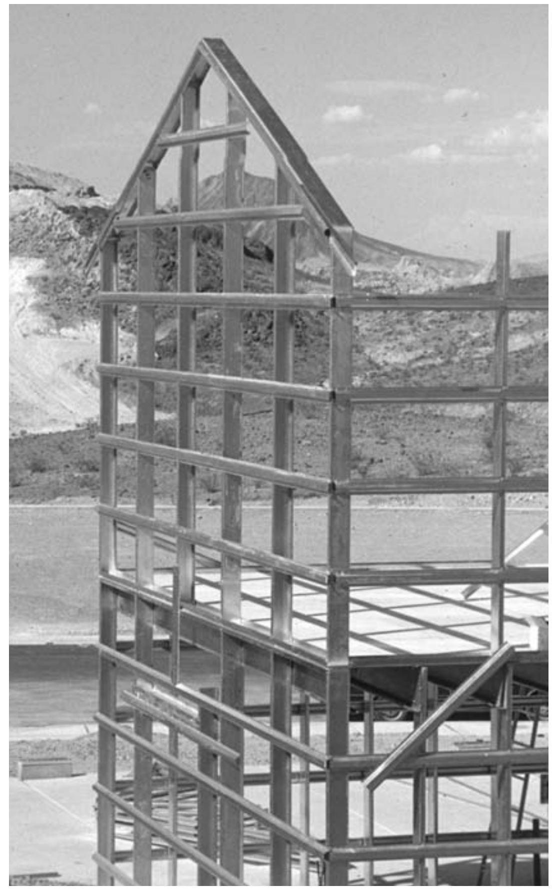


Figure 11-20
Balloon framing

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Chapter 12

Second Floor Construction

If you're framing a two-story house, your first-floor walls should be permanently braced before you start the second floor. If you're using plywood or OSB, sheath the walls before going any higher.

Bearing Walls or Clear Spans

As we discussed earlier in the book, you need to consider the direction of the floor joists and any interior loadbearing walls before you do your layout. Remember that the floor joist sizes depend on the span distance and whether or not your design calls for a single or multiple span joist. In Chapter 10 we saw that multiple span joists may have shorter or longer spanning capabilities than single span joists. Making sure that you have the correct joist size and direction will also prevent bouncy floors. Figure 12-1 shows second-floor joists in place.

Layout

Unless you've selected a structural top track, you'll be using in-line framing for your second-floor joists. You've already established your layout in your first-floor wall framing, so all you need to do now is follow the same layout for your second-floor joists. If you've selected a structural top track, your layout can be anywhere along the top track because the top track can support the joist load between the wall studs.

Mark the first-floor stud positions (every 24 inches) on the top plate. Your mark should line up over the web of the wall stud below. This should also correspond with the opposite wall on the other side. If you have any interior loadbearing walls on the second floor, the studs should also be located where the joists cross. This is why you should start your layout on the same side of the house each time. You also need to keep the open side of the C-shapes pointed in the same direction on both sides of the house. You want your axial loads to line up over the webs of the wall studs and floor joists as much as possible.

Setting Floor Joists

Once you have your layout, set the rim track on both sides of the house, and screw the bottom flange into the top track of the wall below. Use No. 8 screws at 24 inches on center for up to 110 mph wind loads, Exposure A or B, or 90 mph wind loads, Exposure C.

Set your floor joists in the track on layout, then twist the joists into position (keeping the hard side on layout). Using a speed square, check to see if the end of the joist is perpendicular to the rim track. Also make sure you have a 1/8-inch gap between the rim track and the end of the joist. This will help prevent the floor from squeaking. And follow the precautions listed in Chapter 10 to eliminate floor squeaks, pongs and nuisance vibrations. Screw the top and bottom flanges into the flanges of the rim track with two No. 8 screws. For interior bearing walls, screw two No. 8 screws into the top track. (See Table 5.1 in the *Prescriptive Method* for connection requirements.)

Cantilevered Joists

The standards and procedures for installing cantilevered joists on the second floor are the same as for the first floor. (Refer to Chapter 10, Cantilevered Joists, for details.)

Figure 12-1
Second-floor joists

Joist Bracing, Blocking and Bridging

Just as with first-floor joists, second-floor joists require bracing if they're over 12 feet in length. You can install 33-mil steel strap, 1½ inches wide, on the bottom flange. Pull the strap tight and screw it to each bottom flange with a No. 8 screw (Figure 12-2).

When joists are over 12 feet long, you must install *blocking or bridging*. Follow the same procedures that we described in Chapter 10, under Blocking or Bridging.

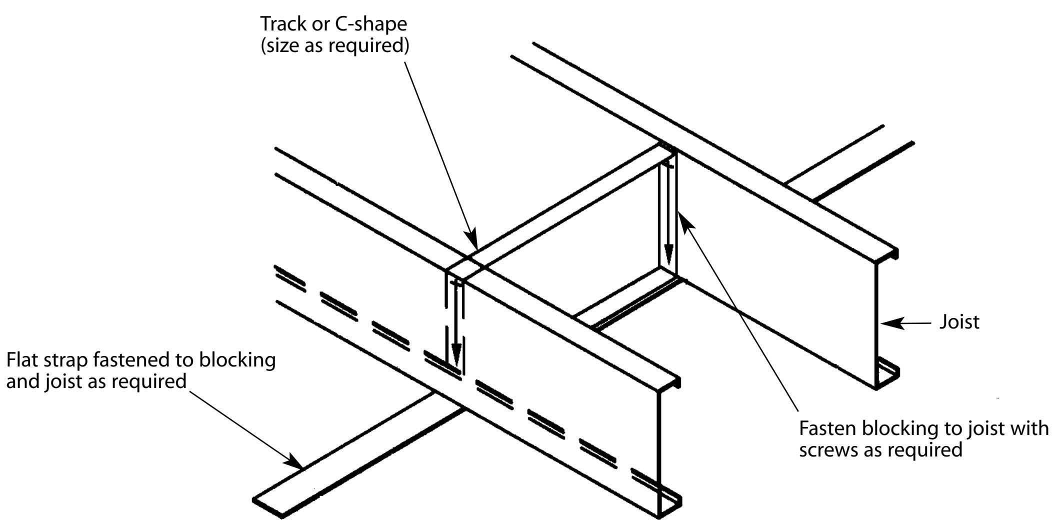
Web Stiffeners

Unless you're using balloon framing, you'll need to install web stiffeners for your second-floor joists. Cut stiffeners from stud or track material the same thickness as the floor joist and screw it to the web of the floor joist on either side. Use four No. 8 screws to attach the web of the stiffener to the web of the floor joist.

Web stiffeners are required on the exterior or interior walls where an axial load is imposed from above; that would be your second-floor walls or roof trusses or rafters. Web stiffeners may also be required where you lap joists together. See Figure 12-3.

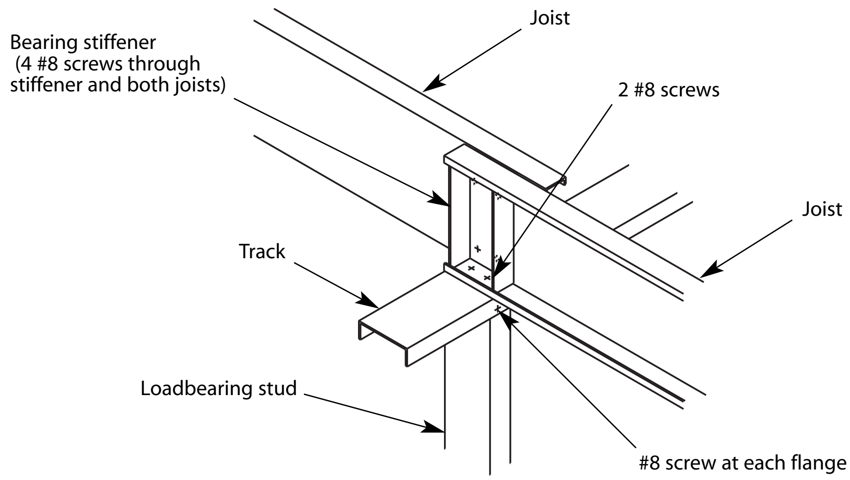
Floor Openings

Frame your second-floor openings the same way you framed your first-floor openings. Make sure you use clip angles and the correct number of screws to frame the openings.



Courtesy: North American Steel Framing Alliance

Figure 12-2
Steel floor bracing



Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing,* Second Edition

Figure 12-3
Lapped joist

The subflooring requirements for the second floor are also the same as the first. Select the correct plywood thickness and fastener spacing as we discussed in Chapter 10.

Safety

Unless you provide a written plan, OSHA requires that you have fall protection when you're working at levels higher than 6 feet. That typically means using safety harnesses (Figure 12-4) or installing a temporary safety rail around the house perimeter as well as around floor openings. You should also be especially careful to secure the subflooring before anyone walks on it. Plywood that gives way to a worker walking on it can create a nasty fall.

Figure 12-4
Safety harness

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Chapter 13

Roof Framing with Rafters

After the walls are erected and braced, you can start framing the roof. Whether you use steel or wood trusses or rafters, the framing modules are the same: either 16 or 24 inches on center. Roof rafter framing is the "stick-built" approach to steel framing. Truss framing is the "panelized" method. We'll discuss framing steel roofs using rafters in this chapter. In Chapter 14, we'll cover steel roof framing with trusses.

Rafter framing typically uses two rafters that rest on the top track on each side of the house, coming together at a ridge member at the top. The weight of the roof and any additional load is carried through the rafters to the top track and down the wall studs. The ceiling joists span across from one side of the house to the other, tying the opposing rafters together. The ceiling joists also prevent the walls from spreading outward because of the weight imposed by the rafters.

You can also add support braces to transfer loads to interior loadbearing walls. Support braces reduce the span and size of the rafters. The span tables and connection charts for typical roof rafter framing are in Chapter 8 of the *Prescriptive Method*.

Unfortunately, the more complicated the roofline, the more detail work is involved. This is the case whether you're framing with wood or steel. Beginners should start with straight gable roofs or intersecting gables. Once you're comfortable framing the easier roof styles, you can move on to more complicated roofs, like hips and cathedral ceilings. It's important to approach this work one step at a time so you don't get overwhelmed. We'll start with how to frame and connect the rafters to the walls, then move on to overhangs, soffits, and fascia.

Designing the Rafter Roof

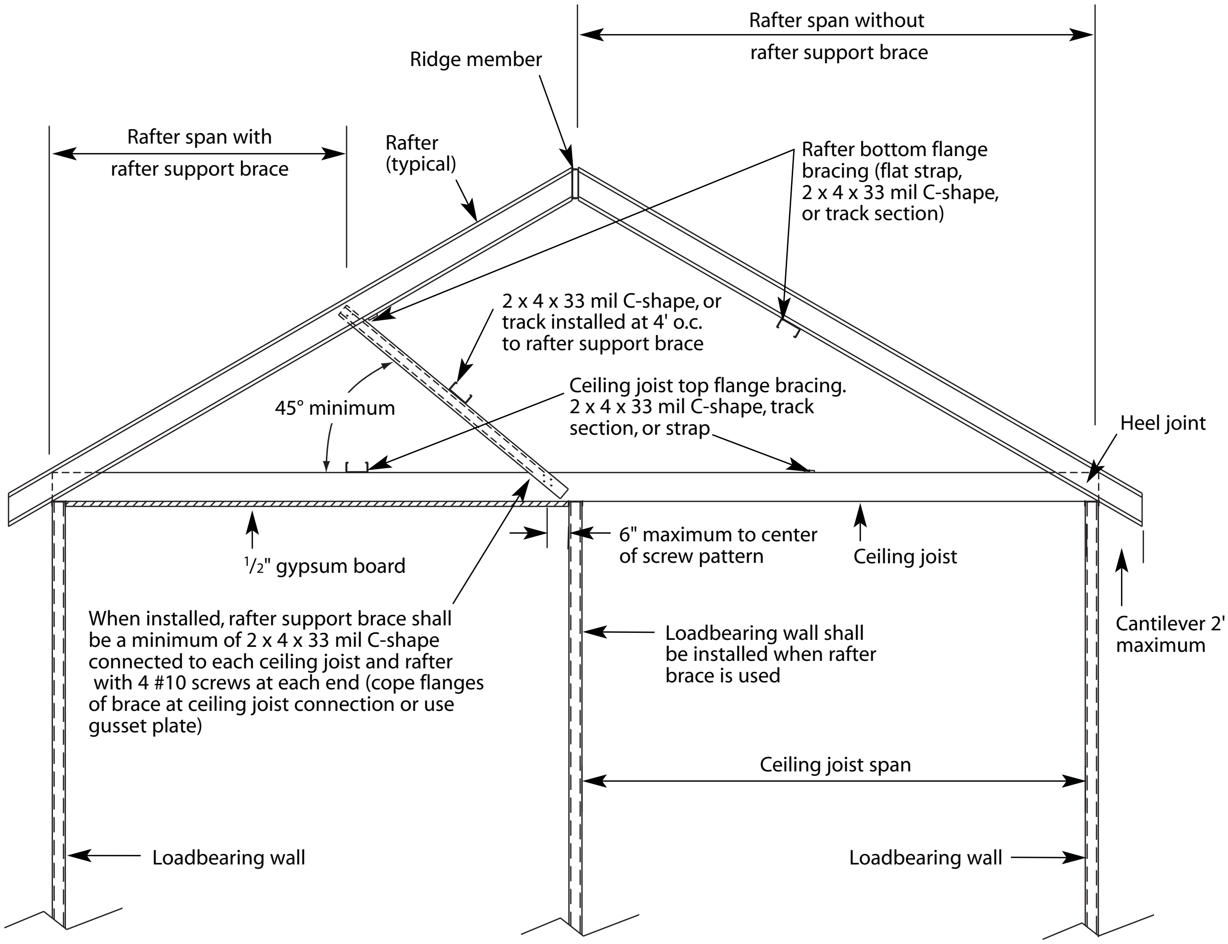
Before you start framing, you should consider both the advantages and disadvantages of roof rafter framing over truss construction. Roof rafter framing with minimal support bracing can provide more attic space than roof trusses. And you'll typically use less steel. That means fewer connections and less labor time for framing a roof. Complicated roof designs may require expensive, specially-designed truss systems. Rafter framing may provide a cost-effective alternative to these systems.

On the other hand, it usually takes longer to frame rafters than to set prebuilt trusses. In addition, roof rafter framing requires more time spent working on scaffolds and ladders, which makes safety considerations much more important.

Because the design example house we were looking at in Chapter 3 uses roof trusses, we haven't covered the design process to determine rafter and ceiling joist sizes. Let's take care of that first in this chapter, by looking at the material cut list, take-off, and some basic design.

Ceiling Joists

Ceiling joists make up the ceilings of steel-framed houses. As in wood-framed houses, they're often used for attic storage. For the design example in this chapter, we'll take the dimensions of the design house from Chapter 3 (26 × 40 feet). Because this size house fits within the applicability limits of Table 1.1 of the *Prescriptive Method*, that lets us use its tables to select our ceiling joists. Let's



Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing*, Second Edition

Figure 13-1
Steel roof construction with rafters

assume that our Salem house will have no attic storage and use single-span joists with web stiffeners. Table 8.4 lists allowable ceiling joists using 33-ksi steel, single spans with bearing stiffeners, and no attic storage.

The only member in Table 8.4 that can carry the 26-foot span at 24-inch spacing is the 2 × 12 × 97 joist. This joist requires third-point lateral supports on the top flange, as shown in Figure 13-1. The table gives us an option to install no bracing on the top flange of the ceiling joists, a mid-span brace, or third-point braces. The more braces we use, the greater the spanning capability of the ceiling joists. We can use 2 × 4 × 33-mil C-shapes or strap material to provide this lateral support.

The 2 × 12 × 97 ceiling joist is a 12-inch-deep member that's very thick. It will take more labor to install, but the table leaves us with no other option as long as we want to span the entire 26-foot span. You may have to trim the 12-inch joist where the roof rafter intersects at the top track. Otherwise the end of the joist may protrude above the rafter because it's so deep. And if you use the 97-mil member, it will require more effort in applying screws.

One possible alternative that you could use is doubling up two 2 × 8 members back-to-back in the clear span area of this house. This would require design assistance by your engineer, however, and that might be more than the additional labor cost of installing the 2 × 12 × 97 joists. Another alternative would be to support the joist with a beam mid-span. However, if you use this method, the beam will be visible (and probably aesthetically objectionable) inside the room. You could also use a cathedral ceiling or trusses. Both would require assistance from your engineer. Yet another option is to use interior loadbearing walls to break up the span of the ceiling joists, letting you use a smaller joist. That's what's typically done in wood-frame construction. This would be the least expensive solution, as long as the interior wall is needed. Of course, you could always go back to using trusses.

In the garage area, you can plan for limited attic storage. From the house line to the beginning of the hip roof, the ceiling joists will span the full 20 feet. Use Table 8.6 of the *Prescriptive Method* to determine the size for the garage joists. This table is for single spans, 33-ksi steel, and limited attic storage. Again, you'll be using third-point bracing and bearing stiffeners with 24-inch spacing. You can select the following joists from Table 8.6:

Joist Size	Span
2 × 8 × 97	20'1"
2 × 10 × 97	21'10"
2 × 12 × 54	20'1"

Reading the table in the last column, select the thinnest member you can use for each size (2 × 8, 2 × 10 and 2 × 12, for example). For each of these sizes, I've listed the thinnest member and its respective spanning capability.

You should select the 54-mil joist for two reasons. First, it's thinner than the other members, so it'll be easier to fasten. Second, it's best to stay with one size joist — and you've already selected the 2 × 12 joist for ceiling joists in the house. As with the house joist, you'll also need to trim this 12-inch joist where the roof rafter intersects above the top track. In the ceiling of the house, the 12-inch joist is more acceptable. Because it's not a second floor subjected to loads, it has less likelihood of producing a "pong."

If you want to use a smaller member, consider eliminating the attic storage in the garage area. Another option is to check with your engineer on using back-to-back ceiling joists. This would double the number of joists, but allow you to use the thinner material.

Roof Rafters

Roof rafters are set at the roof pitch of the house. They rest on a ridge member and the top track.

You can use Table 8.12 in the *Prescriptive Method* to select your rafter sizes, but first you have to check Table 8.13 to find your Wind Speed to Equivalent Snow Load Conversion. Our design house has a 5:12 roof slope, with an 80-mph wind load, Exposure C. Using Table 8.13 and these design parameters, the wind speed to equivalent snow load conversion is 20 psf. That means that the wind would exert a force equivalent to 20 psf ground snow load. In the roof rafter tables, we'll use the largest value of either the wind speed to equivalent snow load, or the ground snow load. In this example, the ground snow load of 30 psf (see Chapter 3) is larger, so we'll use 30 psf in the rafter tables.

House Rafters

Using Table 8.12 of the *Prescriptive Method*, the columns for the 30 psf ground snow load, and 24-inch spacing for the rafters, we can search for the rafters that will be able to reach a horizontal span of 13'0". Here are the members we can select from that table:

Rafter Size	Span
2 × 6 × 54	13'1"
2 × 8 × 43	14'6"
2 × 10 × 43	16'0"
2 × 12 × 43	15'7"

For our design house, we'll select the 2 × 8 × 43 rafter because it's the smallest joist size that has the thinnest section (43 mils). That will make it easier to fasten the members. Also, the 2 × 8 rafter will keep the fascia size smaller than if we chose the 2 × 10 or 2 × 12.

Garage Rafters

We can use the same table (Table 8.12) to determine the size of the garage rafters. This time we'll use a 10'0" span, 30 psf ground snow load and 24-

inch spacing. Once again, you can select the thinnest members for each rafter size from that table:

Rafter Size	Span
2 × 6 × 43	11'8"
2 × 8 × 43	14'6"
2 × 10 × 43	16'0"
2 × 12 × 43	15'6"

While the 2 × 6 × 43 is the lightest member that will do the job, we'll select the 2 × 8 × 43 to match the rafter size and rafter tails we selected for the rest of the house. This will make our fascia detail easier, because the fascia will be one size all around the house.

Ridge Member

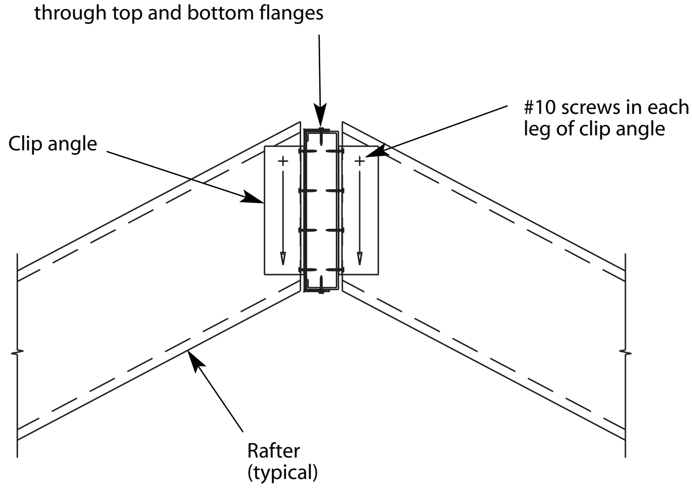
Section 8.4 of the *Prescriptive Method* describes how you make a ridge member from a C-shaped member and track section, with the C-shape nested inside the track. You attach the rafters to the ridge member with 2-inch × 2-inch clip angles of the same or greater thickness than the roof rafter. The ridge member should be the same minimum size and steel thickness as the roof rafters.

Figure 13-2 shows the ridge member assembly. For our sample house, select a 2 × 8 × 43 C-shape member and track to match the rafter size, with 2 × 2 × 6-inch × 43-mil clip angles.

Hip Roofs

Hip roofs change the slope of the roof by sloping towards the ends or the corners of a house — and eliminate the need for gable ends. They're used to break up roof profiles and create different architectural styles. Unfortunately, they also increase the complexity of roof design and framing. *Full hip* roofs slope from the ridge down to the four walls. *Dutch hip* roofs partially slope up to the gabled ends on each side of the house. Figure 13-3 shows both kinds. You can build hip roofs from either trusses or rafters, or a combination of both. We'll look at the rafter method in this chapter.

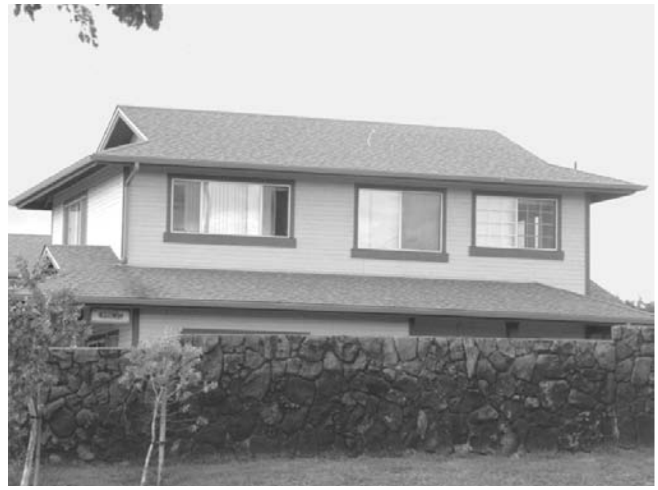
Hip rafters run from the peak of the intersecting ridge of the hip roof down to the corners of the house (Figure 13-4). Jack rafters (sometimes called *bat jacks*) run from the hip rafters down to the wall on layout to fill in the rest of the framing. Hip rafters may be made out of "boxed" sections (C shapes nest-



Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing,* Second Edition

Figure 13-2
Ridge member connection

A Full hip



B Dutch hip

Figure 13-3
Hip roofs

ed in track just like the ridge member). Or they may be made out of two back-to-back tracks set at the appropriate angle to accept the jack rafters. If you use the box hip rafter, you'll have to cut the ends of the jack rafters to the appropriate angle. If you use back-to-back track, you won't need to miter cut the jack rafters.

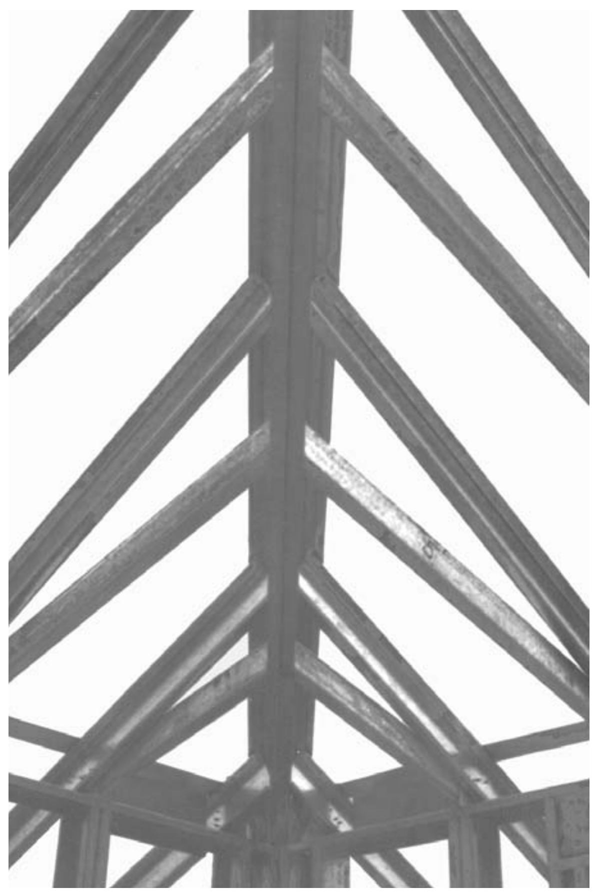


Figure 13-4
Hip rafter with jack rafters

Material Take-Off and Cut List

Figure 8-2, back on page 57, has a sample cut list that includes roof trusses. If you're going to use rafter framing for a roof, you'll need to prepare a cut list for rafters and ceiling joists. Figure 13-5 shows a cut list for rafter framing the same design house that's shown in Figures 3-1 and 3-2.

Roof Rafters

For roof rafters, we selected 2 × 8 × 43 C-shapes for the house and garage sections of the house. Order two rafters for every ceiling joist (2 × 22 = 44 rafters). Calculate the length of the rafter based on a 5:12 roof pitch and a 24-inch overhang. If you prefer, you can draw a sketch and scale the dimension. The length of the roof rafter from ridge to tail for our sample house is 16'1" (line 1 on the cut list).

Roof Framing						
Item No.	Qty.	Size	Manufacturer's Designator	Thick. (mil)	Length (ft. - in.)	Location
1.	44	2 x 8	800S162	43	16′ 1″	Rafter A (no holes)
2.	22	2 x 12	1200S162	97	26′ 0″	Ceiling joist A (no holes)
3.	2	2 x 8	800S162	43	20′ 0″	Ridge member (no holes)
4.	2	2 x 8	800T162	43	20′ 0″	Ridge member (no holes)
5.	24	2 x 8	800S162	33	12′ 10″	Rafter B (no holes)
6.	8	2 x 12	1200S162	54	20′ 0″	Ceiling joist B
7.	1	2 x 8	800S162	43	22′ 0″	Ridge member (no holes)
8.	1	2 x 8	800T162	43	22′ 0″	Ridge member (no holes)
9.	30	2 x 4	350S162	33	10′ 0″	Flange bracing
10.	2	2 x 2	2 x 2 angle	43	10′ 0″	Clip angles
11.	4	2 x 8	800S162	43	11′ 0″	Jack rafters (no holes)
12.	4	2 x 8	800S162	43	9′ 0″	Jack rafters (no holes)
13.	4	2 x 8	800S162	43	7′ 0″	Jack rafters (no holes)
14.	4	2 x 8	800S162	43	5′ 0″	Jack rafters (no holes)
15.	4	2 x 8	800S162	43	3′ 0″	Jack rafters (no holes)
16.	4	2 x 8	800T162	43	16′ 0″	Hip rafters
17.	12	2 x 8	800S162	33	10′ 0″	Ceiling joists in hip area
18.	2	2 x 8	800S162	43	9′ 0″	Fill framing rafters
19.	2	2 x 8	800S162	43	7′ 0″	Fill framing rafters
20.	2	2 x 8	800S162	43	5′ 0″	Fill framing rafters
21.	2	2 x 8	800S162	43	3′ 0″	Fill framing rafters
22.	1	2 x 8	800S162	43	18′ 0″	Fill framing joists
23.	1	2 x 8	800S162	43	14′ 0″	Fill framing joists
24.	1	2 x 8	800S162	43	10′ 0″	Fill framing joists
25.	1	2 x 8	800S162	43	6′ 0″	Fill framing joists
26.	11	2 x 8	800T162	33	20′ 0″	Fascia
27.	13		8.8 flat	33	10′ 0″	Hip, valley and ridge cap

Figure 13-5
Rafter framing cut list

The garage rafters are shorter. Use the same procedure to calculate the rafter length. For this example, we get a rafter from ridge to tail of 12'10" (line 5 on the cut list). We'll order 24 of these rafters.

Ceiling Joists

You need to order the ceiling joists the full width of the house. We're using 2 × 12 × 97s, 26'0" long. Order 22 for the house (line 2 on the cut list). For the garage, order eight 2 × 12 × 54s, 20'0" long (line 6). We selected these member sizes earlier in the chapter — but remember that they're not typical ceiling joist sizes.

Ridge Member

We also selected a 2 × 8 × 43 C-shape ridge member with the same size track nested together. You can make up two 20'0" C-shapes and tracks to come up with the 40'0" length necessary for our sample house. In the cut list, we listed two each of the C-shape and track sections (lines 3 and 4) to make up the ridge member.

For our 20 × 22-foot garage, we need a 22'0" ridge member to span between the hip on the garage and the intersection with the roof of the house. We list one 22'0" C-shape and one track on lines 7 and 8 on the cut list. Order them as 43-mil material, the same size as the rafters.

We'll need to order clip angles to attach the rafter to the ridge member from 2" × 2" × 43 mil angle, as shown in Figure 13-2. We list two lengths of 10'0", 2 × 2 angle (line 10 on the cut list) to make up the clip angles. We'll field cut the angle to length.

Flange Bracing

You need to place flange bracing on the flanges of the rafters and ceiling joists (refer back to Figure 13-1). It should be midspan on the bottom of the rafters and at two locations on the top of the ceiling joists. Use 2 × 4 × 33-mil stud material. We ordered 30 of these 10'0" lengths as line 9 on the cut list.

Hip Roof Material

For this example, we'll make the hip rafters from track material. When we scale off the plan view of the drawing, we find that we need a 16'0" hip rafter. For this design house, you need two hips, one for each front corner of the garage. Two track sections make up the hip. The hip thickness and depth should match the rafter framing, which is 8 inches, 43-mils. Four pieces are listed on line 16 in the cut list.

We also need to order jack rafters for each side of the hip rafter, on each side of the garage. We order four each 11-, 9-, 7-, 5- and 3-foot rafters on lines 11 to 15 to make all the hip rafters. We estimated the dimensions of the rafters by scaling the drawing and allowing for rafter tails. You can cut off the extra length at the tails accurately once the rafters are in position.

Fill Framing

Fill framing consists of cutting joists and rafters to fit the slope that the two intersecting roofs make between the house and the garage. Lines 17 through 25 of the cut list provide the rafters and joists necessary to complete the fill framing. Each progressive rafter and joist gets smaller as they go up the slope of the intersecting roof. We scaled the member sizes off the drawing to determine the lengths. Chapter 14 discusses how to use trusses for fill framing.

Fascia

For this example, the fascia on the example house is an 8-inch track that caps over the rafter tails. (You can look ahead to Figure 15-3 in Chapter 15.) In the previous cut list, a brake shape was ordered to make a perpendicular soffit (Figure 15-4). Scaling off from Figure 3-1, we found the roof perimeter along the rafter tails to be approximately 190 feet. We ordered 11 sections of track 20'0" long for the fascia on line 26 on the cut list.

Hip and Valley Coverings and Ridge Cap

The fill framing steel that caps the ridge, the hip rafters, and transitions at the valleys is flat stock bent to match the slope of the roof. The manufacturer can supply you with flat coil steel that you send out to a sheet metal shop to bend to the correct pitch. Many roll-formers also have brake presses. The roll-former commonly stocks 8.8- and 12-inch flat coil that you can order in specific lengths. We can use 8.8-inch flat coil for this house. We need approximately 120 feet of the material for the example house to make all the hip and valley coverings and the ridge cap. We ordered 13 of these 10'0" lengths in line 27 in the cut list.

That completes the cut list for the roof. When you've received the steel you ordered, you're ready to frame the roof.

Framing the Rafter Roof

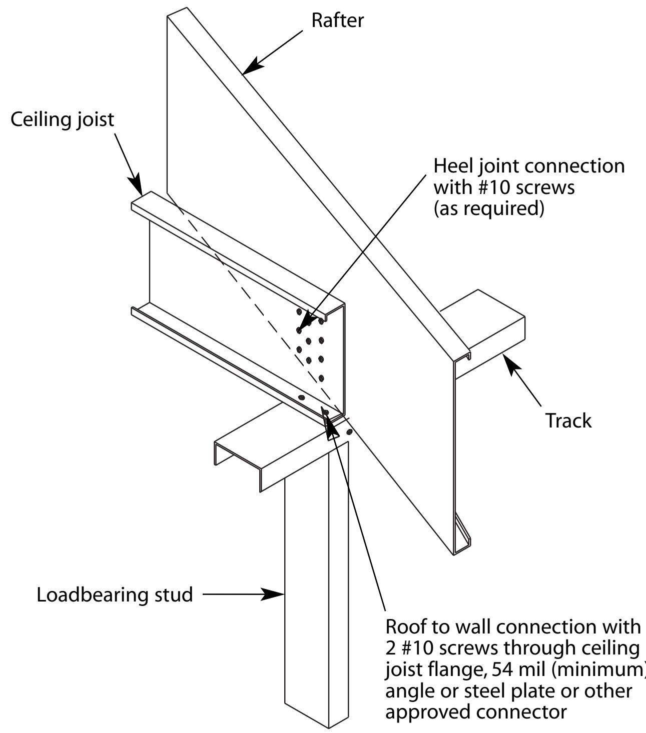
Before framing begins, make sure you have all your components assembled and ready. You may also need scaffolding if you're working more than 6 feet off the ground.

The first step is to assemble the ridge member. Locate the ridge member C-shape and track that you ordered for the house. Nest the C-shape inside the track as shown in Figure 13-2 (Figure 8.3 of the *Prescriptive Method*). Fasten the top and bottom flanges together with No. 10 screws at 24 inches on center. Mark your layout on the ridge member to match the roof design layout and your wall stud locations.

Now you can prepare the other roof framing members. You'll be fastening the steel rafters to the top plate with brackets and screws. Also, cut the 2-inch by 2-inch clip angles to length to prepare for attaching the roof rafters to the ridge member. Then cut the rafters to length, and shape the top end of the rafters to match the slope of the roof. This lets the rafter flush out with the ridge member. Cut all of your rafters the same way, with the hard side facing the same direction. The hard side of the rafter at the top track *must* contact the hard side of the ceiling joist for the connection to be made. See Figure 13-6 . If you ordered your rafters cut to length, you shouldn't need to cut your rafter tails (if you have a straight ridge member). Stack all of your temporary and permanent roof bracing material nearby for easy access during the framing process.

Ceiling Joists

You should set the ceiling joists next. You can do this almost the same way you set the floor joists, except the ceiling joists won't have a rim track. Mark layout on the top track on both sides of the house, working from one end to the other. (Most of the layout is easy — just locate a joist at every stud location.) Measure and mark the layout over the headers in the locations where there aren't any wall studs. Then install the ceiling joists one at a time, moving from one end of the house to the other. Of course you'll keep the orientation of the ceiling joists the same. Anchor the joists at the top track with two No. 10 screws applied from either above or below. Look at Figure 13-6. Install the 2 × 4 × 33 mil C-shape top flange bracing on the ceiling joists as shown back in Figure 13-1.



Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing,* Second Edition

Figure 13-6
Heel joint connection

You can use the ceiling joists temporarily as a platform to install the rafters — if you make sure it's safe. First, check that the joists are properly braced before you cover them with plywood. Second, double-check that all loadbearing walls are secured. The top flanges should be braced, with temporary blocking between the joists on each side of the house. You should install blocking every 12'0" on each side.

This keeps the joists from rolling while you're working on them. Tack down the plywood to prevent injuries from falling.

Ridge Member

You can figure the ridge height using a common rafter or by calculation. The first method uses the cut-to-length common rafters to set the position of ridge members. Using the second method, you can set ridge members by calculating their height from the roof pitch. Let's take a closer look at both methods.

Using the Common Rafters to Set the Height

If you're using the common rafter method, it's important to cut the common rafters accurately so they all have the same miter cut on the top end to match the slope of the roof. To begin, measure in from the tail of the overhang to get the point where the rafter rests on the top plate edge. Screw the tail of each rafter into the ceiling joist on each side of the house, using one No. 10 screw near the outside edge of the top track. This lets the rafters rotate slightly over the outside edge of the top track. With one worker at each heel and a worker in the center of the house, lift up the top sides of the first pair of rafters into position at the ridge. The tails will rotate at the top track. Where the tops of the rafters meet, slide the ridge member into place. Using the clip angles, connect the common rafters to the ridge member with No. 10 screws. (Check back to Figure 13-2.) Repeat this procedure using the pair of common rafters at the other end of the ridge member. Install all the screws in the ridge member and rafter heels. Figure 13-7 shows mitered rafters fastened to a ridge member. Figure 13-8 shows a different way of connecting rafters. They aren't mitered, and the clip angles are longer.

The number of screws you need at each leg of the clip angle to connect the rafter to the ridge is from Table 8.3 of the *Prescriptive Method*. Check Table 8.2 to find the number of screws you need to connect the ceiling joists to the rafters. For our example house, with a ground snow load of 30 psf, a building width of 26 feet (use the column for 28 feet), and roof pitch of 5:12, here's what you'll need:

- Rafter-to-ridge connection: three No. 10 screws
- Joist-to-rafter connection: five No. 10 screws

Calculating the Ridge Height

In wood framing, the rafters are notched (the notches are called *bird's mouths*) to rest on the top plate. This decrease in rafter height is taken into account when determining the height of the ridge member. Steel rafters, however, rest on the top outside edge of the top track. (Check Figure 13-6.) You're not allowed to notch steel rafters because it would compromise the strength of the member. That makes calculating the ridge height easier than it is in wood framing. For the example house, the roof slope

Figure 13-7
Ridge member

Figure 13-8
Alternate ridge member

is 5:12. The house width is 26'0". The ridge member is at the center of the house (at 13 feet). So multiplying the run (13'0") by the slope (5:12), we get a rise of 5'5":

$13 \times 5/12 = 5.4167$ feet, or 5'5"

Then you've got to add the distance from the top plate to the top of the rafter above the top plate. The rafter for the example house is 8 inches deep. To figure the height of the rafter above the top plate, you have to convert the roof pitch to degrees. You can use the roof conversion chart in Figure 13-9.

In our example, the slope is 5:12. That converts to 23 degrees. So here's the height of the rafter above the top plate:

$$\text{Height of rafter above top plate} = \frac{\text{Depth of rafter}}{\text{Cosine (slope of roof)}}$$

$$= \frac{8"}{\cos 23^\circ}$$

$$= 8.69"$$

$$= 8\tfrac{3}{4}"$$

If your calculator doesn't have a cosine function, another way is to scale it off the drawings. In this example, if you didn't take this distance into consideration, and only used the rafter depth of 8 inches, your ridge member would be only 3/4 inch low.

Rise/Run	Slope (degrees)
1:12	5
2:12	10
3:12	14
4:12	18
5:12	23
6:12	27
7:12	30
8:12	34
9:12	37
10:12	40
11:12	42
12:12	45

Figure 13-9
Roof slope conversion chart

Now add that to the ridge height to find the *top* of the ridge member:

5'5" + 8 3/4" = 6'1 3/4"

To find the height of the *bottom* of the ridge member, just subtract the depth of the ridge member. In this case the depth is 8 inches:

6'1 3/4" − 8" = 5'5 3/4"

This is the height of the bottom of the ridge member above the top plate. Add the wall height to get the dimension from the floor to the bottom of the ridge member:

8'0" + 5'5 3/4" = 13'5 3/4"

We'll use this dimension to set the ridge member. Begin by shoring the ridge member in place using scaffolding or temporary bracing or columns. You can use posts, tube or 2 × 4s to make the columns. Make sure the shoring or bracing won't interfere with the rafter framing. For the example house, set the ridge member in the center of the house, with the bottom at 13'5 3/4" above the floor. Then set the rafters one by one, starting at the end of the house. From this point, you follow the same procedure as when you use the rafters to set the ridge height. Add bracing after you set every four rafters.

Common Rafters

Before you install the rest of the common rafters, brace them with a C-shape stud or wood brace. Run it diagonally from the ridge of the roof to the ground, after you make sure the ridge member is in its permanent position. This brace will hold the assembly in place until you install the rest of the rafters and blocking.

Now you're ready to install the rest of the rafters and clip angles. Use the layout on the ridge member and top track to locate the rafter positions. Check the layout of the rafters as you install them to make sure they're 24 inches on center. And don't remove the temporary shoring until all the rafters are in place. Insert rafters one pair at a time until you've got a group of four pair in place. Then brace those four pair before you install any more rafters. Finally, install the rafter bottom flange bracing using 2 × 4 × 33-mil C-shapes, as shown back in Figure 13-1. This adds stability to the framing and prevents swaying.

Hip Rafters

There are several ways you can build hip rafters. One method is to use track material positioned back-to-back on an angle to match the slope of the roof. See Figure 13-10. You can also use track and joist material to make a box shape, the same way you made a box ridge member. To construct hip rafters in the back-to-back method, assemble two track pieces to make an angle (which becomes the hip rafter). Use a wedge-shaped piece between the web of the members to set the angle (Figure 13-11). Make the wedge from flat stock bent into a triangular shape with matching angle. You can use Figure 13-9 to help you make the wedge. If the wedge is the same depth as your track member, the wedge angle will be 2 times the pitch of the roof. For this example, it would be 2 × 23 degrees, or 46 degrees. An alternative to using the wedge is to hold the angle on the hip rafters using a ridge cap or straps.

Assemble the back-to-back hip rafter by clamping the track material for the hip rafters near the radius on one side of the web. Screw the webs of the track together near the flange every 3 feet with No. 10 screws. Pull the other side of the track apart after you remove the clamps. Install the first wedge in the hip rafter in between the tracks on the back side at the top. Insert another wedge 3 feet from the top and screw it to each track with two No. 10 screws. Measure down 3 feet more for your next wedge and repeat for the length of the hip rafter. This should keep you on the 24-inch layout if your hip is at a 45-degree angle with the wall. The jack rafters should line up with the wedges to keep the track material in the hip rafter from collapsing. See Figure 13-10.

You can also construct hip rafters using the box shape method. This method uses box shapes like ridge members. Build a box hip rafter out of stud material nested into track. Screw the hip rafter the same way you put together the ridge members. There's no preset angle for this rafter so you'll need to miter cut all of the jack rafters and attach them with clip angles.

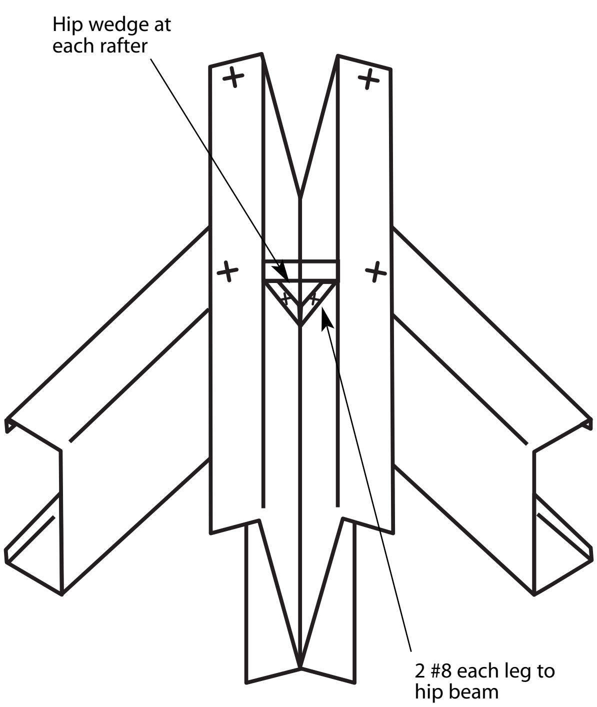


Figure 13-10
Back-to-back hip rafter

Figure 13-11
Wedge

Figure 13-12
Box hip rafters

You install back-to-back and box hip rafters essentially the same way. Connect the top of the hip rafter to the girder truss or ridge member. You can use two No. 10 low profile screws to attach the back-to-back hip rafter. Simply screw the top flanges of the hip rafter into the ridge of the truss. For the box hip rafter, use clip angles on each side of the rafter to connect the webs to the top chords of the truss or ridge member (see Figure 13-12). Next, attach the bottom of the hip rafter to the corner of the house at the top track using a clip angle that's 4 inches long by 5 inches high. Screw it into the hip rafter and top track with the number of screws stipulated by your engineer.

Jack Rafters

Finish framing the hip portion of the roof with jack rafters that extend from the hip rafter to the top plate of the wall, leaving an overhang for the tail. The type of hip rafter you used will determine whether or not the jack rafters will need to be miter cut. Installing jack rafters for back-to-back hip rafters is easier. All you need to do is slip the flanges of the first jack rafter into the hip rafter, keeping on 24-inch center layout. Make sure the web side of the jack rafter is facing toward the corner of the house (downhill). See Figure 13-13. Screw the flanges of the track and stud together. Over the wall, you'll need to cut an angle, 4 inches long by 5 inches high, from the gusset material to use as a clip angle to connect the rafter heel to the top track. Again, use the number of screws recommended by your engineer.

Installing jack rafters for box hip rafters is more difficult. You'll need to miter cut the jack rafters so they fit at the correct pitch along the box hip rafter (Figure 13-14). Use clip angles to attach the jack rafter to the box hip rafter. Attach them the same way

Figure 13-13
Jack rafters

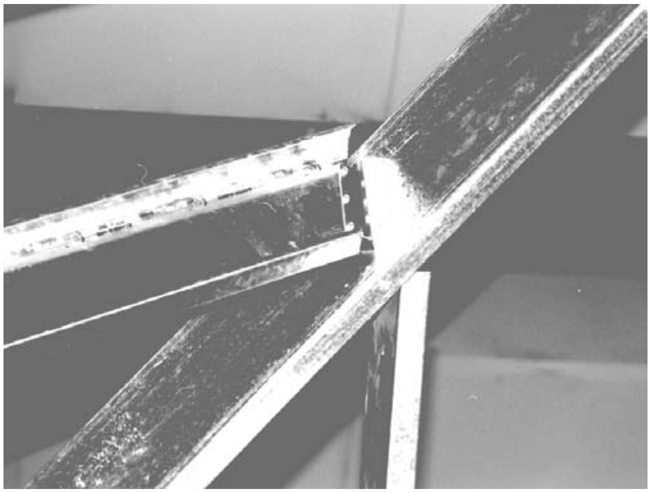


Figure 13-14
Clip angles for box rafters

you attached the common rafters to the ridge member. Attach the heels of the jack rafters on the top track the same as for back-to-back hip rafters.

Finishing the Rafter Roof

After you've set your ceiling joists, ridge members and roof rafters, you can install collar ties or support braces. Also install the rafter bottom flange bracing at this time. This may consist of flat strap 2 × 4 × 33-mil C-shapes or track sections. These are all illustrated in Figure 13-1.

To complete your roof, you'll need to properly anchor it to the walls below, install roof fascia, collector blocks, rakes, soffits, and sheathing. We'll cover these steps in Chapter 15.

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Chapter 14

Roof Framing with Trusses

Roof trusses are pre-engineered structural triangular frames that, when assembled according to design, effectively carry their own weight plus any superimposed loads. You can order them already assembled by a truss fabricator, or you may do it yourself on the job site. Trusses usually span the entire width of the house, and are typically spaced 24 inches on center.

Trusses have a couple of advantages over rafters. First, they're faster to install, and therefore more cost effective. Truss framing requires less time and effort because you install the ceiling joists and roof framing at the same time. Second, they almost never require an interior wall for support. That gives the designer or engineer more options when laying out the rooms in the house. And steel roof trusses have further advantages over wood trusses. Properly-built steel trusses seldom sag, and they're lighter in weight.

Manufactured (Pre-engineered) Trusses

Today there are several steel truss manufacturers that can provide the whole package, just like wood truss manufacturers do. They design, fabricate and deliver steel trusses. In fact, many wood truss manufacturers now offer steel trusses as an option. Alpine, MiTek, Tri-Chord, American Studco, Western Metal Lath, Steel Construction Systems, Dietrich Industries and Dale/Incor are just some of the manufacturers that provide manufactured steel trusses. These steel trusses don't all look the same, however. They come in many different shapes and cross sections. If you're considering buying manufactured steel trusses, of course you'll compare the cost of the available trusses. But don't forget to also compare their durability, workability, weight and shape:

- The trusses need to be durable to take movement during shipping and handling.
- While strong enough to support snow loads, trusses may not be strong enough to support the weight of a worker installing them. If you'll have workers up there, make sure the chord members of the truss you select are strong enough to support your workers' weight.
- Steel trusses are generally lighter than wood. Lighter trusses give you the option of setting the trusses by hand instead of by crane. Or you can assemble all the trusses on the ground and make one pick of the entire roof assembly by crane.
- Each one of the manufacturers has a different profile for the steel members in their trusses. Consider how you plan to frame your rake and soffits as well as work with the tails and fascia. Make sure the trusses you select will meet all of your needs at the job site.

Some manufacturers sell the pieces for you to assemble in the field. But most of the manufacturers fully engineer and assemble a truss package for your needs, including step trusses for hip roofs.

Site-Built Trusses

While steel truss manufacturers are springing up around the country, steel trusses still aren't as readily available as wood. It may be more convenient and

Figure 14-1
C-shaped truss

cost-effective for you to build your own trusses in a panelization yard or right at the job site. Remember, if you choose to build your own trusses, you've got to have them designed by an engineer. Also, check in advance that the building department in your jurisdiction is comfortable with site-built trusses. If you decide to handle the job yourself, take time to learn how to build trusses correctly — and consider the extra cost for setting up a jig and labor to build them. This chapter will concentrate on how to build your own cost-effective trusses out of standard C-shapes.

There are many different ways you can design and build trusses. NASFA has published a guideline for the design of steel trusses: Truss Design Guide NT13-95. This guideline presents basic information for your engineer. Call 1-800-79-STEEL to order a copy.

Basic C-Shape Truss

Many contractors build their own trusses from C-shapes because they're readily available from all roll-formers. When the ends of the trusses are mitered, the truss may be assembled with the C-shaped members together in one plane. The resulting truss is one C-shaped member thick. While some C-shaped trusses have mitered cuts, others use gusset plates to connect the members together. These trusses are the thickness of two C-shaped members (one stacked on top of the other). Even though this truss is thicker, it saves on framing time because you don't have to make mitered cuts. While it takes slightly more material, it's still cost effective.

One of the easiest-to-build generic C-shaped trusses is shown in Figure 14-1. Both top chord members and all intermediate chords are set with the hard side up (web side up) but the bottom chord has the hard side down. This lets you leave all the ends of every chord square cut. Mitered cuts consume a lot of work-hours. By using gusset plates made from track pieces with one leg cut off, you can eliminate all mitered cuts and save on truss assembly time.

Remember, trusses have to be designed by an engineer. The engineer should give you truss details, including the panel points (the position where the chords intersect), size of the members, and the screw count for each connection. Your engineer should also show a roof framing plan on his drawings. The engineer will usually perform his calculations on truss software like P-Frame, RESTRUSS, Truss D & E, Keymark, Alpine or MiTek. In case your engineer is looking for a computer program, a list of cold-formed steel computer programs is available from the Center for Cold-Formed Steel Structures at the University of Missouri — Rolla at (573) 341-4471.

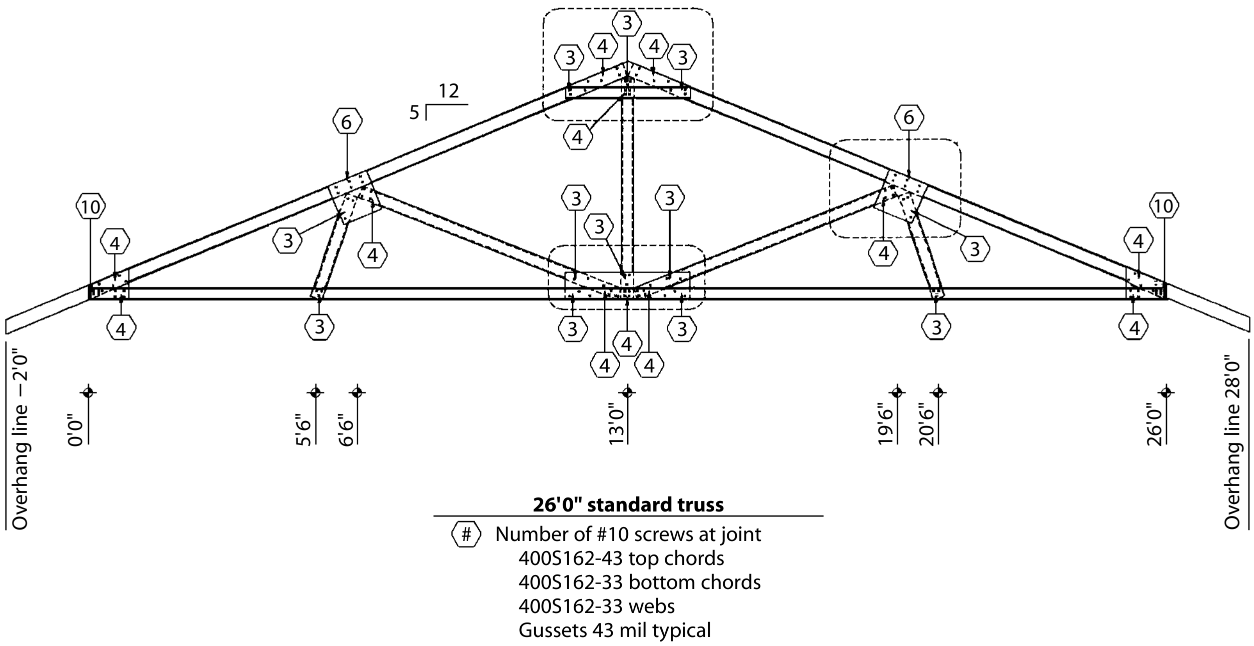


Figure 14-2
Engineers drawing of a truss

Figure 14-2 shows an engineer's drawing for a 26'0" truss. The panel points are labeled across the bottom of the truss, as well as the gusset plates at the heels, ridge, and intermediate points. Screw counts and patterns are also indicated. Figure 14-3 shows the roof framing plan including the truss layout.

Truss Cut Lists

Let's look at the steps you should follow to prepare a material take-off and order from the roll-former or distributor. Remember, you should run all the truss members unpunched. Punchouts can weaken a truss, especially if they end up at a critical bending point. Also, try to order your truss material a full 4 inches wide instead of 3½ inches. This gives your trusses more strength and lets you use 33-mil material (although occasionally 43- or 54-mil steel is required).

Back in Chapter 8, we developed a cut list for our sample house from Chapter 3. I'm repeating the roof framing section of that cut list here so you can refer to the listing of truss material. See Figure 14-4. Notice that there are two types of truss material in the sample house: Truss A (for the house) and Truss B (for the garage). The engineer has indicated that the top chords must be 43-mil and the rest of the members 33-mil for Truss A. See Figure 14-2. This is how they've been ordered on the cut list. Also notice that we ordered 2 × 4.0 members (4.0 for full 4-inch webs) and specified no punchouts for all material. The proper nomenclature is 400S162.

Truss take-offs can be complicated. You could figure out all the angles and calculate the chord lengths. But I recommend redrawing the trusses on a full-size drawing (24 inches × 36 inches) at a scale of 1 inch = 1 foot. Use the panel points provided by the engineer and assume square cut members. Once you've drawn the truss, find the lengths by scaling off the members, and list them on the cut list.

Starting with Truss A in the design example, there are a total of 21 trusses. You'll need to order 42 top chords (two top chords per truss) that are 16'1" long and 43 mils thick. (Look at item 14 on the cut list.) Then list the bottom chord material. On our cut list we ordered 22 bottom chord members (that's 21 plus one extra in case of damage). They're 26'0" long (the building width). That's item 15 on the cut list.

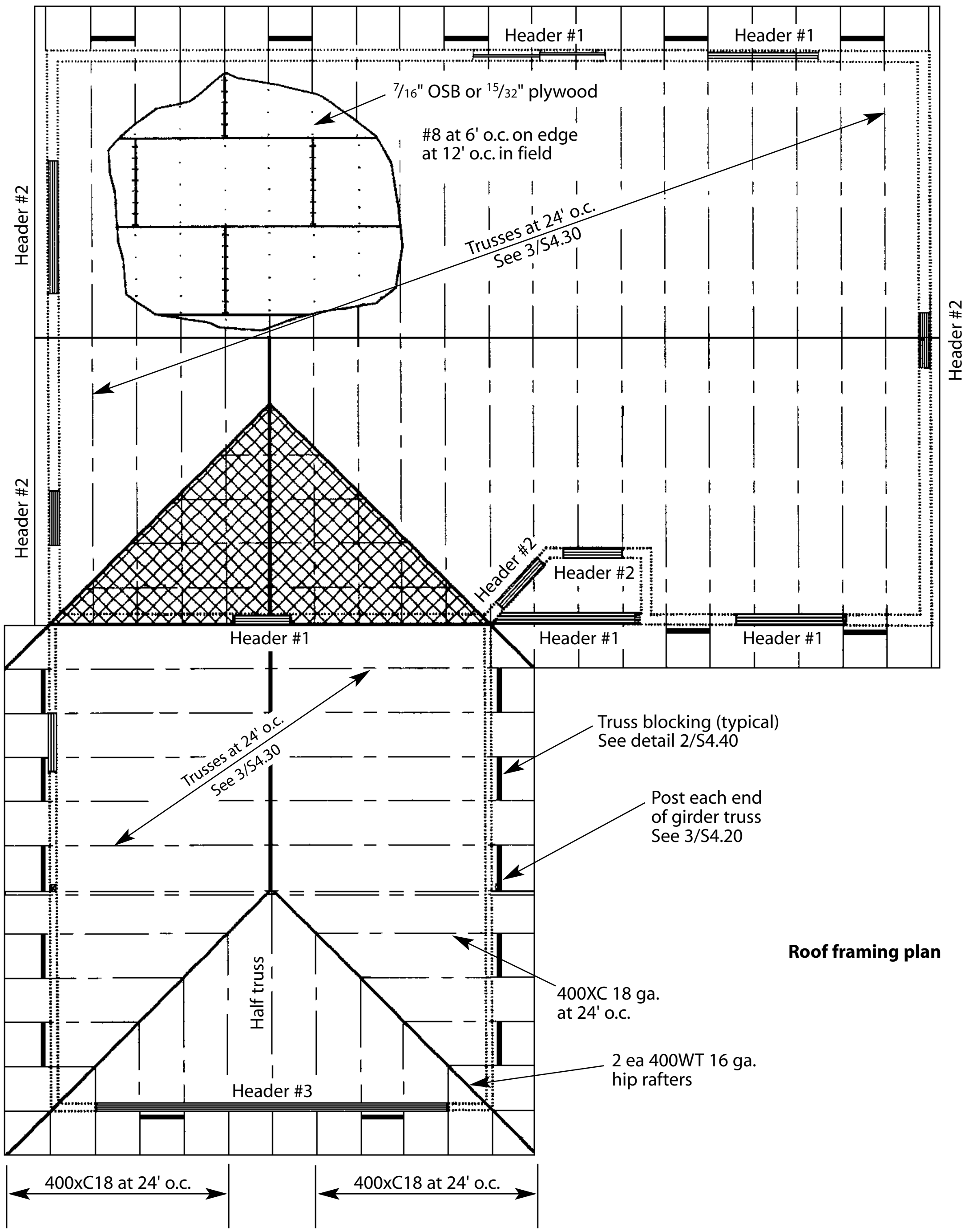


Figure 14-3
Roof framing plan

Item No.	Qty.	Size	Manufacturer's Designator	Thickness (mil)	Length (ft-in)	Location
Roof Framing						
14.	42	2 x 4.0	400S162	43	16'1"	Truss A (no holes)
15.	22	2 x 4.0	400S162	33	26'0"	Truss A (no holes)
16.	8	2 x 4.0	400S162	33	16'1"	Truss A (no holes)
17.	42	2 x 4.0	400S162	33	6'6"	Truss A (no holes)
18.	22	2 x 4.0	400S162	33	5'3"	Truss A (no holes)
19.	22	2 x 4.0	400S162	33	3'0"	Truss A (no holes)
20.	42	2 x 4.0	400S162	33	2'9"	Truss A (no holes)
21.	12	2 x 4.0	400S162	33	20'0"	Truss B (no holes)
22.	24	2 x 4.0	400S162	33	12'10"	Truss B (no holes)
23.	24	2 x 4.0	400S162	33	5'0"	Truss B (no holes)
24.	12	2 x 4.0	400S162	33	4'0"	Truss B (no holes)
25.	12	2 x 4.0	400S162	33	3'0"	Truss B (no holes)
26.	24	2 x 4.0	400S162	33	2'0"	Truss B (no holes)
27.	4	2 x 4.0	400S162	43	11'0"	Hip rafters (no holes)
28.	4	2 x 4.0	400S162	43	9'0"	Hip rafters (no holes)
29.	4	2 x 4.0	400S162	43	7'0"	Hip rafters (no holes)
30.	4	2 x 4.0	400S162	43	5'0"	Hip rafters (no holes)
31.	4	2 x 4.0	400S162	43	3'0"	Hip rafters (no holes)
32.	4	2 x 4.0	400T162	54	16'0"	Hip
33.	12	2 x 4.0	400S162	33	10'0"	Ceiling rafters
34.	30	8.8 flat strap	8.8 flat	33	10'0"	Fascia, hip, valley, ridge
35.	130		1 1/2 x 8″ angle	43	1'0"	Gusset
36.	70		1 1/2 x 8″ angle	43	3'0"	Gusset
37.	50		1 1/2 x 1 1/2 angle	33	10'0"	Bracing
38.	20	1 5/8 x 1 5/8 stud	162S162	33	10'0"	Gable end
39.	10	1 5/8 x 1 5/8 track	162T162	33	10'0"	Gable end
40.	4	2 1/2 x 1 5/8 stud	250S162	33	12'0"	Gable end

Figure 14-4
Cut list for roof framing truss material

Figure 14-5
Truss assembly

Next, order your long diagonal members that intersect with the bottom chord and the king post. You need 42 of these members, each 6'6" long (item 17 on the cut list). The king post scales out to be 5'3" long. You need 22 (21 plus an extra) of these (item 18). Next, you need 22 (21 plus one extra) 3'0" members to use at the ridge of the truss (item 19). This will stiffen the ridge in case you want to use a forklift to lift the trusses. Finally, you need 42 2'9" members (item 20) for the small pieces that fit between the top and bottom chord on each end.

You have the option of ordering standard length material and cutting it in the field, but truss assembly is easier and faster if you have the truss material precut and prepackaged. Figure 14-5 shows a truss jig laid out with precut pieces stacked in position.

You'll also need to order gusset material. The rollformer can make gusset material from 8-inch track, rolling only one leg of the track. These stiffened gussets resemble angle material. You need to order one 3'0" gusset for the bottom chord connection, and one 3'0" gusset for the ridge of each truss. You also need to order a 1'0" gusset for each heel and for the intersecting members on each top chord. Remember that you'll need to trim part of the 3'0" gusset at the ridge and the two heel gussets in the field to match the slope of the top chord of the truss. You'll need a total of 42 3'0" gussets, and 84 1'0" gussets (four per truss). These pieces, along with the gussets for Truss B, are included in items 35 and 36 on the cut list. Figure 14-6 shows the gusset plate at the bottom of a truss.

Figure 14-6
Gusset plate at the bottom of a truss

Your cut list for Truss A is now complete. The gusset quantities are higher on the cut list because they also include the Truss B gussets.

Continue the take-offs for Truss B in the same way. Referring to the roof framing plan, you'll find a total of eight B trusses. The first Truss B in the garage is a girder truss which consists of two trusses screwed together.

In addition to the B trusses, you'll need to order enough members to fabricate half trusses (B trusses cut in half), and hip and hip jack rafters. And don't forget to order enough material to make the modified step-trusses at the intersecting gables. You'll also need extra material for the gabled end trusses for Truss A. Extra pieces are included in item 16 in the cut list. We'll discuss assembly of gabled end trusses and overbuild trusses later in this chapter.

Truss Jigs and Truss Assembly

Building the same truss with identical profiles and dimensions over and over again is much easier if you use a jig. Jigs are simply assembly tables that help you make all your trusses uniform. You can see an elevated jig table in Figure 14-7. Jigs prevent irregularities in roof profiles by making sure all the trusses have the same pitch and geometry. This results in more professional-looking houses with smooth, even roofs. Truss fabrication is also much simpler when you use jigs, especially if you're building three or more trusses.

Your choice of a jig table depends on your budget and the number of units you're going to build. While you can invest a lot of money in an automated jig table, you can also build an effective jig for the price of six sheets of plywood. If you're planning to build a simple one, you need to find a flat level surface on the ground, away from the flow of traffic around your house. If space is a problem, you can use your first or second floor deck to build your jig table.

If you have room on the ground, lay four sheets of plywood end-to-end to make a cost-effective jig table. To one side of the two center sheets, place two more pieces of plywood in the same direction. Connect the sheets together in the corners with 2- × 1-inch 33-mil steel plates.

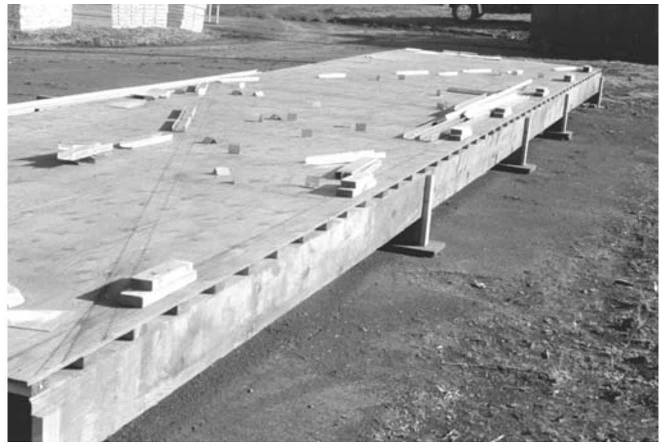


Figure 14-7
Elevated jig table

Using the edges of the plywood as references for straight lines, mark the center of your truss vertically on the plywood by snapping a chalk line. Along the bottom, snap a chalk line that represents the bottom edge of the bottom chord. This line should extend about 1 foot longer than the bottom chord tails on each end. So for a 26-foot truss, this line would be 28 feet long. Put a mark on each end of the line representing the bottom chord to measure 26 feet. These marks will be the heel locations.

Now you need to establish the roof pitch. For a 5:12 pitch, measure in from one heel 12 feet along the bottom chord. From this point, measure up perpendicular from the bottom chord 5 feet. Now, holding your string line at the heel, snap a line intersecting the 5-foot mark. Then extend this line to cross over the center of the truss. Do the same thing for the other side of your truss. These lines represent the bottom edges of your top chords.

Lay the top chord pieces down on these marks, so they meet at the top. Make sure that the tails extend beyond the bottom chord line the same distance on each end of your truss. Next, place the king post at the center of the truss, splitting the centerline you marked. Take your longest intermediate diagonal chord members and place them so they touch the king post on one end and the top chord on the other. The small diagonals should intersect the bottom chord, but not extend below it. You don't need to measure panel points if you did your take-off accurately. See Figure 14-2 for the truss chord diagonal layout.

Figure 14-8
Ridge of truss

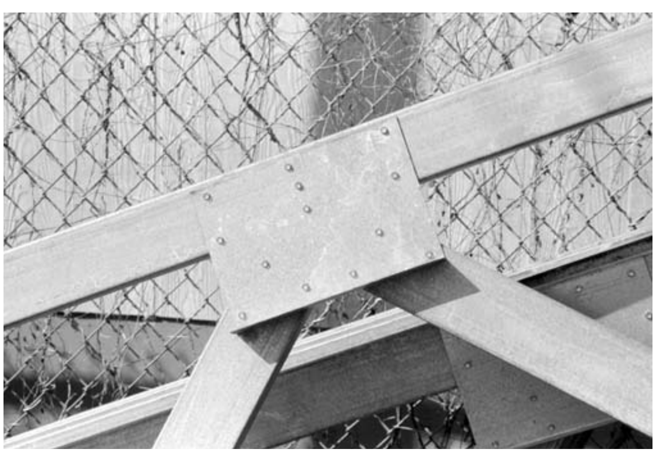
Now you're ready to set gussets. One of the 3'0" gussets rests at the bottom center of the truss, with the flange down on the bottom. The other 3'0" gusset is the ridge piece. Set the gusset at the ridge, and scribe a line to cut off the slope on each end. This forms a triangular piece. The flange will be on the bottom, facing upward. You can use this piece as a template to make all your ridge pieces for the trusses. The 3'0" C-shaped member rests under the triangular ridge piece. This is also centered over the king post. Figure 14-8 shows the ridge of the truss.

For the heels, set a gusset with the flange piece along the bottom chord line facing down. Scribe a line to cut off the part that sticks above the top chord. Do this for each heel, and cut enough heel gussets for each side to complete all your trusses.

Where the interior diagonal members intersect the top chord, place a 1-foot gusset. The gusset should lay with the flange at the bottom, facing upwards. The top of the gusset sets about $^1/_8$ inch below the top chord, so it doesn't interfere with the roof sheathing. See Figure 14-9.

Now that you have all of your gussets in place, you can set the bottom chord member. The bottom chord rests web (or hard) side down, and each end will lie even at the heel points. When you set your jig stops, put a small crown ($^1/_4$ to $^1/_2$ inch upward) in the center of the bottom chord.

Check all members for accuracy. Make sure your top chords are on the chalk lines, the tails measure the same, all pieces rest below the top chord plane, and so on. Then put one screw in each connection, being careful not to move any of the parts. After you've secured the truss, come back and finish screwing the truss together.



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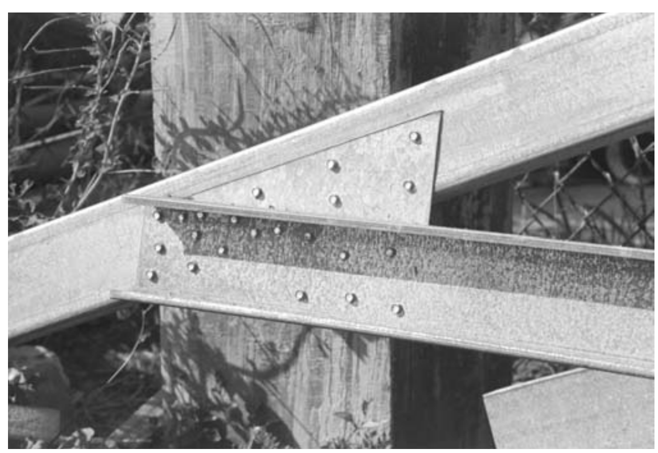

B Heel

Figure 14-9
Interior and heel gussets

Putting Stops in a Jig Table

When your first truss is finished, leave it in place so you can finish your jig. Take a pencil and scribe a line on each side of each chord member. This will help you identify the truss members after you lift the truss out of the jig. Take a couple of extra wall studs and run them up against each side of the top chords. Screw them down into the plywood tight against the top chords. These will serve as the stops for your top chord.

For all the members laying web side up, you can secure each truss part by screwing stud material along the side of each member. Some pieces may only need to be 4 inches long. In other areas you can use longer pieces. For the bottom chord that's in the second plane, use 4-inch stud material resting on one flange. Put the web up tight against the bottom chord on the top and the bottom. For the heels, use a piece of 1-inch angle bent around the heel flange to make sure the heel's in the correct position every time. This is critical because it's the part that bears on the wall.

Figure 14-10 shows a carpenter assembling a truss in a jig table with stops at each chord location. You can see the stops in position. Once you've finished putting in the jig stops, you can remove the truss. Stack the trusses out of the way or in a position ready for stacking on the roof.

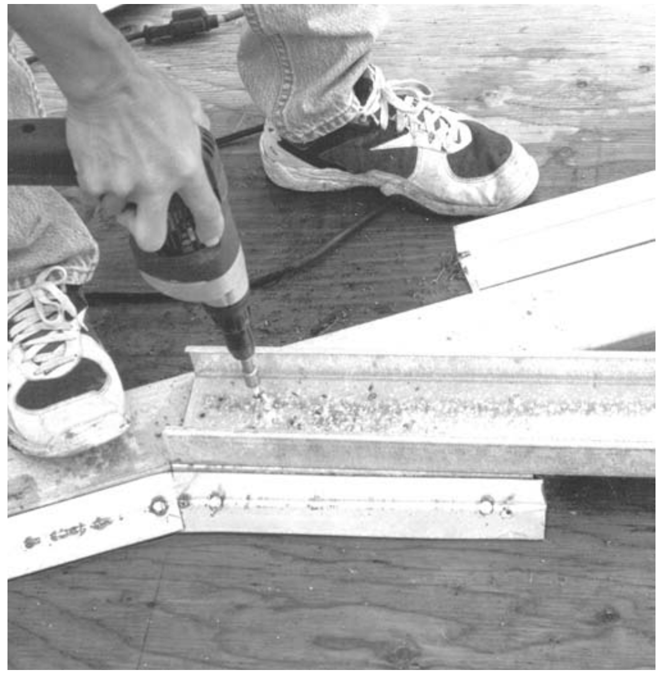

Figure 14-10
Assembling truss in jig table

Stacking the Trusses

As you prepare to stack your trusses, you need to have all of your equipment in place. OSHA standards don't allow contractors to walk on the top plate. To safely stack trusses, use two ladders (one at each end wall) and a scaffold with locking wheels and a guardrail in the center. You should always use OSHA-approved scaffolds and ladders.

When stacking trusses, use at least two people to carry each truss, depending on the truss weight. When you use trusses 30 feet or longer with 54-mil steel, you'll need a third person. Keep one person standing on the scaffolding. Screw a steel stud about 18 feet long to the outside of the wall, letting it extend above the top plate at least 6 feet. You can use this as a brace for the gable end truss.

Have screw guns available on top of the scaffolding and on each ladder. Keep a bungee cord on the scaffold to temporarily hold the trusses together.

Start with the gable end truss. Feed it between the studs with the tails up. It should be oriented so the gable wall side is facing out when you swing it up into position. Run the truss straight across the width of the house and lift the tail above the top plate on the other side. Run the tail far enough up so that the other tail can clear the wall and come inside the house. Lift that tail up onto the top plate as well. Now center the truss over the walls. Drag the truss to the end of the house and lift the ridge up in the air, handing it to the person on the scaffold. The scaffold person can then drag the truss over to the end wall. The two workers on the ladders help the scaffold person guide it into place. See Figure 14-11.

Measure perpendicularly from each outside wall to the top end of the truss tail. The length should be the same on each side of the house. Once you have the truss in position, clamp it to the brace stud you screwed to the outside wall. Now screw the truss to the top plate on the end wall with a No. 10 screw every 24 inches, or as indicated by your engineer. Temporarily brace the truss back to the ground with stud material and ground stakes. Use the guidelines for truss bracing found in the *Light*

Figure 14-11
Installed roof trusses

Gauge Steel Engineers Association Design Guide for Construction Bracing of Cold-Formed Steel Trusses, Technical Note No. 551d. You can call (202) 785-2022 for your copy. It's important to leave the temporary bracing in place until you've installed all permanent bracing and sheathing.

After you've secured the gable end truss, stack up four more trusses against the gable end and tie them together temporarily with the bungee cord. Screw one 10-foot piece of $1^1/_2$- × $1^1/_2$-inch angle (sometimes called *rat run*) to the top of the king post. Also screw rat run to the bottom of the king post of the gable end. See Figure 14-12.

Mark your truss locations on the top plate of both sides of the house on 24-inch centers. (This should match your wall stud layout.) Also mark the truss locations on the top rat run. Pull the first truss out 8 feet from the gable end. Check the tails to make sure that they're equal on each end. Screw the truss to the angle brace and to each top plate. Use No.10 hex washer head screws for each connection.

Pull the next truss out 6 feet and repeat the procedure. Pull the next one out 4 feet and then 2 feet, repeating each time. Once the first four trusses are in position, install your X-bracing with the $1^1/_2$ × $1^1/_2$ angle on the king posts as shown in Figure 14-12.

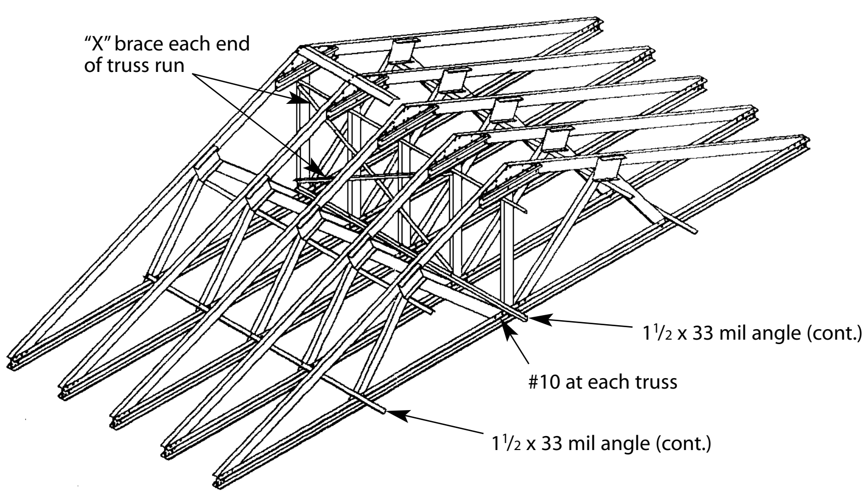

Figure 14-12
Truss bracing

This keeps the trusses secure and prevents them from racking. This is usually only necessary on the four end trusses.

Once you have your end trusses secure, bungee four more trusses together against the last truss and repeat the procedure, pulling out 8, 6, 4, and 2 feet respectively.

This is just one method you can use to stack your trusses. There are several other approaches you can consider. One includes layering your completed trusses like a deck of cards spread out on your top plate, then flipping them up into position. You could also individually lift each truss to the roof by crane or hoist.

Another popular method for truss framing is to frame the entire assembly on the ground, then lift it into place. You can assemble the trusses on a fake stem wall on the ground, then lift the entire assembly into place with a crane. This lets you do most of the work on the ground — so you won't spend a lot of time above the top plate. You can even sheath your roof this way. Another advantage of doing this is that it eliminates the extra expense of providing fall protection.

If you choose to assemble your roof on the ground, use caution when lifting it. Make sure the crane operator uses a long spreader bar and several lift points to distribute the load. Use safety lines to guide the roof into place. Although steel roof trusses usually lift very well this way, check with your engineer to see if any additional bracing is required.

Other Trusses

We've just described a standard C-shaped truss — but you may need other C-shaped trusses to complete the house roof. Depending on the complexity of the roof framing, you may need some of the following trusses.

Girder Trusses

Girder trusses are two standard trusses screwed together with stud material along the king post and intermediate chords. See Figure 14-13. When you build a hip roof, your engineer usually specifies a

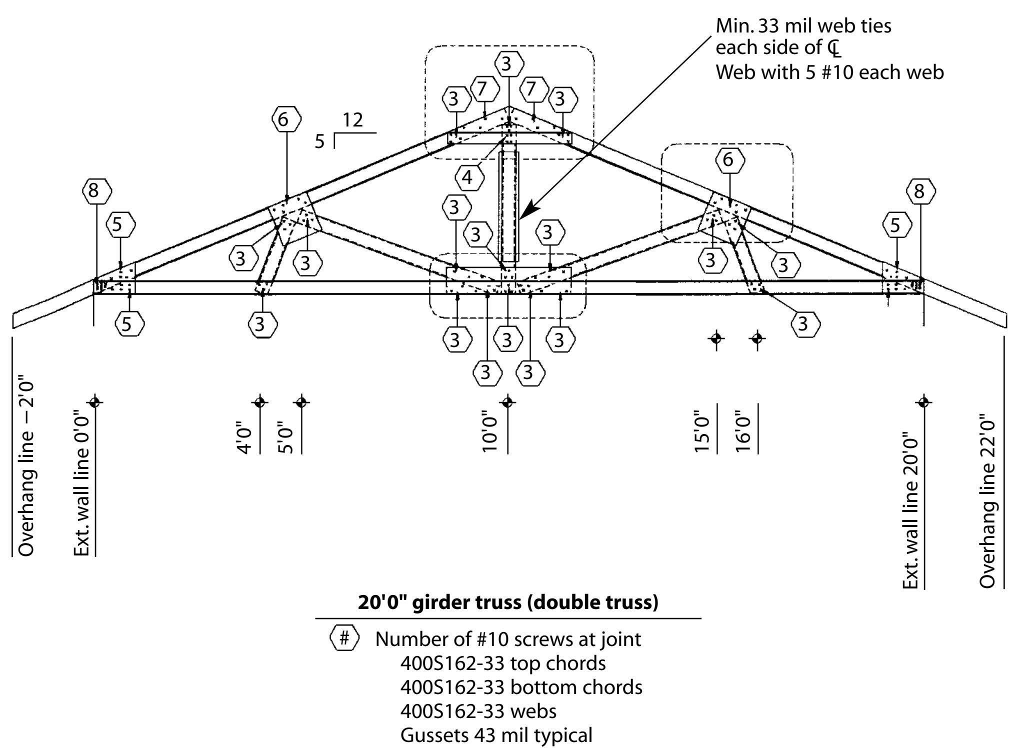

Figure 14-13
C-shaped girder truss

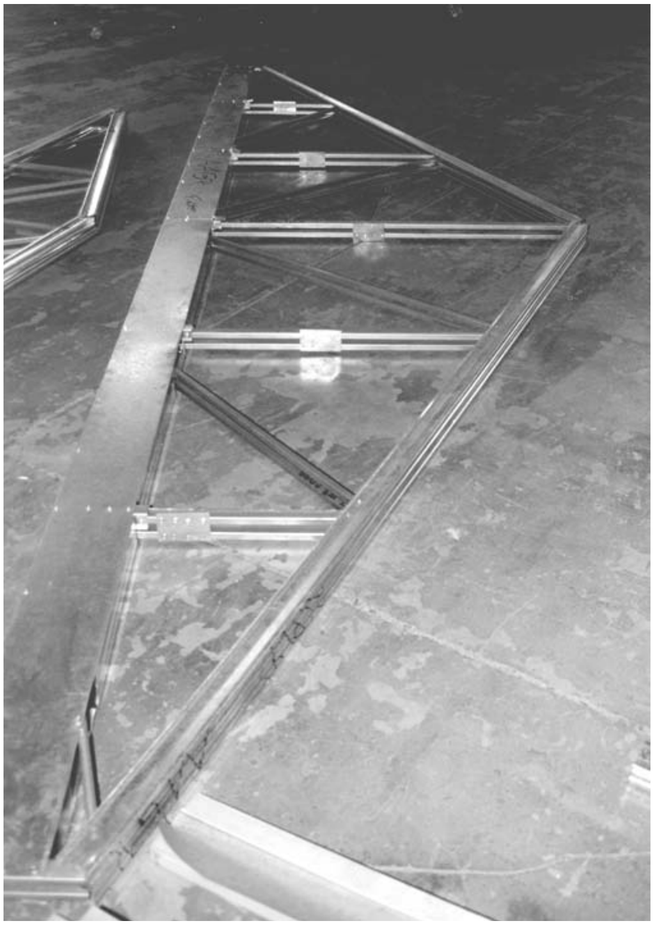

Figure 14-14
Proprietary girder truss

girder truss for the last conventional truss. The girder truss assumes much of the load from the hip roof section. The girder truss has a greater load capacity than a standard truss. Figure 14-14 is a proprietary girder truss that's assembled much the same way. A half truss on the hip roof usually intersects and ties into the gable truss, and usually consists of two trusses screwed together. You should install a half truss perpendicular to the center of the girder truss (rather than stepping down the trusses) and from that ridge install your hip rafters.

Half Trusses

Half trusses are sometimes specified on a hip roof to intersect the gable and to taper down to the outside wall. It may be easier for a framer building and assembling trusses to frame a hip roof using half trusses with jack rafters. They're commonly used where a hip roof ties into a gable roof. Half trusses usually fasten to a girder truss. Look back to Figure 14-3 for the half truss location for the Salem house.

To make the connection, screw the flange of the king post of the half truss to the web of the king post of the girder truss. Use the number of No. 10 screws specified by your engineer. Occasionally, you may need to run stud material on each side of the king post on the half truss to connect to the king post of the girder truss. Figure 14-15 shows half trusses stacked on a roof ready to be positioned.

Figure 14-15
Half trusses

Figure 14-16
Step-down trusses

Step-Down Trusses

An alternative method for framing a hip roof is to use step-down trusses instead of half trusses and rafters. Step-down trusses have flat top chords that match the slope of the hip (Figure 14-16). For larger roofs, step trusses may be more cost effective. Step trusses must also be designed by an engineer.

Overbuild

When an L-shaped house has two intersecting gable roofs, you'll need to overbuild (or fill frame) the area where the gables intersect with a series of smaller trusses. Look at Figure 14-17.

Overbuild is also called California fill or valley framing. With a few modifications, you can construct overbuild framing using the same jig table you made for trusses. To modify your jig table for overbuilding, leave the top chord stops in place and remove the rest of the stops in the jig. Move the bottom chord up 5 inches for every 12 inches of spacing. In other words, for the first step-down truss 24 inches in, raise the bottom chord 10 inches ($5 \times 2 = 10$). Frame each overbuild truss in a single plane with the hard side of the member up. You need to make mitered cuts in this truss to keep all members in the same layer. Fabricate one truss for every 24 inches, stepping the bottom chord up 10 inches and using the top chord pitch each time. Set the bottom chords, and miter the top chords by cutting off the flange so the web of the top chord fits over the web of the bottom chord. Install a king post with the web side down for each truss. The 33-mil steel is usually adequate because overbuild trusses aren't full-spanning trusses. You may need intermediate members for larger overbuild trusses.

The next step is framing the overbuild trusses. To frame the overbuild, first sheath the lower roof surface with plywood or OSB. Screw or pin the sheathing down to the roof below. Next, run a string line along the ridge of the gable trusses to the point where the ridge line from those trusses intersects the sheathing that will support the fill. This point of intersection is the top of the two valleys that make up the overbuild.

Find the location of the bottom of these two valleys and pull a string line from the top of the ridge on the sheathing to each of the bottom points. These are the rough locations where the valleys will run. Now you can run ridge cap (a brake metal shape that covers the ridge of the house) from the gable trusses to the sheathing. Set each of the overbuild trusses in place. See Figure 14-18.

Screw the flanges of the bottom chord of the overbuild trusses down to the flanges of the top chords of the trusses below the sheathing. Repeat this for each truss until you've completed the fill framing.

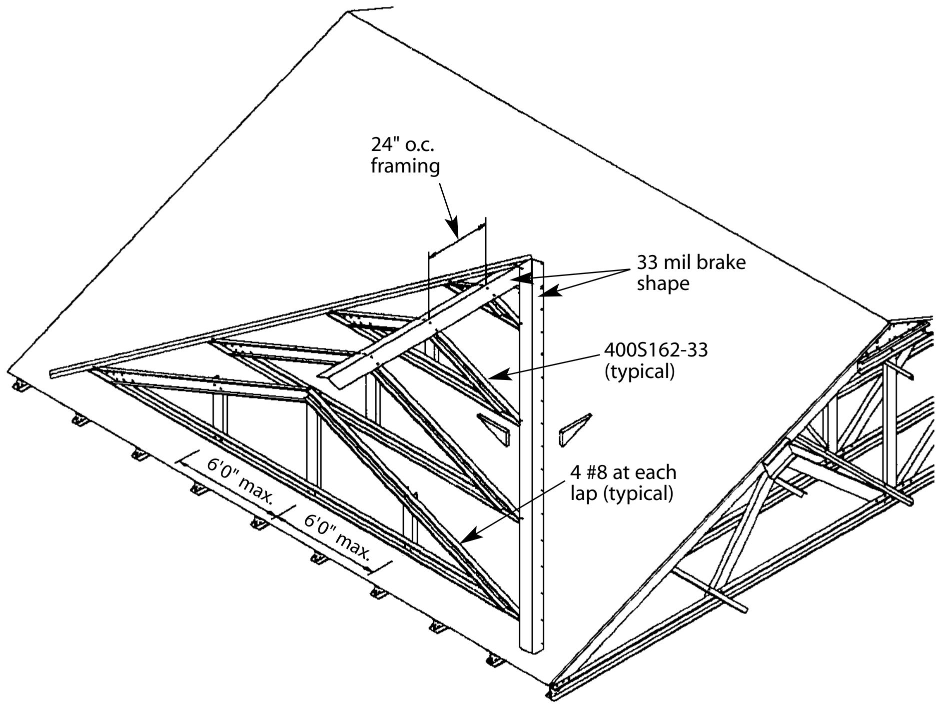

Figure 14-17
Schematic of overbuild

Figure 14-18
Framing overbuild trusses

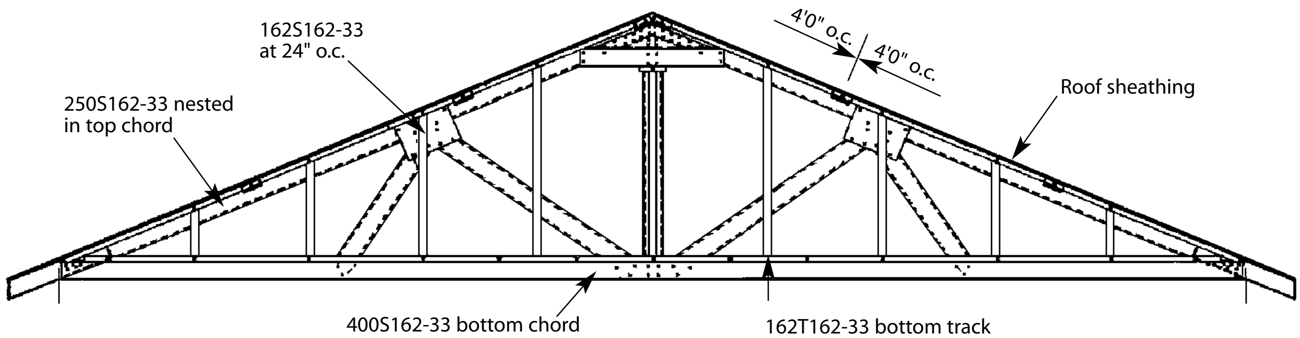

Figure 14-19
Gable end truss

Gable End Trusses

There are several ways you can build trusses for the gabled ends (end walls) of houses:

- Fill frame the end wall
- Build a truss specifically for the gable end
- Modify a standard truss to use at the gable end

One of the easiest ways to frame the gable end is to modify a standard truss by adding vertical members so you can attach your sheathing. This requires less work and materials, saves time for you and your engineer, and eliminates the headers in the wall below.

To build gable end trusses, fasten 2½-inch × 1⅝-inch stud material to the bottom of each chord in the top chord. This will reinforce the top chord, especially if you're notching for outlookers. On the hard side, secure 1⅝-inch × 1⅝-inch × 43-mil track at the top of the top chord and along the top of the bottom chord (Figure 14-19). Install 1⅝-inch × 1⅝-inch × 43-mil stud material at 24 inches on center to match the stud spacing in the wall below. This serves as your end wall truss, so you don't have to build a whole new truss.

Scissors Trusses

If you're building cathedral ceilings, you can use scissors trusses for support. Scissors trusses have bottom chords that slope to match the pitch of the cathedral ceiling. To do this using Cs, the trusses have two bottom chords. One is in the same plane as all the other chords in the truss, and the other is out of plane with the web side down. Figure 14-20 shows an example. Again, your engineer will design the truss for you and give you member sizes and screw counts.

Ridge Caps

Ridge caps are brake metal shapes that cover the ridge of the house (Figure 14-21). Ridge cap is used to attach the sheathing. Install it after all of your trusses and permanent bracing are in place. The ridge cap is shown as item 34 on the cut list in Figure 14-4. Using the 8.8-inch flat strap, you'll need to bend the metal to match the slope of the roof. You can either do this on your brake press or send it to a sheet metal shop. Run the ridge cap from one end of the roof to the other, and fasten with two No. 8 low profile screws at each truss. Figure 14-22 shows the common pitches and the corresponding brake angles. You can also use this table to determine brake angles for calculating the angles for hip and valleys as well for walls that intersect at 90 degrees.

Bracing

As with wall framing, it's important to brace your roof trusses to protect the frame during construction, especially in high wind areas. Install the angle bracing

Figure 14-20
Scissors truss

Pitch	Angle (degrees)
3:12	160.2
4:12	154.1
5:12	148.4
6:12	143.1
7:12	138.3
8:12	133.8
9:12	129.8
10:12	126.2
12:12	120.0

[1] Can also be used for hips and valleys when the walls intersect at 90 degrees.
[2] Taken from the LGSEA Newsletter, October 1996, p.5.

Courtesy: Light Gauge Steel Engineers Association

Figure 14-22
Brake metal angles for ridge cap

Figure 14-21
Ridge cap

(rat run) shown back in Figure 14-12 to reduce the risk of collapse. Figure 14-12 also shows X-braced trusses on the king posts at each end of the building and rat runs installed in six places along the entire length of the house. You can use $1^1/_2$-inch × $1^1/_2$-inch × 33-mil angle to brace the trusses. (Your engineer will usually specify this in the plans.) You should brace your trusses as you work. Never position more than four trusses at a time without bracing. The bracing will help you keep the roof framing system rigid and prevent the trusses from falling over in a domino effect.

Chapter 15

Roof Completion Details

Your roof, whether it was framed with steel rafters or trusses, needs several more details before it's complete. First, you have to detail the rafter heels. Then you'll need to install hold-downs, fascia, collector blocks, rakes and soffits. In this chapter we'll look at how to finish these details on your rafter- or truss-framed roof.

Rafter Heels

The heels of steel rafters are different than in wood rafters. You should *never* cut bird's mouths in steel rafters because you'll destroy the strength of the members. Each steel rafter will rest on the outside radius of the top plate of the supporting wall. Rafters use ceiling joists or clip angles to transfer the load. If you're using trusses, the heel gusset plate and bottom chord member must bear on the top track of the wall. This transfers the load down evenly to the aligned stud below.

The screws that tie the bottom flanges of the ceiling joist to the top track of the wall hold down the roof framing. You can find the number of screws you'll need in Table 8.1 of the *Prescriptive Method*. In our design example house, you need two No. 10 screws to make this connection for wind conditions up to 70 mph Exposure C or 90 mph Exposure A or B. You'll need to install uplift connectors or hold-down clips if you're building in higher wind or seismic conditions. Use Table 8.14 of the *Prescriptive Method* to determine the uplift load and connector requirements.

Roof Hold-Downs

For your hold-downs (or uplift connectors), you can use 54-mil straps or brackets made from 54-mil angles, or premanufactured hold-downs made by companies like Simpson Strong-Tie. These manufacturers rate their connectors for uplift loads. One type of hold-down bracket is shown in Figure 15-1.

Select sizes to meet or exceed the loads in Table 8.14 of the *Prescriptive Method*. You may also ask your engineer to design hold-downs for roof framing. You'll notice that no extra hold-downs are required for the design example house.

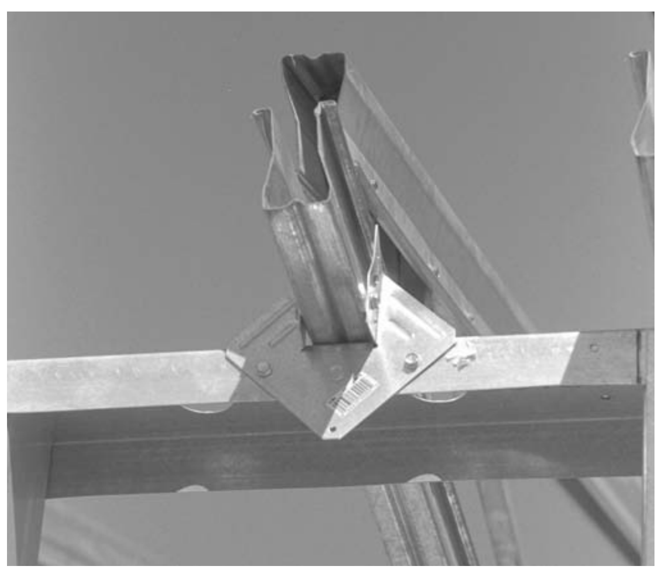

Figure 15-1
Hold-downs

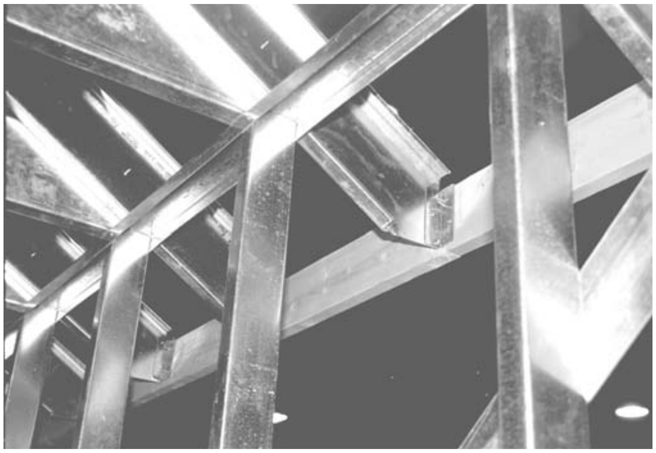

Figure 15-2
Perpendicular fascia

Roof Fascia

The roof fascia gives you a finished look for the end of the rafter or truss tail. You can design the fascia perpendicular to the ground to match the side of the house (Figure 15-2) or perpendicular to the pitch of the roof (Figure 15-3).

If you want to make the fascia with the face perpendicular to the ground, there are two ways to do it:

- You can miter cut the rafter tails to make the tails perpendicular to the ground.
- You can also square cut the rafter tails and add a long piece of metal bent to fit over the end (known as a *brake shape*). The resulting finish will be a fascia edge that's perpendicular to the ground (Figure 15-4).

Figure 15-3
Square tail fascia

Figure 15-4
Brake shape fascia

There are at least two different ways of framing the fascia if your rafter tails are perpendicular to the pitch of the roof:

- You can use metal track attached to the rafter tails, then screw a 2 × 4 or 2 × 6 wood fascia directly to the track. See Figure 15-5.
- Or you can use a wood 2-by for the fascia. Install the wood by connecting it to $1\frac{1}{2}$- × $1\frac{1}{2}$-inch angles screwed to the rafter tail and fascia. Either method gives the house a finished “wood” look.

You should pay special attention to the truss and rafter tails when installing the fascia to make sure it’s kept straight. A crooked fascia line looks *very* unprofessional. If you built the trusses and rafters to exactly the same length, the tails should already be in a straight line. But check them with a string line to see if any of the tails need trimming. If the ends of the rafters don’t create a straight line, cut them to the correct length with an electric shear or circular saw.

If you use a brake shape or steel track for the fascia, clamp each end of the track or brake shape to the truss or rafter tail. Next, use the string line to check that the fascia is straight. Screw the brake shape or steel track to each flange on the truss or rafter tail with low-profile screws. Repeat all the way around the house. When you install fascia in the corners or valleys on the roof, you’ll need to cut the flanges on the fascia and screw the webs together. See Figure 15-6.

Figure 15-5
Wood fascia on steel track

Figure 15-6
Corner fascia

Collector Blocks

Collector blocks are flat pieces of steel or brake metal shapes that connect the roof sheathing to the wall sheathing. They’re typically required only in high seismic or wind areas. Install collector blocks, made to match the pitch of the roof, every 8 feet or less between the trusses or rafters. See Figure 15-7. Collector blocks transfer the shear from the roof diaphragm down to the wall diaphragm.

If your engineer requires you to install collector blocks, you’ll also need to install collector straps — strips of 4-inch sheet metal 33-mils or thicker. Collector straps are installed on the top chords of the trusses or rafters to tie together the trusses or rafters and the connector blocks. They’re also screwed down to the top of the collector blocks. Look at Figure 15-8 (the collector block is the piece with the number 22 on it).

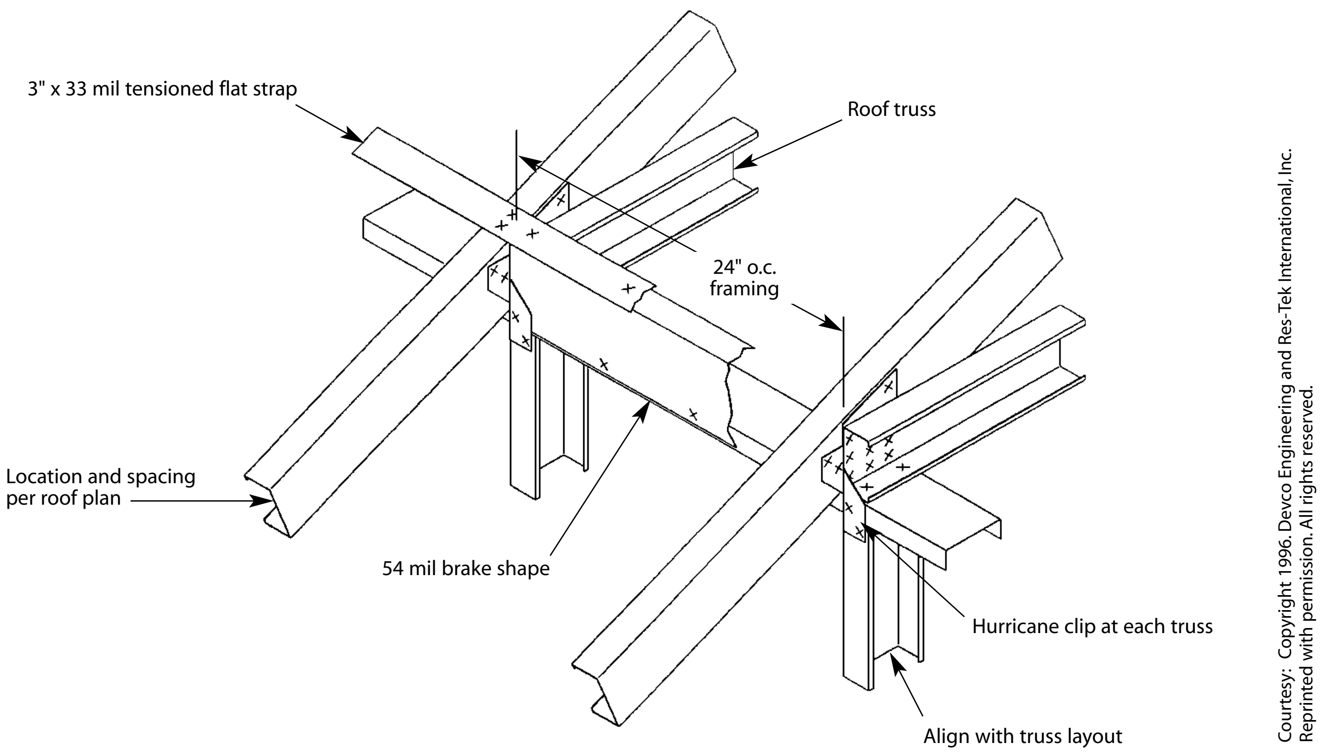

Figure 15-7
Collector block detail

Figure 15-8
Collector block

Rakes

The rake of the roof is the portion that extends beyond the walls on the gabled ends. They may overhang up to 12 inches (that's the limit in the *Prescriptive Method*) and support the sheathing on the roof. See Figure 15-9.

Rakes often consist of plywood extending over the edge of the roof. You can also use barge rafters (rafters on the outside of the house) to support the outside edge of the roof. This is also shown in Figure 15-9.

You may prefer to use outlookers for framing rakes. Outlookers consist of wood or steel framing 2 feet on center from the gable end to the barge rafter (see Figure 15-10). You can prefabricate outlookers in "ladder-like" sections or you may choose to frame them in place. Many times outlookers start 2 feet back at the next truss in from the gable end and extend out to the barge rafter.

If you're following the *Prescriptive Method*, it's important that you use rakes that are 12 inches or less. If you use longer lengths, you'll need an engineer to check the uplift loads.

Figure 15-9
Rake

Barge Rafters

I mentioned barge rafters above as one possible way to frame rakes. You can install barge rafters by attaching them directly to the ridge cap and the fascia. To do this, run the ridge cap out over the end truss. Clamp the barge rafters (which are the same length as the rafters or the top chords of the trusses) to the ridge cap and the horizontal fascia material and screw them together with low-profile screws. Run the roof sheathing out to the barge rafter and screw in place. See Figure 15-11. If you're using the *Prescriptive Method*, make sure that your barge rafters also don't overhang more than 12 inches.

Soffits

Soffits are the roof overhang at the ends of the rafters or truss tails. If you're using the *Prescriptive Method*, you may frame soffits up to 2 feet long. An engineer must check larger soffits for uplift loads.

Figure 15-10
Outlookers

Figure 15-11
Barge rafters

Figure 15-13
Wood soffits

Figure 15-12
Exposed soffits

Figure 15-14
Enclosed soffits

If you want to frame an exposed soffit (Figure 15-12), you can use steel tails and paint over them for a finished look. Or you can use wood tails inserted into your steel rafters or truss tails (Figure 15-13). Slide the wood tail up into a 4-inch steel top chord truss member and screw it into the top flange of the top chord. The distance the wood tail slides into the top chord should be the same as the length of the exposed tail. You can follow the same procedure for roof rafters.

Enclosed soffits have a horizontal member that runs level with the ground, from the wall to the fascia. Aluminum, vinyl, or wood usually covers the soffits. You can also frame the enclosed soffits, as shown in Figure 15-14, with the enclosed soffit along the rafter tails.

Once all of your framing members are in place, your steel roof is ready to be sheathed. Follow your local building code or your engineer's recommendation for screw spacing.

Chapter 16

Specialty Framing

For framers to keep up with the latest trends in home design, they're always having to learn something new. That's part of the challenge — and the fun — of framing, whether in wood or steel. Today's designers often use hips and dormers to create interesting house profiles, instead of the straight gable roofs we're all used to. Rectangular doorways are often transformed into curved archways. Circular stairwells and vestibules have also become popular. You can use steel framing in all of these designs. In fact, sometimes these details are actually easier to frame in steel. In this chapter, we'll look at how to do it.

Curved Walls

You frame curved walls for partitions or exterior loadbearing walls, like the one in Figure 16-1, using curved track. You can bend the track at the job site by slitting the flanges, or order curved track from specialty companies that will bend the track to the radius you specify.

To curve the track yourself, cut one flange and the web on the top and bottom track at 2-inch intervals for the length of the radius. Leaving at least 12 inches of uncut track at the end of each arc, bend the track to the desired radius. Use a string to scribe the radius on the slab, then work the track to match the radius you scribed. Tack the track down as you curve the track around the line. Support the cut flange with a piece of 1-inch wide 18-mil steel strap fastened to the inside of the flange with a set of locking clamps. You should use track that's the same thickness (or one thickness heavier) as the wall studs.

If you order your track precurved, a specialty company will be able to bend the track without slitting the flanges. That gives you a track that's neatly bent to the exact radius you specify (Figure 16-2). Wall track is bent around the flanges and joist track is bent around the web. This is because walls are curved along the surfaces of the wall, and floors are curved at the ends.

Whether you've formed the radius yourself or ordered it preformed, position the studs in the track with their open sides facing in the same direction. Screw them into both the top and bottom track. And make sure you start and end each radius with a stud.

You can install gypboard on curved walls either wet or dry, but you can bend wet gypboard more than dry gypboard. You need to make sure that you use the correct radius when curving gypboard. Use Figure 16-3 as a guide when you apply gypboard *dry*. If you thoroughly moisten the face and back papers and core, you can bend the gypboard to radii shorter than those in Figure 16-3. Moisten with clean water using a short nap paint roller, a water pump or a spray gun. Don't let the moistened gypboard stand for more than an hour.

Make sure you handle the moistened gypboard with care — it's easy to damage it. When installing your gypboard, attach one side of the board to the stud with screws, then progressively push the gypboard into contact with each stud and fasten securely. Work from one end to the other, on each side of the wall. See the Gypsum Association's report called "Application of Gypsum Board to Form Curved Surfaces" (GA-226-96) for more information. You can call them at 202-289-5440.

Figure 16-1
Curved walls

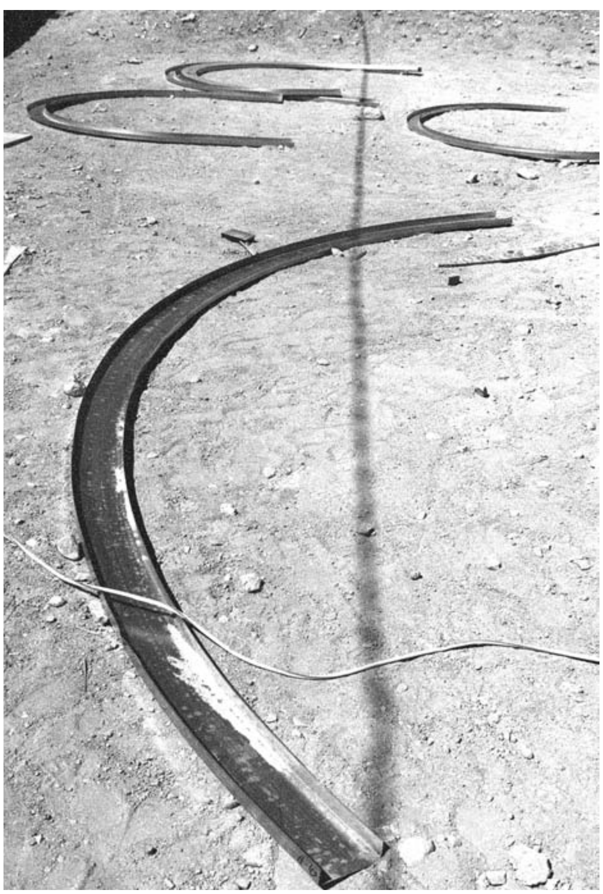

Figure 16-2
Curved track

Gypsum board thickness (in)	Bent lengthwise (ft)	Bent widthwise (ft)
1/4	5*	15*
5/16	6 1/4	20
3/8	7 1/2	25
1/2	10*	**
5/8	15	**

* Two 1/4 inch pieces bent successively may be used to obtain a final 1/2 inch thickness at the shorter bending radius.

** Shall not be permitted to bend widthwise while dry.

Courtesy: ©1996. Gypsum Association, "*Application of Gypsum Board to Form Curved Surfaces*," (GA 226-96)

Figure 16-3
Minimum bending radius of dry gypboard

Curved Floors

You can frame curved floors using rim track that's bent along the web. Either order the track precurved or cut it in the field by snipping the top *and* bottom flanges. Then cut each floor joist to fit into the rim track (Figure 16-4).

Figure 16-4
Curved floor

Archways

Archways add a Spanish architectural style to door or window openings (Figure 16-5). You can frame arches in entryways and doorways by using steel track bent to the desired radius. For archways, snip and notch the flanges of the track used for the arch. After making sure it matches the desired radius of your archway, install it in the doorway or window.

Then cut your gypboard to the proper length and width. If the radius is short, moisten the board or score it across the back with cuts at 3/4-inch intervals. Be sure to hold the gypboard tight against the framing when driving the fasteners, working from one side of the arch to the other.

Figure 16-5
Arched doorway

Dormers

Dormers break up gable roofs and add space to the inside of the house (Figure 16-6). They're popular in the Northeast, especially in Cape Cod homes with steep roof pitches. You can frame a dormer by doubling the trusses or rafters on each side of the dormer (girder trusses or rafters). Install headers at the top and bottom of the dormer about like the headers for stair openings in a floor.

Build your dormer on top of the girder trusses or rafters. Attach the bottom track directly to the top of the rafter or truss. Set the top track at the top of the dormer (parallel with the ground). Frame the roof of the dormer as a hip or a gable. You can size the studs and joists in the dormer the same as the stud and joist sizes in the house, or have your engineer specify the sizes.

Figure 16-6
Dormer

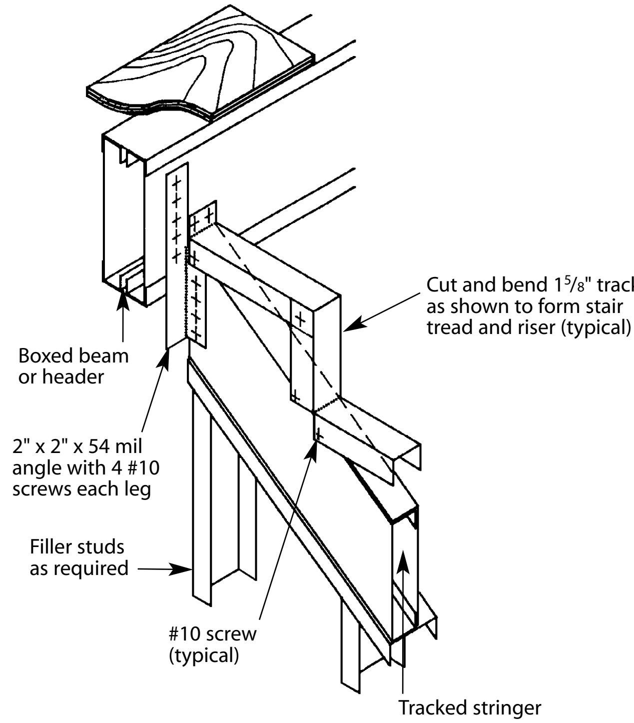

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Figure 16-7
Stairway detail

Stairways

You can choose to frame your stairways out of either wood or steel. They're not always called out on the plans. Some framers like to use wood because they think it takes more time to frame out of steel; others prefer the sturdy solid stairs that are framed with steel. If you're comfortable using steel this way, there are many details you can choose from. Figure 16-7 shows one way to frame stairs out of steel and plywood. Figure 16-8 shows how this detail is framed. Other framers use steel and concrete. The choice is up to you.

If you bend the stair stringers into a curved radius, and attach the riser across the stringers, you can build a curved stairway.

Figure 16-8
Framed stairway

Chapter 17

Thermal Considerations

The exterior walls, ceiling joists and floor joists of your house may require different amounts of insulation, depending on your location and environment. The requirements for making houses thermally efficient vary from region to region and state to state. *Thermal efficiency* is how much energy it takes to keep a house at a constant temperature and comfort level. One of the most important factors in thermal efficiency is the type and amount of insulation in the house. Generally, if you're required to install batt insulation in your wood-framed home, you'll also need to install batt insulation in your steel-framed home. The energy codes for your area determine the levels and amounts of insulation required in steel-framed homes.

There are several energy codes or standards, including the CABO *Model Energy Code* (MEC), the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) Standard 90.2, and California's Title 24. They may require you to meet certain energy performance criteria, which usually are developed around thermal transmittance — or U-values. Thermal U-values indicate the effectiveness of a wall at holding warm or cold air inside.

Meeting the Energy Code

The *Model Energy Code* (MEC) provides tables of equivalent thermal values for steel- and wood-framed construction. If you compare the current steel and wood thermal values for 24-inch-on-center studs with R-13 insulation between the studs, the tables imply that wood-framed walls generally have twice the effective R-value (thermal resistance of the wall) of steel. That's why you'll usually have to apply exterior foam insulation to steel-framed walls to get an effective R-value equivalent to wood framing.

MEC tables were produced based on information and data gathered through laboratory testing of wall panels (called *hot box testing*). They discovered that studs in a wall act as "thermal bridges." They let the cold pass through the wall faster than the points between the studs. This is equally true of both wood and steel studs — steel just happens to be a little more efficient in transmitting heat loss or heat gain.

Practical Experience

Experience from steel framers around the country has shown that energy bills for steel-framed homes are directly comparable to those for wood-framed homes of similar size, construction and occupancy. Of course, the thermal efficiency of a steel-framed home depends on how well the house is constructed, how airtight it is, and the number of areas where studs are clustered together. A relatively airtight home has joints that are straight and close together, which reduces air infiltration. Clustered studs (studs located close together) will usually make a cold spot in the wall. Properly built and insulated steel-framed homes can be just as thermally efficient as wood-framed homes.

In short, what the experts from the energy code recommend for insulation requirements and what steel framers have discovered from actual fieldwork aren't the same. We're waiting for an alternative method of rating insulation requirements in steel-framed homes that takes into account practical experience and some of the additional thermal benefits of steel framing, like air tightness. The Department of Energy, NAHB Research Center, and the North American Steel Framing Alliance are currently working together to more thoroughly evaluate the thermal efficiency of steel framing, and to provide cost-effective solutions. Today, most framers simply add rigid foam insulation to the exterior flange of exterior wall studs to meet local building code requirements.

Ghosting

Ghosting is the collection of dirt and dust particles on wall surfaces (usually at stud locations). It commonly occurs when there's a significant difference in the temperature of the wall surface at the studs compared with its temperature between the studs. Particles adhere to the colder areas of the wall, so streaks develop at the steel studs in the wall. Ghosting also has a good chance of occurring in houses where the occupants smoke or frequently burn candles, because there are more particles in the air.

Ghosting isn't limited to steel framing, but it occurs more often with steel because of its higher level of thermal conductance. Attaching foam insulation to the exterior of the wall effectively solves the ghosting problem.

One rule of thumb to determine if you need to provide ghosting protection is to examine the mean temperature difference between the outside and the inside of the home. If it's 50 degrees F or greater for a week at a time during the year, ghosting has an increased chance of occurring within one year or less.

Moisture

Moisture condensation can impact all types of framing, including steel — and excessive moisture degrades thermal insulation. It can also damage the architectural finishes, including exterior sidings or interior gypboard. To date, there haven't been any widespread reports of moisture problems in steel-frame houses that used conventional framing methods and insulation materials. However, it's important to note that because steel-framed houses usually have less air infiltration, moisture can build up more readily than in wood-framed houses. Although reducing the airflow helps make a home more energy efficient, it also reduces the air exchange that helps release moisture trapped behind the walls.

You need to apply the same type of moisture or vapor barriers to steel framing that you use for wood. If you use foam insulation as a vapor barrier, make sure you tape the joints, following the current practices in your area.

Thermal Design Guide

The NAHB Research Center wrote the *Thermal Design Guide for Exterior Walls (NT 14-95)* for AISI in 1993. This document is still used to help evaluate the thermal performance of steel framing. You can get a copy from NASFA by calling 1-800-79-STEEL.

This guidebook shows three different ways to determine the amount of insulation you need in a steel-framed house, based on tests performed on wall samples. One method uses a thermal degree-day map with color codes and a table indicating if any extra foam board is required. The guide also includes a chart method and a calculation method. Until the MEC introduces an alternative way, these suggested insulation levels are the generally-accepted methods.

Figure 17-1 gives effective R-values for various types of steel-framed construction, depending on what R-value your energy code requires. In order to obtain the effective R-value in the Effective Wall R-Value column, you'll need to use the appropriate cavity insulation *and* exterior insulated sheathing.

Cavity Insulation

Because a metal stud is open on one side, the wall cavity formed between the wall studs is wider than in wood framing. It's important for you to select batts that are the full width of the cavity so there's no air space left around them. Insulation manufacturers usually make batt insulation sized for use with metal framing. You can also use a spray-applied insulation that completely fills the cavity.

Figure 17-2 lists some of the products that are available from various manufacturers. Fiberglass insulation is held between the wall studs by friction. You'll have to tape or glue kraft-faced insulation to the side that doesn't have lips to hold it in place.

Effective Wall R-Value	Wall Construction	Cavity Insulation	Exterior Insulated Sheathing
21	2 x 4	R-11	R-13
20	2 x 6	R-19	R-10
15	2 x 6	R-19	R-5
15	2 x 4	R-11	R-7
13.5	2 x 4	R-11	R-5
12.5	2 x 6	R-19	R-2.5
10	2 x 6	R-19	0
8.5	2 x 4	R-11	0

Figure 17-1
Effective R-value for steel-framed construction

Manufacturer	Product Type	R-Value	Thickness (in)	Width (in)	Length (in)	Face
CertainTeed	Batt	R-19	$6^1/_4$	24	48	Unfaced
CertainTeed	Batt	R-19	$6^1/_4$	16 & 24	96	Unfaced
CertainTeed	Batt	R-19	$6^1/_4$	16 & 24	96 or 48	Kraft or foil
CertainTeed	BIBS	R-15	$3^1/_2$	Variable	Variable	Unfaced
CertainTeed	Batt	R-13	$3^1/_2$	16 & 24	96	Unfaced or kraft
CertainTeed	Batt	R-11	$3^1/_2$	16 & 24	96 or 48	Kraft or foil
Icynene	Spray-foam	R 3.6 per inch	Applied to fit	Applied to fit	Applied to fit	Unfaced
Knauf Fiber Glass	Batt	R-19	$6^1/_4$	16 & 24	96	Unfaced, kraft or foil
Knauf Fiber Glass	Batt	R-15	$3^1/_2$	16 & 24	96	Unfaced, kraft or foil
Knauf Fiber Glass	Batt	R-13	$3^1/_2$	16 & 24	96	Unfaced, kraft or foil
Knauf Fiber Glass	Batt	R-11	$3^1/_2$	16 & 24	96	Unfaced, kraft or foil
Owens Corning	Batt	R-22	$6^3/_4$	16 & 24	96	Unfaced, kraft or foil
Owens Corning	Batt	R-19	$6^1/_4$	16 & 24	96	Unfaced, kraft or foil
Owens Corning	Batt	R-13	$3^1/_2$	16 & 24	96	Unfaced, kraft or foil
Owens Corning	Batt	R-11	$3^1/_2$	16 & 24	96	Unfaced, kraft or foil

Figure 17-2
Representative cavity insulation products for steel framing

Figure 17-3
Wall insulation

Wall Insulation

Remember to place fiberglass insulation in your exterior walls, jambs, headers, corner studs, any built-up members, and inside multiple studs. Any of these areas could produce a cold spot in your wall. Also pay special attention to areas behind the outlet boxes in exterior walls. Figure 17-3 shows a fully-insulated steel-framed wall.

Figure 17-4
Ceiling insulation

Insulating Ceilings

Install full-width batt insulation between ceiling joists below unheated attics. Here are some other ceiling areas that may require insulation: between ceiling joists of unheated garages or other areas where the rooms above are used for living purposes, below stairways to unheated attics, knee walls in attics, and cathedral ceilings. You can see an insulated ceiling in Figure 17-4.

Insulating Floors

Floors require insulation placed around the joists or track, between the joists and along the end walls, between joists above any unheated living space and between floor joists over a crawl space. You'll need to secure the insulation in place between the joists just like you do with wood joists. You can use strapping, ties or chicken wire to hold the insulation permanently in place. If you're using gypboard, you won't need ties.

Foam Insulation

In colder regions, the *Thermal Design Guide for Exterior Walls* recommends using foam sheathing for additional insulation on the outside of the home. Foam sheathing products are usually made from extruded polystyrene or polyisocianurate. The thickness of the foam you'll need depends on the extra R-value required for the house. Figure 17-5 shows some R-values for foam products available today.

Attach the foam board to the exterior of the house with screws, adhesives or nails, depending on the type of sheathing or siding that's installed:

- For stucco houses, attach the foam to the steel with a long self-drilling screw with a plastic washer. Attach the metal lath to the foam with a long self-drilling screw with a washer to hold the lath in place. See Figure 17-6.
- For houses sheathed with plywood or OSB, attach the foam board to the sheathing with roofing nails or adhesive. Attach the siding over the foam with nails or screws that penetrate through the foam into the sheathing or studs. See Figure 17-7.
- For vinyl siding, use nails, staples, or screws to attach the siding into the sheathing or studs according to the siding manufacturer's recommendations.

Product	R-values at 75°F Mean Temperature by Nominal Board Thickness				
	1/2″	3/4″	1″	1 1/2″	2″
Celotex Thermax	3.6	5.4	7.2	10.8	14.4
Celotex Tuff-R	4.0	5.6	8.0	12.0	16.0
Dow Styrofoam	3.0	4.0	5.0	7.5	10.0
Owens Corning Foamular	2.5	3.8	5.0	7.5	10.0
Owens Corning Foamular IS	3.0	4.0	5.0	—	—

Figure 17-5
R-values of some typical foam sheathing products

Figure 17-6
Attaching foam

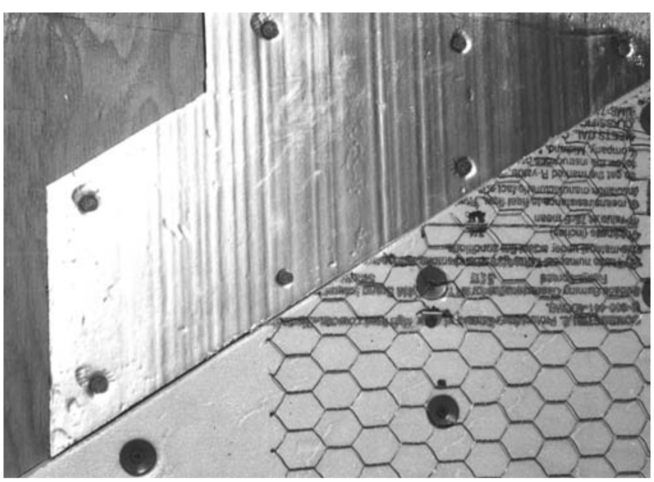


Figure 17-7
Attaching foam over steel or plywood

Figure 17-8 lists some of the fasteners you can use to attach foam sheathing for use under common exterior finishes. You should use plated screws, and the screw length is determined by thickness of materials. The screws must penetrate the siding, foam, structural sheathing, steel studs, plus a minimum of three exposed threads. The manufacturer of the siding product or engineer specifies the number of screws you need. Where structural sheathing is used, you may not have to fasten the foam to the studs, only to the sheathing.

Ease of Construction and Cost Issues

Foam insulation is readily available and relatively inexpensive. But installing siding over the foam and fastening the siding product to steel may be more expensive than installing siding over plywood or OSB. The cost of the longer fasteners and associated labor costs can be high. And long screws have a tendency to flop or fall over when they're screwed in. In fact, NAHB Research Center cost studies show that it costs twice as much to attach foam insulation to steel than to wood sheathing. Here are the cost issues you must consider when you're using foam insulation:

1. Cost of foam insulation
2. Cost of fasteners needed to drive through the foam
3. Cost of labor to install the insulation

When you're required to install foam insulation on a home, it may be less expensive to sheath the house with plywood instead of using X-bracing.

Application	To Structural Sheathing	To Steel Studs
Foam sheathing	Roofing nails	Grabber Bugle Head Self-Drilling #6 min with plastic washer Compass Darts 'SD' Point Bugle Head Phillips #6 min with plastic washer
Vinyl siding	Roofing nails Grabber Wafer Head Steaker #8 Compass Self-Piercing Modified Truss Phillips #8	Grabber Wafer Head Self-Drilling #8 Compass Darts Self-Drilling K-lath #8
Lap siding, Hardboard/OSB	Ribbed Head Deck Grabber #8 Compass CW-Drill #8	Ribbed Head Exterior Grabber Gard Driller with #3 pt #8 Compass C-Wing #8
Fiber cement board	Ribbed Head Deck Grabber #8 Compass CW-Drill #8	Ribbed Head Exterior Grabber Gard Driller with #3 pt #8 Compass C-Wing #8
Panel siding	Ribbed Head Deck Grabber #8 Compass CW-Drill	Ribbed Head Exterior Grabber Gard Driller with #3 pt #8 Compass C-Drill #8
Stucco with metal lath	Grabber Wafer Head Streaker #8 with plastic washer Compass Self-Piercing Modified Truss Philips #8	Grabber Wafer Head Self-Drilling #8 with plastic washer Compass Darts Self-Drilling K-Lath #8
Brick ties	Grabber Hex Header Streaker #8 Compass RPS Self-Piercing Hex Washer Head #8	Grabber Hex Head Self-Drilling #10 Compass Darts 'SD' point Hex Washer Head #10
Wood shingles	Grabber Bugle Head Streaker #6 Plated Compass Marker 'S' point Bugle Head Phillips #6 Plated	N/A

Figure 17-8

Suggested fasteners for typical exterior finishes over foam sheathing

Figure 17-9
Sprayed-in foam insulation

Figure 17-10
Thermal studs

Spray-In Foam

Besides rigid foam insulation, you can use spray-in foam, like Icynene, to fill wall cavities. Sometimes you'll install the gypboard first, then the Icynene is injected into the wall cavity. It expands in the wall cavity to seal off all voids to prevent air infiltration. Figure 17-9 shows sprayed-in foam insulation in place. While this method usually costs more in labor and materials, the resulting air-tight wall will pay off with reduced energy costs.

Thermal Studs

Thermal studs are an alternative that may either reduce or eliminate the need for foam insulation (Figure 17-10). Thermal studs remove a substantial amount of the web of the stud to reduce its thermal conductivity. Some of these studs are so effective they eliminate the need for exterior foams altogether. Consult with thermal stud manufacturers to find the thermal resistance values and the cost of the material to see if they'll be a benefit to your job. Remember to consider the cost savings you'll realize by reducing the amount of foam and fasteners you'll need.

Loose Cellulose

Another alternative for insulating a home is loose cellulose. Loose cellulose is installed the same way in both steel- and wood-framed homes — by blowing the insulation material into the wall cavity or attic space with forced air. Loose cellulose tends to be a little messy when you're installing it in wall cavities, but it can be a time-saver when insulating ceilings.

Chapter 18

Wall Construction — Nonbearing Walls

After you've made sure all of your loadbearing floors, walls, and roof members are properly braced and fastened in place, you're ready to install your nonbearing walls. Nonbearing walls are partition walls that divide up the rooms of a building. Unlike the loadbearing walls discussed in Chapter 11, a nonbearing wall doesn't support the structure or any weight except its own. (They're typically designed to withstand their own weight plus a minimum 5 psf interior pressure.) So you don't have to be concerned about in-line framing, and your studs don't have to be structural quality. In short, you can frame with thinner materials. In this chapter we'll discuss framing nonbearing walls — starting with layout.

Layout

While laying out interior nonbearing walls is similar to layout for bearing walls, here are some tips to consider:

- Clear out and clean the floor area before you attempt to lay out your walls. Then follow your drawings and measure the locations for all the interior walls.
- Use your chalk line to lay out the location of the walls, paying close attention to chase walls (typically 6 inches wide).
- Mark all locations for closet doors, passage doors and other wall openings.

Cut your base track to fit on the layout. At door openings, you'll want to use a wood stud that fits in the track at the hinge and strike sides to stiffen the walls. Secure the bottom track to the slab with a powder-actuated fastener, or use No. 8 self-piercing screws over a subfloor.

Nonbearing Wall Studs

You can frame the nonbearing walls with studs the same size as your bearing studs. But you do have the option of using thinner, less expensive studs. Commercial framers typically use 18- and 27-mil studs (sometimes called *drywall studs*) to frame partition walls. Typically these walls have longer spans than residential construction, and use intermediate bridging. If you choose the lighter studs, you can save up to $1.00 per stud in material costs, which can add up to significant savings.

But here's something to consider: Because walls are typically closer together in residential buildings, the studs are more likely to get bumped or dented during construction. The easiest way to prevent this from happening is to order walls studs the same thickness as your bearing wall studs. For this reason, many residential framers choose to use a minimum 33-mil stud for nonbearing walls to keep the studs from getting bent or damaged during the construction process.

The minimum standard for nonbearing studs is ASTM C645, with a minimum base metal thickness of 18 mils. The minimum coating weight is G40.

Wall Stud		Clear Height	
		Stud spacing	
Nominal size	Industry designator	16"	24"
2 x 4 - 18	350S125-18	9'10"	6'6"
2 x 4 - 27	350S125-27	15'10"	13'10"
2 x 4 - 33	350S125-33	17'0"	14'10"

Courtesy: Commentary on the *Prescriptive Method for Residential Cold-Formed Steel Framing,* Second Edition

Figure 18-1
Maximum allowable clear height
for fully-braced nonbearing wall studs

The height limits of nonbearing walls depend on the size of the studs you use. These limits prevent the walls from overdeflecting. Figure 18-1 gives the allowable heights for partition walls supported with gypboard on both sides and a deflection criteria of L/180. Notice that you can't use 18-mil studs for 8-foot walls if the studs are spaced 24 inches on center.

Figure 18-2
Framing isolators

Wall Assembly

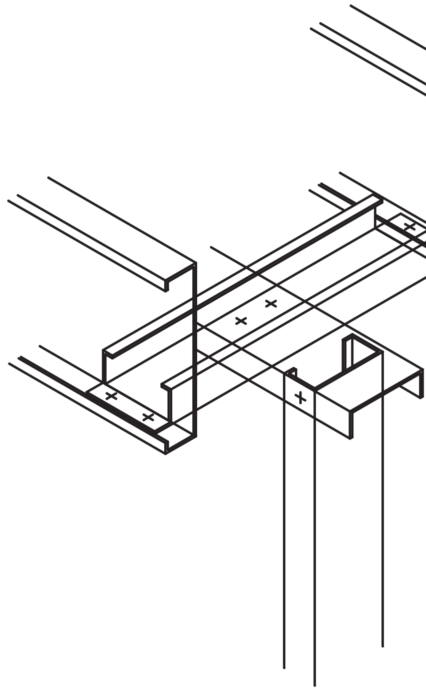
You have two choices for your wall assembly. You can assemble them on the floor or deck, raise them into position (tilt-up), then fasten them with self-piercing screws for 18- and 27-mil studs. Or you can stick-build the walls by framing them in place. If you frame your walls on the floor and tilt them into position, you should follow the same procedures discussed in Chapter 11. Because we've covered tilt-up framing in detail there, the remainder of this chapter will concentrate on in-place framing.

Depending on the spans for your roof trusses or joists, you may need to isolate your nonbearing walls from the roof framing to make sure they don't assume any of the loads deflected by the trusses or joists. In commercial construction, adding framing isolators (Figure 18-2) to nonbearing wall framing is a common practice where deflection may be significant. They're simply screwed to the top plate and ceiling joist (or truss) above. In most residential applications, the deflection isn't significant enough to add isolators. It's usually enough to secure the top track tightly against the ceiling joists. If deflection is noticeable, cracking may occur in your gypboard whether you use isolators or not. While isolators aren't common in residential construction, you need to be aware of what your local building code requires.

In-Place Wall Framing

Nonbearing walls are typically installed in place. You can use a level and a stud to find the location of the top track on your ceiling joists. For sloped walls or for cathedral ceilings, you can use a plumb bob with a string to mark the location of the top track by lining up the plumb bob with the layout on the floor. Screw the top track to the ceiling joists, the bottom chord of your trusses, or second floor joists with No. 8 self-drilling screws.

Where your interior walls run perpendicular to the joists or trusses above, screw your top track directly into the joists or trusses. If the walls run parallel to the joists or trusses, use pieces of track or stud material as blocking every 24 inches. See Figure 18-3



Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing*, Second Edition

Figure 18-3
Blocking when wall is parallel to joists or trusses

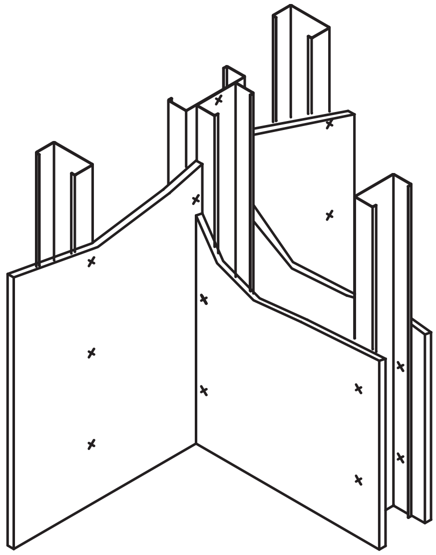
Figure 18-4
Leaving space for wood bucks

(from Figure 7.1 of the *Prescriptive Method*). Cut the blocking 2 inches longer than the distance between the joists. Clip the flanges off 1 inch on each side to allow the webs to lap over the joists. Screw the blocking on both ends with two No. 8 self-drilling screws.

Mark your track for 16- or 24-inch stud spacing, leaving $1\frac{1}{2}$ inches from the edge of the rough openings to allow room to wrap your doors with wood (Figure 18-4). Install the studs open toward the beginning of your layout, especially when using 18-mil studs. Make sure your drywaller understands this layout and good steel-framing principles to ensure good drywall joints. They should place their screws close to the web of the stud, where it's more rigid. Twist your studs on layout and secure the flanges on both sides in the track with No. 6 or No. 8 self-piercing screws.

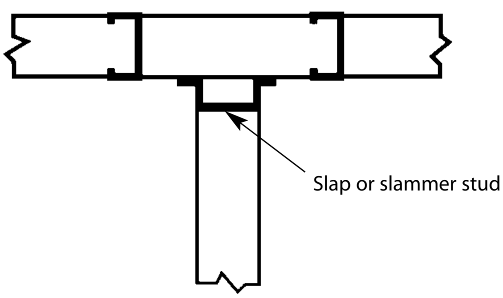
If you're using wood bucks, install them in the door or wall opening as a lining, or as a replacement for the metal king stud. See Figure 18-5.

Figure 18-5
Wood bucks



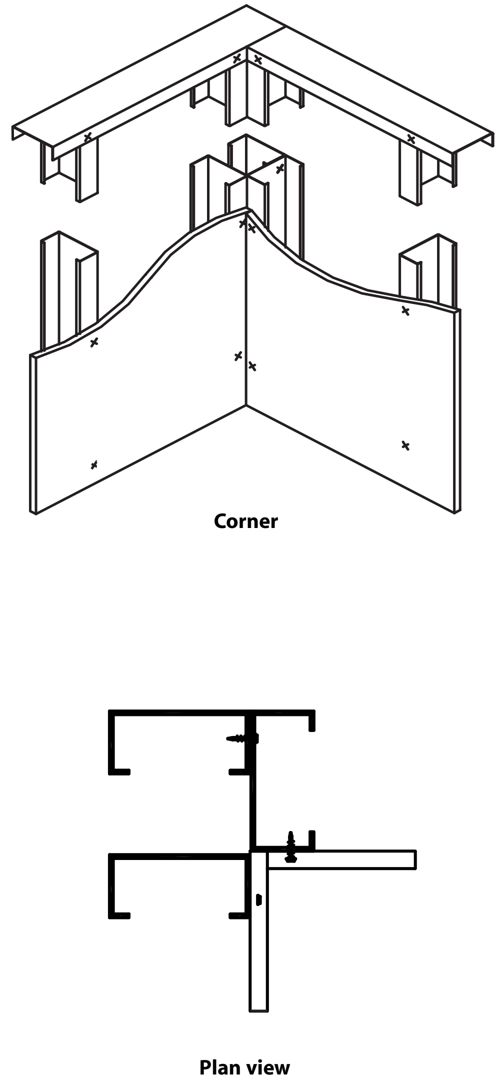
Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing*, Second Edition

Figure 18-6
Intersecting walls



Courtesy: North American Steel Framing Alliance

Figure 18-7
Slap stud



Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing*, Second Edition

Figure 18-8
Corner framing

Corner Framing

Where nonbearing walls meet exterior load-bearing walls, position a 6-inch or larger stud in the exterior wall so the web of the stud serves as a connecting surface for the nonbearing wall. You can see this in Figure 18-6. You can also use blocking between the studs to attach nonbearing walls to exterior walls. The stud or blocking will attach the nonbearing wall, and also act as a backer for the gypboard on the exterior wall. You can also use a slap stud at intersecting walls. A *slap* stud eliminates the need for using two studs at an intersecting wall and provides a great backer for the gypboard. See Figure 18-7.

Where two nonbearing walls come together to make a corner, add an additional stud into one of the walls, 3 inches in from the end. It will join the two walls together and act as a backer for the gypboard. See Figure 18-8.

Rough Openings

Openings in nonbearing walls don't have to be as sturdy as openings for bearing walls. But you should pay careful attention to openings in high traffic areas as they're more easily damaged due to wear and tear. Line your interior doors and closet doors with wood studs to provide extra support at the hinges and strike plates. Allow $1^1/_2$ inches on each side of the door openings to install wood studs full height or to the top of the opening (Figure 18-5).

If you prefer not to use wood, double up with two steel studs. If you use steel studs next to the wood, be sure to turn the jamb studs so the hard side faces the opening.

Use wood or steel for the head of the opening. For steel, cut the web back so that the flanges protrude an extra inch on each side. Then install the cripple studs above the door opening to match your layout for gypboard attachment.

Gypboard Installation

You may attach the gypboard panels either parallel or perpendicular to the studs. In either case, make sure to place all the ends over the framing members. When you're working with parallel installations, stagger the joints in successive courses so the joints don't run the full length of the panel. Plan ahead to maximize the lengths of the material to cut down on the number of end joints you'll have to tape. Fit the edges closely together — but don't force them.

Use $1^1/_4$-inch self-piercing screws spaced 16 inches on center in the panel field and along the edges. Space the screws on 12-inch centers along the exterior edges of the panel at the studs. See Table 6.14 of the *Prescriptive Method.*

You can also use construction adhesive to apply your gypboard, but only to steel studs that aren't treated with oil. Some adhesives today have enough holding power to replace screws. But be careful when applying gypboard on oily studs because fingerprints on gypboard aren't easy to cover with paint.

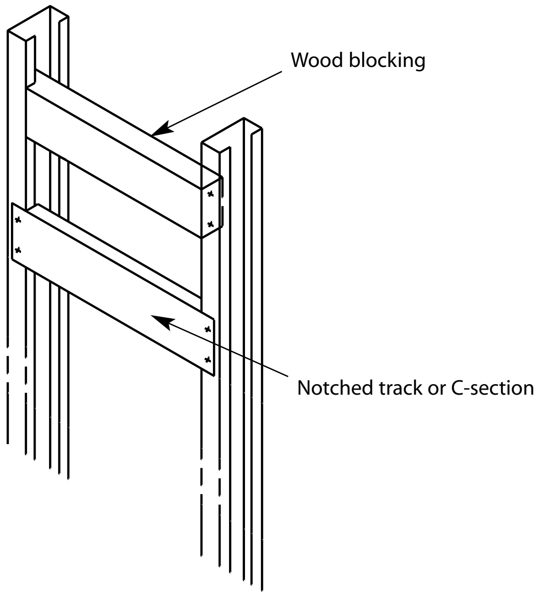
For double layer applications, apply the base layer with the length of the panel parallel to the framing and the face layer perpendicular to the studs. Or you can also install the face layer parallel, as long as you offset the joints. Use longer screws spaced 24 inches on center for the base layer and 16 inches on center for the face layer.

Attaching Molding, Cabinets and Shelving

One of the easiest ways to install baseboard is to use adhesive. Construction adhesives today are very strong and durable. Instead of adhesives, you may use finishing nails on an angle to tack the baseboard in place by "bradding" it against the steel (Figure 18-9). *Bradding* is when the nail just penetrates the steel and bends along the flange to hold the baseboard in place. If you use nails, you can putty over the heads or leave the hole as is. Or you can use finishing screws with small heads (about $^1/_8$ inch wide) that leave an acceptable-looking finish. Many contractors do both. They glue the baseboards and then shoot pins to the track.

Depending on the size of the chair rail and ceiling molding, you may be able to screw or nail them directly to the studs or track. For large ceiling molding,

Figure 18-9
Nailing baseboard



Courtesy: *Prescriptive Method for Residential Cold-Formed Steel Framing,* Second Edition

Figure 18-10
Cabinet blocking

you may want to use top track with deep flanges. The deeper flanges will extend farther down the wall to provide a larger backing area for attachment. Or you can attach the molding to wood blocking installed between the studs.

You can install cabinets and shelving directly to the wall studs (if they're 33-mil or thicker) or use wood or steel blocking (Figure 18-10). If you're attaching them directly to the studs, use 2-inch No. 8 self-drilling screws. Check for available finish colors if the screw heads are left exposed; self-drilling screws normally only come in black.

You may choose to add wood or steel blocking to make cabinets easier to attach to the wall. Notch one end of the wood (or the flanges of track material if you're using steel) so it'll fit in the lip of the stud. To attach wood supports for closet shelving, use self-piercing fasteners for 18- and 27-mil studs and self-drilling screws for 33-mil and thicker. We covered the different types of screws in Chapter 6.

Chapter 19

Exterior Finishes

Once the house is finished, you can't tell by looking whether it was framed with wood or steel. The exterior finish — whether stucco, brick, lap siding or hardboard — covers up the framing. But while the outside appearance of a steel-framed and a wood-framed house may be identical, the methods of attaching the exterior finishes are different. This chapter covers how to attach vinyl siding, hardboard/OSB, fiber cement board, stucco, and masonry finishes to steel framing.

Factors to Consider

You need to consider several factors before you install the exterior finish, including the kind of fastener you'll use, the wall stud spacing, and whether or not you're using foam insulation. Together, they'll determine how you install your finish.

Fasteners for Steel Studs

You can use screws or pin fasteners to attach siding, sheathing and other exterior finishes. The type of screw or pin you'll use depends on the exterior finish manufacturer's recommendations, the thickness of the layers the fastener must penetrate (including the stud, insulation and finish), and whether or not you used structural sheathing on the house. Using plywood or OSB structural sheathing greatly simplifies attaching the siding materials because it provides a wood backer you can nail into.

You can use Figure 6-9 (back in Chapter 6) and Figure 17-8 (from Chapter 17) to find suggested fasteners for attaching different types of exterior finishes. If you're installing a finish that's not covered in the tables or that requires different fasteners, just follow the manufacturer's recommendations.

Spacing of Wall Studs

Some siding manufacturers don't recommend that their products be attached to wall studs spaced greater than 16 inches on center. In some cases, the products just aren't compatible with any greater stud spacing. Some products aren't tested at 24 inches on center because traditional stick-built framing was always spaced at 16 inches. It's important to check with the manufacturer to verify that the siding product can be installed on studs spaced 24 inches on center — either with or without structural sheathing on the wall. Also check to see if the siding can be attached only to the structural sheathing. Verify whether the fastener is adequately supported in the sheathing material or if it must be embedded in a wall stud.

All of these factors will help you determine what fasteners and siding products you can use.

Foam Insulation

As discussed in Chapter 17, foam insulation installed on a steel-framed house increases the length of the fastener you need to attach the siding to the house. The thicker the foam, the longer the fastener must be. When foam thickness is greater than 1 inch, the fastener may be awkward to handle and have a tendency to fall or flop over when screwed or nailed. In colder climates, the foam may be up to 2 inches thick, requiring even longer fasteners. This will impact the amount of time it takes you to install the siding and could result in increased labor time and cost.

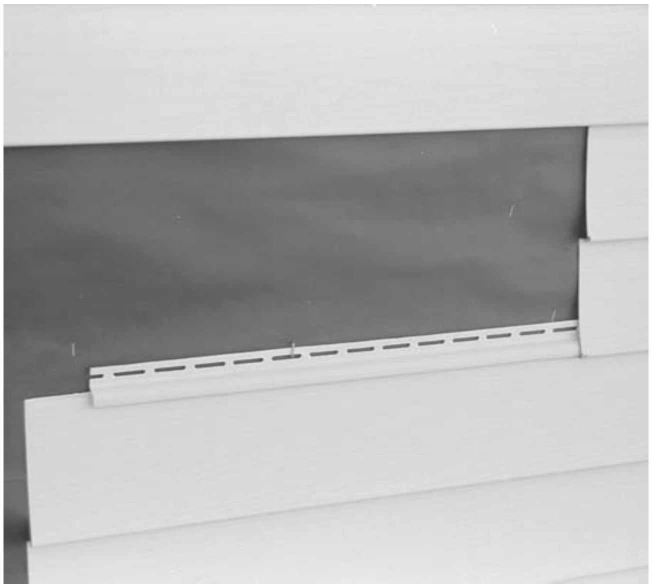


Figure 19-1
Attaching vinyl siding to structural sheathing

Figure 19-2
Lap siding over steel framing

Attaching the Exterior Finish

Now let's look at each type of exterior finish, and how to attach it to your steel-framed house.

Vinyl Siding

You can attach vinyl siding directly to the plywood or OSB with roofing nails or staples at the recommended spacing. See Figure 19-1. Check with the siding manufacturer to verify both the method of attachment to the sheathing or the studs and the number of fasteners you'll need. If you have foam over the sheathing, you'll have to find a longer fastener to attach the siding. If there's no foam insulation, make sure you install a vapor barrier or thermal wrap.

If you're not using structural sheathing, you'll need to use a self-drilling screw or pin to attach the siding directly to a stud. Make sure that the fastener you choose doesn't distort the siding by overtightening through the vinyl. If you're using screws, you may want to leave a $^{1}/_{8}$-inch gap to prevent this distortion. The gap isn't noticeable from the exterior and allows the siding a chance to expand or contract with fluctuations in temperature.

Hardboard/OSB and Lap Siding

First, check with the manufacturer to find out if 24-inch stud spacing is permitted. If it's not, you'll have to use 16-inch stud spacing if you want to apply that particular exterior finish. When you're fastening hardboard or lap siding over structural sheathing, you can use nails directly into the sheathing when the manufacturer allows it. If not, you'll need to use self-drilling screws that are long enough to pass through the siding, foam and structural sheathing, and still have at least three threads penetrating through the steel of the wall stud. Use corrosion-resistant screws to prevent stains from forming on the siding.

Figure 19-2 shows lap siding installed on a steel-framed house with no structural sheathing. The studs are spaced 16 inches on center.

Panel Siding

Installing panel siding like LP or T-111 is often easier than installing lap siding. Self-drilling screws penetrate the wood and steel studs to hold the panel securely in place. Make sure that the screws draw the panels flush and tight against the wall studs, with no gaps. Again, use a corrosion-resistant screw that won't stain the wall.

Wood Shingles

Wood shingles must be installed over sheathing. Nail or screw the shingles to the sheathing, following the recommendations of the shingle manufacturer.

Fiber-Cement Board

Fiber-cement boards such as HardiPlank are becoming increasingly popular, especially in high-moisture or termite-infested areas. You install it like hardboard siding, with self-drilling screws to fasten the siding to the steel studs or to the structural sheathing. Check with the manufacturer for the allowable stud spacing. You may want to use a "ribbed" screw which nests itself flush into the siding to prevent damage to the finish.

Stucco with Metal Lath or EIFS

You can use either traditional stucco with metal lath or EIFS, a synthetic stucco, as an exterior finish for your steel-framed house. Figure 19-3 shows a steel-framed home being finished with stucco. If you have structural sheathing attached to your wall studs, you can apply the stucco and lath directly over the sheathing. Just tack the lath to the sheathing with staples or nails.

Lath manufacturers are researching new products with wire spaced closer together so you could screw the lath directly to the studs, with no backing. The screw heads alone will hold the lath in place. But until they're on the market, you have to have some kind of backing for the lath. If there isn't any sheathing, you can use a foam backer or Dens Glass to support the stucco. Foam insulation products like those listed in back in Chapter 17 (Figure 17-5) don't only provide a backer, but a thermal value as well. Dens Glass provides the additional benefit of providing wall shear.

It can be difficult to attach the foam backers to the steel studs when there's no structural sheathing. There are several different methods you can use:

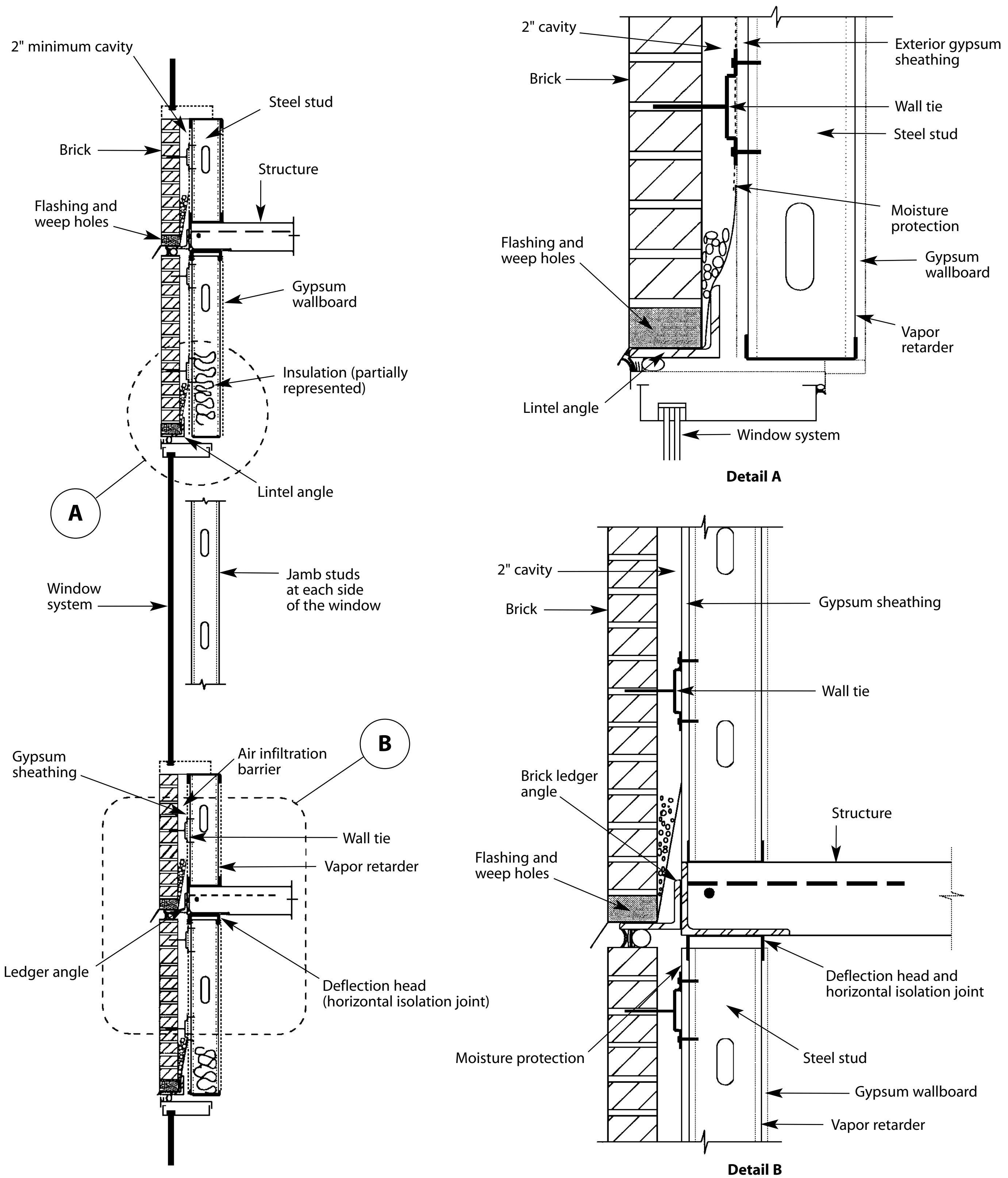
- Adhesives may do the job in dry climates.

Figure 19-3
Stucco applied on a steel-framed home

- You can use screws with washers that prevent the screws from tearing through the foam. The washers also prevent the foam from slipping out underneath the screw head.
- You can also use pins with washers.

The method you ultimately use will depend on how cost effective the job is. Most contractors are currently using screws with washers where there's no structural sheathing. Then once the foam and lath are in place, you're ready to apply the stucco over the foam.

EIFS systems are installed over steel studs just like traditional stucco. The exterior gypboard or Dens Glass is screwed directly to the steel studs. The most important part of an EIFS system is waterproofing, especially around window and door openings. If water penetrates the wall and contacts the studs, it can cause corrosion. If you use EIFS, be careful. Many contractors have experienced problems with this product. Once moisture gets inside the walls, it rots wood studs and causes metal studs to rust. Either use the ventilated EIFS or *make sure* your EIFS wall is waterproof.



Courtesy: *Design Guide for Anchored Brick Veneer Over Steel Studs*, Western States Clay Products Association

Figure 19-4

Masonry finishes

Masonry Finishes

Follow the architect's specifications and details when installing brick finishes. You'll need to apply structural sheathing for wall shear, wall covering, and support for the brick veneer wall. See Figure 19-4. Anchor the brick with approved brick ties attached to the steel studs through the structural sheathing with two No. 8 self-drilling screws for each tie. Anchor the bricks to the wall as recommended by the Brick Industry Association (usually 16 inches on center). And use steel angles or concrete ledges to support the bricks, as approved by the architect.

When you've got the exterior finish on, you're finished with the actual construction of the house. In the remaining chapters, we'll cover related topics, including working with utility contractors, meeting fire and sound ratings, dealing with the inspectors — and the all-important sale of the house if you're building on spec.

Chapter 20

Working with Utility Subcontractors

Many plumbing, electrical and HVAC subcontractors aren't yet familiar with residential steel framing. That means you need to understand how the utilities are installed, and be willing to devote some time to training inexperienced subcontractors. If you can help increase the subcontractors' speed and efficiency, that will keep their costs down and profits up. Otherwise, they may charge more to cover the extra time they need to learn how to do the job efficiently. Knowing they can make a profit will encourage more of them to bid on steel framing projects.

It's to your advantage to have several subcontractors to choose from. You can lower your subcontractor costs through competitive bidding. Experienced plumbing, electrical and HVAC subcontractors charge the same for a steel- or wood-framed house. And remember, there are commercial subcontractors who have worked with steel framing for many years, although they might not be willing to work on small residential jobs. Production housing may have more appeal for them.

It's also a good idea to include the subcontractors early in the project. If steel framing isn't common in the region, take the time *before* framing begins to locate a plumber, an electrician and HVAC installer who are either experienced or willing to learn to work with steel.

Planning for Utility Runs

While you're framing, you have to look ahead to the mechanical services that will be installed in the house. Always leave as much space as possible for the utilities to avoid problems for the subcontractor. Plan the runs for the plumbing, electrical, and HVAC lines so they don't interrupt structural framing members. This simplifies the planning of mechanical risers such as ducts, vents, and plumbing stacks that must pass through the structure.

You need holes in the framing to run the utilities in the house. Remember to line up your prepunched stud or joist holes to make it easier for your subcontractors. If there aren't natural punchouts where you need them, punch the holes for the plumber or electrician ahead of time. Line up or make punchouts in the studs under window sills. And make sure punchouts line up in corner studs. If a corner stud is inaccessible after framing, install a grommet to ease the workload for the plumber or electrician. Even when you've made and lined up the punchouts in preparation for the plumber or electrician, they'll usually need to make a few more holes.

The number and location of the holes has an effect on the structural integrity of the members. *Never* cut or punch the flanges of a stud, joist or track. Section 2.7 of the *Prescriptive Method* covers holes in the webs of joists and studs, including maximum sizes and hole patches. There are several different tools you can use to make holes in metal studs, joists or track material for running utilities.

Hole Punches

If small holes are needed, you can use punches available from Greenlee or Caddy. See Figure 20-1. These punches can fit around the flange and punch

Figure 20-1
Hole punch

Figure 20-2
Hole saw

round holes approximately 1 inch in diameter. They work up to a thickness of 33-mil material. You can also get special bushings or grommets to fit in the resulting holes.

Hole Saws

For thicker steel and holes up to 6 inches in diameter, you can buy hole saws by companies like Lenox, Greenlee or Klein. See Figure 20-2. These saws are used on a drill motor to cut through the steel.

Figure 20-3
Unibit

Unibits by American Tool Companies (Figure 20-3) and *Step Bits* by Greenlee may also make holes in steel up to $1\frac{3}{8}$ inches. Unibits are usually more expensive than hole saws but tend to cut through steel faster.

Plasma Cutters

Plasma cutters (check Figure 5-13 back in Chapter 5) also make fast holes — but they're the most expensive way to do it. You need a welding unit and a separate power source. Plasma cutters cut quickly, but leave rough edges. Grommets aren't made to fit in plasma-cut holes — so you may have to use foam insulation or other material to protect wiring or plumbing lines. Watch closely if plumbers or electricians use this method of cutting. Don't allow excessive hole-cutting that may interrupt the structural integrity of the house.

Working with Plumbers

In these sections on subcontractors, I'll talk about products like hangers and isolators. The subs will be choosing, supplying and installing these products —

but many don't know they're available. You may need to help educate the sub about what's required and what's available to make their job easier.

Here are some tips that'll help you make the job run smoothly for your plumbing subs:

- Cluster plumbing lines for the kitchen, laundry, bathrooms and water heaters as close as possible to minimize the number and length of piping runs.
- Stack bathroom and plumbing facilities in two-story homes vertically as much as possible. With alignment framing (where rafters, joists and wall studs are stacked), establish a clear vertical path without interrupting structural members.
- Avoid locating plumbing runs in exterior walls — for a couple of reasons. First, they're more likely to interrupt structural members there. Second, they'll probably reduce the thermal value of the wall. In colder climates, pipes may even freeze.

The plumbing sub must run the plumbing lines through the walls and floor framing, hang and secure the piping in place and test the lines. Make sure your plumbers comply with the applicable plumbing codes in the area where you're building. They need to ensure that all fittings are tight, and that the pipes are properly secured and protected from damage and corrosion.

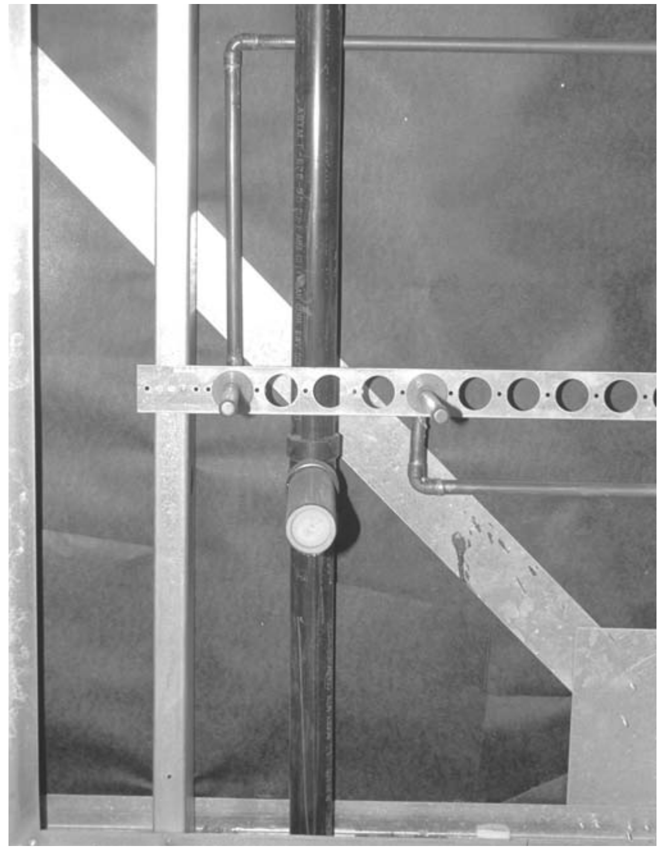


Figure 20-4
Pipe hangers

Hangers

Just as in wood-frame construction, plastic or copper pipe must be supported with hangers secured to the studs with screws. See Figure 20-4. Use a minimum No. 6 self-piercing screw in 18- and 27-mil studs, and self-drilling No. 8 screws for thicker steel. You may need to make sure your sub is comfortable installing these hangers, and even has the right screwgun and fasteners to attach them to the steel.

Don't attach copper hangers directly to steel studs. Copper and steel are dissimilar metals. If they're in contact with each other and get wet, the resulting electrolysis will cause corrosion. Use plastic isolators between the copper hangers and steel studs, steel hangers with an isolator for the copper pipe, or some other method that prevents the two metals from touching. Plastic pipe hangers (like those made by Hang 'Em) and plumbers' tape eliminate electrolysis problems. Pipe hangers are available as specialty products in typical plumber supply catalogs.

Isolators

You also have to secure and protect plastic and copper pipe from both sharp edges and electrolysis when they're passing through metal studs. Figure 20-5 shows typical pipe isolators. You can order plastic pipe insulators and clamps from plumber supply catalogs. FLEX-FIN is one manufacturer of pipe insulators and suspension clamps to protect the plastic pipe or to insulate copper. Some building inspectors allow pieces of foam pipe insulation placed around the pipe at stud punchouts. This is an inexpensive solution where it's allowed. It also works well where copper pipe runs vertically along the studs.

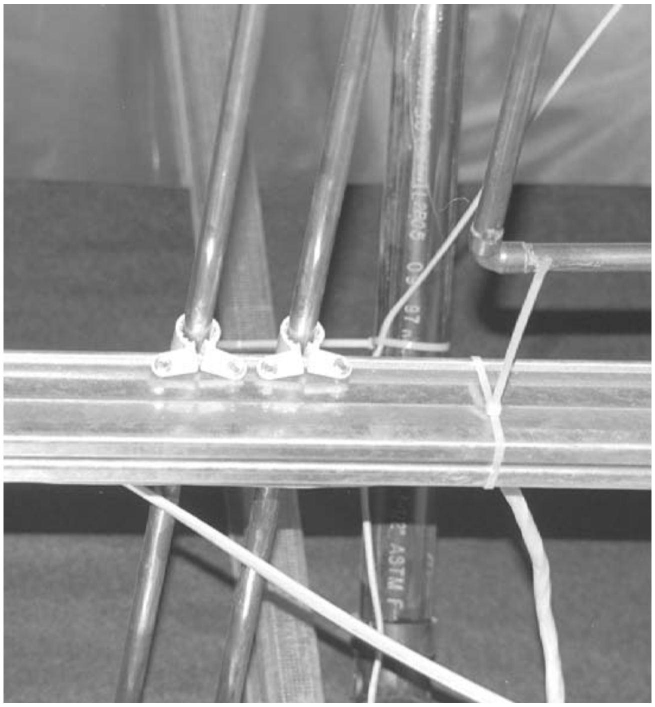


Figure 20-5
Pipe isolators

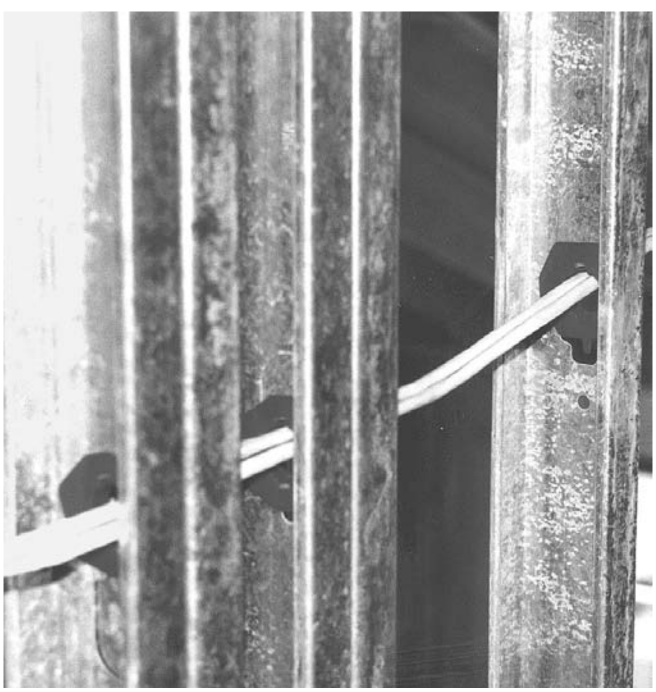


Figure 20-6
Grommets

Working with Electricians

It's important for everyone involved — the architect, builder, framer and electrician — to think through the electrical layout. Put the service panel (breaker panel box) close to the kitchen or utility area, if you can, to minimize the length of heavy wiring runs.

Make sure your electricians follow the *National Electrical Code*, plus any additional local regulations for wiring and electrical methods. They also must ensure that electrical cable is properly secured and protected from sharp metal edges. Like the plumbers, electricians are faced with cutting holes, securing wires and protecting them from contact with steel. Cutting holes is covered earlier in this chapter. We'll cover securing and protecting wire next, as well as installing electrical boxes and service panels.

Wire Protection

Snap-in plastic bushings (like those manufactured by Arlington Industries) fit into existing irregularly-shaped punchouts in metal studs. See Figure 20-6. They comply with paragraph 300-4 (b) (1) of the *NEC*, which requires nonmetallic sheathed cable (like Romex) to be protected by bushings or grommets when it passes through metal studs. Make sure that the grommets fit properly in the hole so they won't slide out when the electrician pulls the wire.

Securing Wiring

Duct tape isn't recommended for securing electrical wiring. Instead, make sure your electrical subs use nylon zip ties to secure wires, especially at receptacle locations. Ty-Rap is one manufacturer of these zip ties. There are also ties with a molded screw hole that fastens to the steel. Where vertical running wire needs to be secured, use zip ties to tie the wires to the metal stud. Many roll-formers have an extra small hole punched next to the normal stud punchout for this purpose. There are also standoff clips available to secure the wiring. The clips are screwed into the stud with No. 8 self-drilling screws. Figure 20-7 shows wiring tied to the bottom chord of a truss.

Electrical Boxes

Finding the correct electrical box to use is one common problem facing novice electricians. To make their job easier, RACO makes plastic boxes

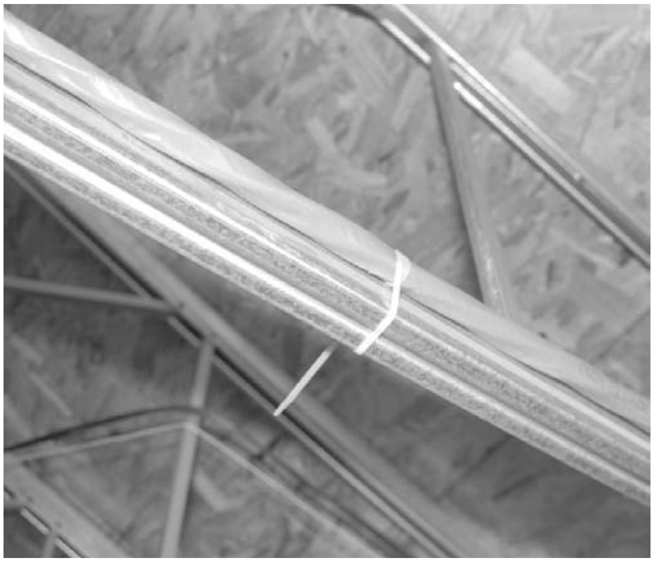


Figure 20-7
Zip tie

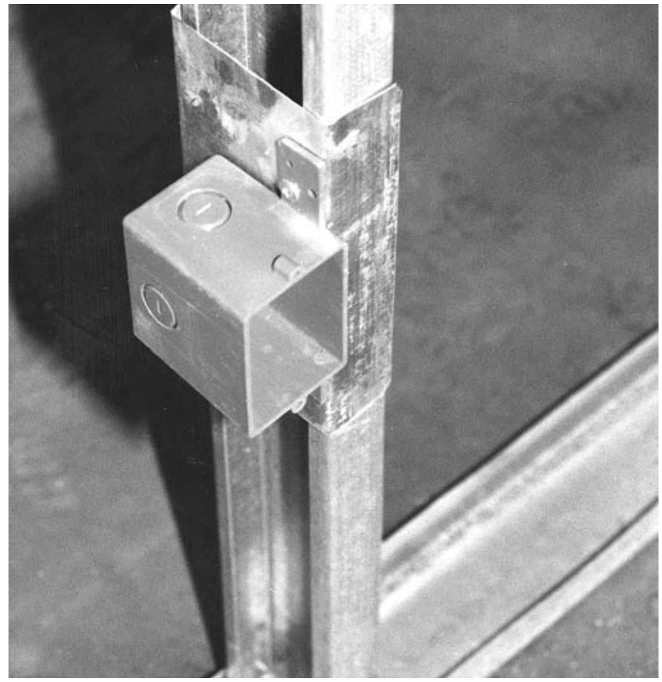


Figure 20-8
Electrical box installed on track material attached to steel stud

with side-mounted tabs for switches or single outlets. The tabs screw into the web of the stud. Typically, these are only available in single boxes. The side tab keeps the gypboard from bulging out or forming a bump in the surface of the wall. For larger boxes, electrical catalogs have two- and three-outlet electrical gang boxes. The thin metallic face tabs on these boxes typically don't make a noticeable bulge in the gypboard.

It's also important to realize that because of the layout, not every electrical box or switch can be mounted on the hard side of the metal stud. If you attach the box to the open side of the stud and screw it only to the return lip, any force exerted on the electrical box in the wall could bend the attached stud's flange and crack the gypboard. It's a good idea to precut extra track material, 6 to 8 inches long. The electrician can use it to cover the stud to properly mount the electrical box (Figure 20-8). Having the track precut saves the electrician time.

Service Panels

When installing a service panel (Figure 20-9), use either wood or steel blocking behind the panel to provide a solid backing. It may also help to attach a wood 2 × 6 between the studs immediately above

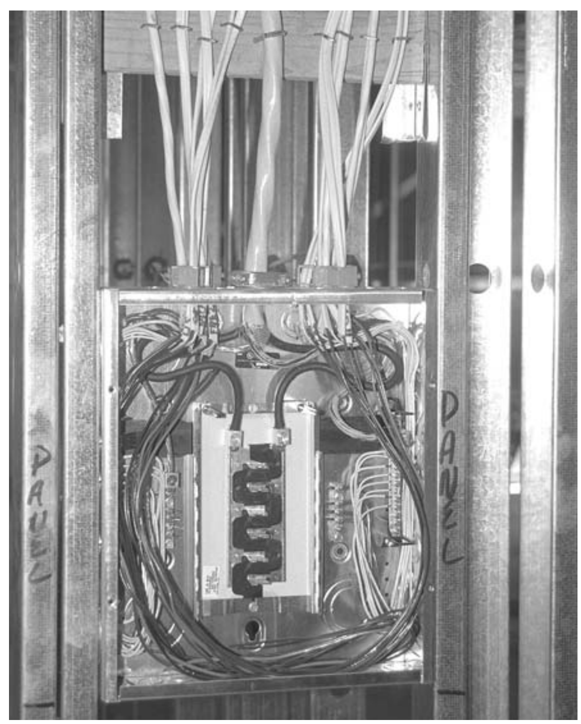


Figure 20-9
Service panel

the panel to provide a nailer for securing the wiring entering the panel. Make it easy for the electrician by providing the backer, or installing it yourself.

Working with HVAC Contractors

Your HVAC subcontractor will probably have the most experience working with steel, especially if they use metal ductwork. All HVAC installations must comply with the mechanical code. No. 8 self-drilling screws are generally used to attach plastic or metal ductwork to the framing. Sometimes you'll need to frame a chase wall to conceal the ductwork. Before you start framing, coordinate with the architect for the location of the duct runs.

Place the heating and cooling equipment in a central location on the floor plan to provide good air distribution and minimize the number and length of duct runs. The longer the ducts, the greater the loss of energy. Make sure you provide for any needed vertical or horizontal chases for ducts, flues, or returns. Don't let them cause complications with the structure or other utilities.

Chapter 21

Inspections

If you want to pass the building inspector's inspection, you've got to maintain good quality control on your job site by inspecting the houses yourself. Take the time to walk through and scrutinize each home before the building inspector makes the framing inspection. If there are any problems, you want to find and correct them before you fail your framing inspection.

You've also got to keep in mind that some building inspectors aren't familiar with steel framing. They've spent their whole careers inspecting traditional wood-framed houses. It's up to you to provide the inspector with a copy of the *Prescriptive Method* and review all plans and details with him or her — before you even start your project. The extra effort you spend to bring your inspector in the loop will pay off in the long run.

As increasing numbers of jurisdictions accept steel framing in their building codes, more and more inspectors will be familiar with steel framing. If you run into resistance in your area, call the North American Steel Framing Alliance at (202) 785-2200. They have two- and six-hour seminars they can give to your code officials at no cost to help bring them up to speed quickly on steel framing.

The Inspection Checklist in Figure 21-1 is reprinted by permission from the Light Gauge Steel Engineers Association. A pocket-sized version is available from the LGSEA, Technical Note 1010b. You can contact them at (202) 785-2022.

Well, you've planned ahead, maintained good quality control, and passed your inspections. Your steel-framed house is finished — and it's beautiful. If you were building it on spec, all that's left to do is sell it. But will you run up against resistance from prospective buyers who are only familiar with wood-framed construction? Selling your steel-framed home is the subject of the last chapter.

Inspection Checklist
For Load-Bearing Cold-Formed Steel Framing
Field Guide, LGSEA Tech Note (1010 b)

This document is intended to provide building inspectors, contractors, architects, and engineers with a partial list of items to be reviewed during construction of a project. It provides some basic, but necessary, checks to assure that the approved design drawings are constructed per plans and industry standards. This document is intended only as an aid to the qualified inspector. For more specific information, a design professional experienced in cold-formed steel design should be consulted.

Limitations

1. This guide is limited to steel materials that can be verified;
2. This guide is limited to conventional framing practices with stud, joist, and truss framing spaced at 24" on center, or less;
3. This guide should only be used as an aid to inspecting load-bearing cold-formed steel structures. For specific details, refer to the approved drawings.

Definitions

1. ***Inspector*** — A building official, third party inspection agency, architect, or engineer who has responsibility for inspecting the building.
2. ***Design Professional*** — A licensed engineer or architect responsible for the structural design of the cold-formed steel framing.
3. ***Plans*** — The approved design drawings prepared by a design professional.
4. ***Cold-formed steel (also called "light gauge steel")*** — Shall be defined as cold-formed sheet steel with thicknesses ranging from 97 mils (12 gauge) to 33 mils (20 gauge). Although not discussed in this document, thinner steels (22 mil/27 gauge and 18 mil/25 gauge) may be used in nonload-bearing conditions.
5. ***Contractor*** — Company responsible for receiving and erecting the cold-formed steel framing.

Figure 21-1

Inspection checklist for load-bearing cold-formed steel framing

Section I: General Requirements

1. All construction should conform to the approved plans, specifications, and local building code, in addition to the following specific items;
2. All variations from the approved plans and specifications must be approved by the Design Professional responsible for the Plans;
3. Should there be a conflict between the information in this document and the Plan, the Plan should govern and the party responsible for the plans should be notified to resolve the conflict.
4. This document is intended to be an aid in the inspection of a project using cold-formed steel framing and does not imply that a specific project will be in compliance with local code requirements.
5. If any of the checklist items below are not satisfied, the contractor shall correct the item or have it approved by the design professional or code official.

Materials

Steel Verification

❑ Confirm that the cold-formed steel members being installed match the project's specified size, type, mechanical properties and spacing.

❑ Each stud should bear a logo, name or initials of the manufacturer, base metal thickness (uncoated), and minimum specified yield strength (if other than 33 ksi).

❑ Verify that the lengths of webs, flanges, and return lips are the same as specified in the Plans, specifications, or code.

❑ The galvanized coating weight of load-bearing studs and track should be G60 or equivalent, per ASTM A955-97, unless other coating weight is specified on the Plans.

❑ In jurisdictions that do not require labeling of the cold-formed steel framing members, the contractor shall be responsible for verifying the steel delivered to the job site is in compliance with project specifications, and shall obtain Material Certificates which verify chemical, mechanical, and galvanization coating properties. Copies of all Material Certificates shall be maintained at the job site and supplied to the Engineer of Record upon request.

❑ Visually inspect the cold-formed steel members for cracking in the steel at the bend radius locations. Observe the studs for red rusting or scaling of the protective coating.

Allowable Penetrations

❑ Confirm that punchouts conform with the Plans, prescriptive building code, or other approved method. Typically, penetrations are not closer than 24" on-center or located closer than 10" from a bearing condition. The size of a punchout or penetration should not be larger than one-half the web depth, or 2½" maximum in the web direction, and not more than 4½" long in the member direction. Web holes violating these tolerances may be patched using a design approved by the Design Professional.

Figure 21-1 (continued)
Inspection checklist for load-bearing cold-formed steel framing

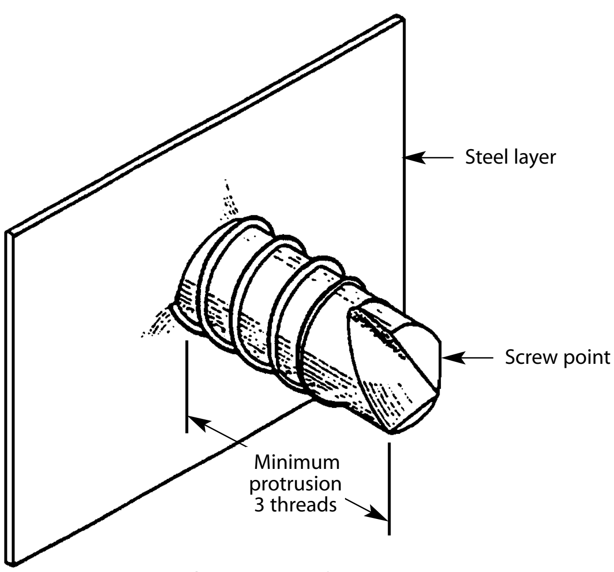
Field Cuts

- ❑ Verify that there are no field cuts or notches through flanges or the lips of any load-bearing cold-formed steel structural members unless specifically approved by the Design Professional.

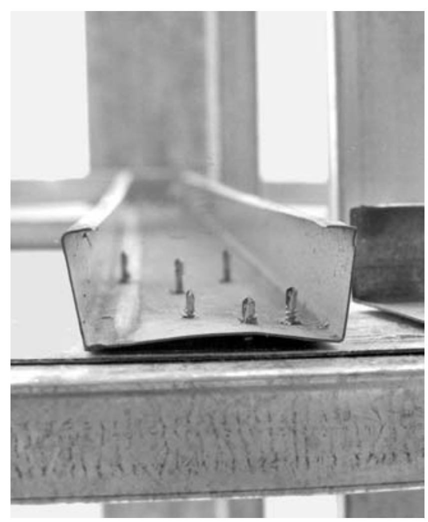
Fasteners

Screws

- ❑ Verification of Manufacturer's Allowable Capacity: Review the Plans for specified style and size used for specific applications. Screws for steel-to-steel connections shall be self-drilling tapping, in compliance with SAE J78. The contractor should provide data confirming the screws supplied will comply with the Plans for screw shear, pullout requirements, diameter, and point style in relation to the combined thickness of all connected steel frame members.
- ❑ Inspect screws to ensure they are fully driven and have a minimum penetration of three threads through the last material joined.
- ❑ Screws shall penetrate individual components in the connection without causing permanent separation between the components.
- ❑ Inspection: Look for popped screw heads that may indicate improper installation method, tool, screw type or quality of screw.
- ❑ Check for stripped connections (i.e., screws that turn freely).



A Screw penetration



B Illustration of permanent separation between components

Courtesy: LGSEA Design Manual

Figure 21-1 (continued)
Inspection checklist for load-bearing cold-formed steel framing

Pneumatically Driven Pins

- ❑ Review the plans for specified style and size used for specific applications, noting the manufacturer's research report number or approved test data, head-marking, and values. The contractor shall provide manufacturer data confirming the pins installed will comply with the plans and meet code requirements.
- ❑ Verify that the pins are fully driven and have a minimum penetration of 1/4" through the last material joined. No attempt should be made to reset underdriven pins; another pin should be installed in another location.
- ❑ Confirm that the pins have the protective coating as specified on the Plan for the project environmental conditions.

Welding

- ❑ All welding shall be in accordance with the "Structural Welding Code:," AWS D1, and "Structural Welding Code — Sheet Steel," AWS D1.3 for sheet steel. All welding shall be by certified welders, using E6013 or E71T11 electrodes adjusted to eliminate "burn through" in all light gauge steel materials.

Bolted Connections

- ❑ Review the Plans for size, type, and spacing of bolted connections. Bolts should meet or exceed the requirements of ASTM A307. Bolts shall be installed with nuts and washers. Center-to-center spacing of bolts connecting sheet metal material to concrete should be a minimum of three bolt diameters.
- ❑ At the foundation sill track, preset anchor bolts, expansion bolts, or epoxy bolts are to be installed per manufacturer specification. Pre-drilled holes in the sill track for preset bolts should not be oversized more than 1/16" for bolt sizes up to 1/2" diameter and no more than 1/8" for bolt sizes larger than 1/2" in diameter. No burned holes are permitted.

Low Velocity Fasteners

- ❑ Inspect the fastener type, spacing, and edge distance requirements for conformance to Plan.

Figure 21-1 (continued)

Inspection checklist for load-bearing cold-formed steel framing

Section II: Installation/Erection

Floor Joists

- ❑ Check floor joist members for span to make sure they conform with the Plans or prescribed building code. Check for multiple or single span joists and that they conform with the Plans.

Joist Stiffeners

- ❑ Check that bearing stiffeners conform with the Plan, prescribed building code, or other stiffening method approved by the Design Professional.

Joist Bracing

- ❑ Check to ensure that joist bracing is installed in accordance with the Plans, prescriptive building code, or other method approved by the Design Professional. Bracing may consist of gypsum board, steel strapping with blocking, or X-bracing.

Joist Splicing

- ❑ No joist splicing is permitted unless approved by a Design Professional. Joists lapped over an interior support are not considered spliced.

Joist Punchouts

- ❑ See the Plan or prescriptive building code for allowable punchout sizes and locations. Typically, punchouts should not be located closer than 10 inches from a bearing support.

Floor Cantilevers and Openings

- ❑ Shall be installed in accordance with the Plans, prescriptive building code, or other method approved by the Design Professional.

Floor Trusses

- ❑ Shall be installed in accordance with the manufacturer recommendations.

Figure 21-1 (continued)
Inspection checklist for load-bearing cold-formed steel framing

Walls

Bearing Stud Seating

- ❑ Check to ensure that load-bearing studs are seated tightly within the stud track. Gaps between the end of the stud and the track web shall be no greater than $1/8$".

C Stud seated in track

Bearing Stud Alignment

- ❑ Review the Plans to identify if the stud wall system indicated is either “in-line” or a “wall top plate distributor system” and that loads are properly transferred as appropriate to the system used.
- ❑ For “in-line framing,” where the roof trusses, rafter, and floor joists are aligned over a bearing stud, the acceptable tolerance for alignment is $3/4$" between the centerline of the bearing stud and centerline of the horizontal framing element.
- ❑ For the “wall top plate distributor” system, check to make sure the top track is properly framed following the Plans.

Foundation Connection

- ❑ Steel-framed walls should be anchored to foundations or floors in accordance with the Plans, prescriptive method, or other approved method.
- ❑ Load-bearing walls should be constructed in accordance with the Plans, prescriptive method, or other method approved by the Design Professional.

Bearing Wall Bracing

Lateral wall bracing of load-bearing walls should be in accordance with one of the following (as specified in the Plans):

- ❑ Gypsum board or structural sheathing;
- ❑ Horizontal steel strapping on both sides in accordance with the Plans or prescribed building code.
- ❑ A combination of the two above methods.

Figure 21-1 (continued)

Inspection checklist for load-bearing cold-formed steel framing

Splicing

- ❑ Studs and other structural members should not be spliced without an approved design. Track splices should be made continuous by means of splicing the track with an approved connection, as shown on the Plans or prescribed building code.

Shear Walls

- ❑ Review the approved drawing and identify the lateral load resisting shear wall system being used. This guide addresses only “sheathed” and “X-braced” shear walls.

Sheathed Shear Walls

Inspect the following:

- ❑ Panel sheathing type (i.e., structurally-rated plywood or OSB, per current building codes, or other approved sheathing as indicated by the Design Professional as to thickness and type);
- ❑ Roof diaphragm boundary to blocking fastener size, and spacing;
- ❑ Roof blocking to wall top track fastener size and spacing;
- ❑ Panel sheathing boundary, and field fastener size and spacing;
- ❑ Bottom wall track through floor diaphragm to rim track fastener size and spacing;
- ❑ Floor rim track to top wall track fastener size and spacing;
- ❑ Foundation track fastener type, size and spacing;
- ❑ Holddown size, location and fastener requirement.

“X-Braced” Shear Walls

- ❑ Confirm that diagonal straps are installed taut and remain taut after all dead loads have been placed on the walls.
- ❑ Verify all track and rim track connections as detailed in Sheathed Shear Walls above (as applicable).

D “X”-brace connection

Figure 21-1 (continued)

Inspection checklist for load-bearing cold-formed steel framing

Miscellaneous

- ❑ Verify that screws or pins are driven so that the head is no more than 1/16" below the surface of the sheathing;
- ❑ Confirm that all sheathing is installed with continuous strap or other approved blocking detail at horizontal intermediate panel edges (if applicable);
- ❑ Inspect edge fasteners at multiple studs to ensure that all are driven into the member connected to the holddown device (if applicable);
- ❑ Verify that the bottom track connection, to the foundation or structure, meets all requirements called out on the Plans;
- ❑ Verify that the blocking and/or shear transfer connections at the tops of the walls meet all requirements called out or detailed on the approved drawings;
- ❑ Confirm that all shear wall ends have boundary studs (typically, a minimum of 2), per current code assemblies, or as required by the Plan;
- ❑ Where holddowns are indicated, verify that all holddowns are attached through the webs of (2) studs.
- ❑ Where anchor bolts are used, verify that nuts and washers are properly installed.

Beams/Headers

Beam/Header Stud Composition and Support Studs

- ❑ Inspect the beams/headers to make sure they conform with the Plans, prescriptive building code, or method approved by the Design Professional. Inspect the members used to make built-up beams for punchouts or other penetrations. Beam penetrations should be allowed only with the approval of a Design Professional.

Beam Stiffeners

- ❑ Review the Plans or prescriptive building code for beam stiffener requirements. Unless otherwise noted, beams require stiffeners at the ends and at intermediate interior locations where point loads occur (i.e., girder truss bearing).

Figure 21-1 (continued)
Inspection checklist for load-bearing cold-formed steel framing

Trusses

Truss Chord and Web Members and Panel Points

- ❑ Check the plans for truss details. The plans may call for Pre-Engineered Trusses to be designed by others rather than the Design Professional, and therefore a separate set of truss shop drawings may be required by the Plans.
- ❑ Check these drawings for design loads, chord sizes, gauges, panel point connections, and number of fasteners to confirm compliance with the Plans. Also, verify that they contain the shop drawing review approval seal of the Engineer of Record.
- ❑ Check that connections of truss heel to top track conform with the Plans, prescriptive building code, or other method approved by the Design Professional.

Truss Bracing

- ❑ Reference the Plans and the Pre-Engineered Truss Shop Drawing Plans for specific requirements.

Truss Tail Holddown

- ❑ Check the Plans to determine if truss tail holddown connections are required. If required, the holddown typically will attach to the truss and to the aligned stud below.

Shear Connector Blocking at Exterior Bearing Walls

- ❑ Check the Plan details to determine if a strap, and intermediate blocking or continuous blocking, are required for the transfer of shear from the roof to wall diaphragms. If required, reference the Plans for specific requirements.

Utilities

In addition to the LGSEA Checklist, check these two elements of the utility installation:

- ❑ Copper pipe is isolated from steel using nonferrous material.
- ❑ Electrical wire is protected from sharp steel edges using bushings or grommets.

Figure 21-1 (continued)

Inspection checklist for load-bearing cold-formed steel framing

Chapter 22

Selling to the Homebuyer

Now that you've built your steel-framed spec house, how are you going to sell it? Experience around the country has shown that most homebuyers readily accept the idea of owning a house framed with steel — and that very little selling is necessary. Most buyers are looking at other features, not what framing material is hidden behind the drywall. When they understand the advantages like noncombustibility, durability, termite resistance and straighter walls, they usually have no problem embracing the idea of a steel-framed home. In fact, many prefer steel framing.

What *are* the two main concerns of the homebuyer? Experience has shown them to be:

- Does the house look like a home? In other words, does it look like a house that fits in the style of the neighborhood the buyers want to live in?
- Do they qualify for the mortgage?

What does that boil down to? Unless you're framing an upscale home, the steel-framed house must be cost-competitive with other houses on the market. The average buyer won't pay more for steel framing, in spite of the advantages. So build a quality house at a fair price, then sell it just like other builders sell their houses.

Marketing Tools

For those homeowners who want to know more about steel, start with a job site tour or a model display. See Figure 22-1. Some builders and developers give open houses, and set up displays to demonstrate the benefits of steel framing. This helps the potential homebuyer understand its benefits. Another way is to open up your job site for a tour of steel framing in progress, so the potential homebuyer can see the framing as it's going up.

Another way you can show the benefits of steel is to build a display in one of your model homes, like the one in Figure 22-2. I've seen some developers build wall sections and trusses out of both wood and steel and use them for comparison purposes. Some have gone the extra step of covering the mockups with Plexiglas and labeling the components of the walls.

Figure 22-1
Job site tour

Figure 22-2
Display of steel framing

Figure 22-3
Cut-out view in model home

Here's another suggestion. You can remove a small section of gypsum board in the hallway of a model home and frame it over with glass so the potential homebuyer can see the actual steel framing in the walls. Look at Figure 22-3.

There are also some other marketing tools you can explore. One of the basics is to hand out brochures or to show videos explaining the benefits a steel-framed house has to offer. Many of these are available from the North American Steel Framing Alliance. They are available for a nominal fee by calling 800-79-STEEL. They'll answer the questions your prospective buyers are likely to have.

Destroying the Myths

The fact is, the homebuyer can easily accept the idea of a steel-framed house. People generally understand the strength and durability of steel, so it's an easy feature to sell. However, you still may get bombarded with questions like:

- Will my steel-framed home attract lightning?
- How will it affect radio and TV reception?
- Will it expand and contract due to heat and cold?
- Will my house rust?

- Will my steel house look different?
- How do I hang a picture?

Let's look at how to answer those questions.

Lightning

Lightning tends to strike the highest object in the area, like a tree, telephone pole or flagpole. If you're unfortunate enough to have your house struck by lightning, there are many ground paths that the energy can follow, all leading to the ground. In a wood-framed house, it usually follows the electrical wiring or plumbing, taking out appliances along the way. Your steel-framed house is well grounded, so it should protect you better in a lightning strike than wood framing. Explain that you'll follow the building code requirements in your area to ground the electrical panel, and that the steel-framed house will not attract lightning.

Radio and TV Reception

Because steel studs are spaced on 16- or 24-inch centers, there's plenty of air space between the studs for radio waves to pass through. Steel framing doesn't prevent your house from receiving TV and radio waves.

Expansion and Contraction

It's true that steel tends to expand and contract due to fluctuations in temperature. But the member must be quite long to make a significant difference. If your house is exposed to major temperature changes, you'll need a joist or truss about 40 feet long to produce a significant expansion or contraction. For the most part, this doesn't occur in residential housing. If you have these conditions, you might want to consider an expansion joint to prevent gypboard cracking. Normally, the homebuyer doesn't need to worry about expansion or contraction.

Rust

As for rusting, just follow the coating recommendations in the *Prescriptive Method*. Under normal conditions, G60 will protect the structural members for the life of the home. If you live in a harsh environment, and have some members exposed to the environment, it may be advisable to bump up the coating weight to G90.

Explain to the customer that the metallic coating standards for steel framing protect the steel for the life of the home. Once the framing is enclosed in the wall, it's protected because it takes water to make steel or zinc corrode. In the absence of water, there won't be any rust. If water gets into the wall cavity, you will have a problem — but you'll also have a problem with a wood-framed wall if it gets wet.

Appearance

Your steel-framed house shouldn't look any different from any other houses being built in your neighborhood. The architectural styles can remain the same; you're only substituting the wood-framing members with steel ones. You may be able to open up the interior with greater spans and open spaces, but the overall look should be the same. Whether you're building a southwestern ranch, an eastern colonial, or an island bungalow, your steel-framed house should have the same look and feel as the wood or concrete houses in that region. See Figure 22-4. If it doesn't, you may have a difficult time selling your home.

Hanging Pictures

Of course, the number one question every homebuyer is concerned about when it comes to steel framing is: "How do I hang a picture?" If they don't want to use a metal screw at a stud location, there is a little 3-cent insert to handle that problem (Figure 22-5). They screw into the drywall and provide an opening for a screw to be inserted. You might even throw in a package as a bonus.

Conclusion

Many builders are attracted to steel framing, especially when lumber prices increase. If you do your homework, you can overcome most — if not all — of the obstacles there are today. You're now familiar with the *Prescriptive Method* that will soon be in all the model building codes. You'll know what tools are

A California

B Maryland

C Hawaii

Figure 22-4
Steel-framed houses

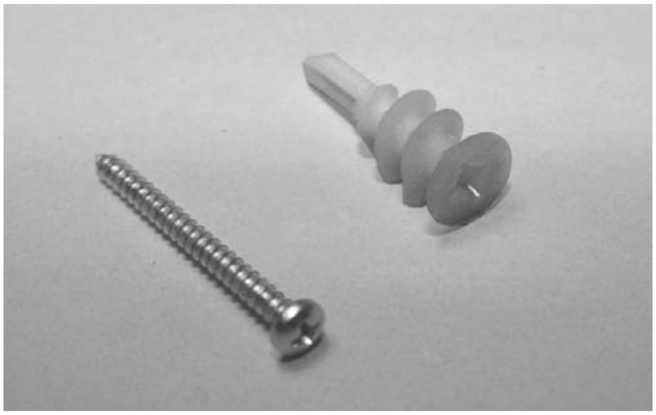


Figure 22-5
Plastic insert

best to use and the importance of training. You'll know how to order steel and how to work with the roll-formers or distributors. And you'll know what to do to meet the Model or State Energy Code in your area (see Chapter 18).

Those who don't do their homework usually have a bad experience. Then they blame the bad experience on steel instead of their poor planning. The more you learn about steel framing before you even pick up a screw gun, the easier it will be to make the transition.

The techniques, details, fasteners, and tools that support steel framing are rapidly evolving. A better idea, detail, or tool may soon replace the information in this handbook. Keep in touch with the North American Steel Framing Alliance or a Steel Framing Alliance in your area. They'll have new information in the years ahead as residential steel framing increases in popularity.

If you need more information, call one (or more) of these organizations for help:

North American Steel Framing Alliance
1-800-79-STEEL — Publications
(202) 785-2200 — General information

Hawaii Steel Alliance
(808) 485-1400

Southern California Steel Framing Alliance
(760) 634-5696

Midwest Steel Framing Alliance
(414) 529-8448

Southeastern Steel Framing Alliance
(850) 475-3023

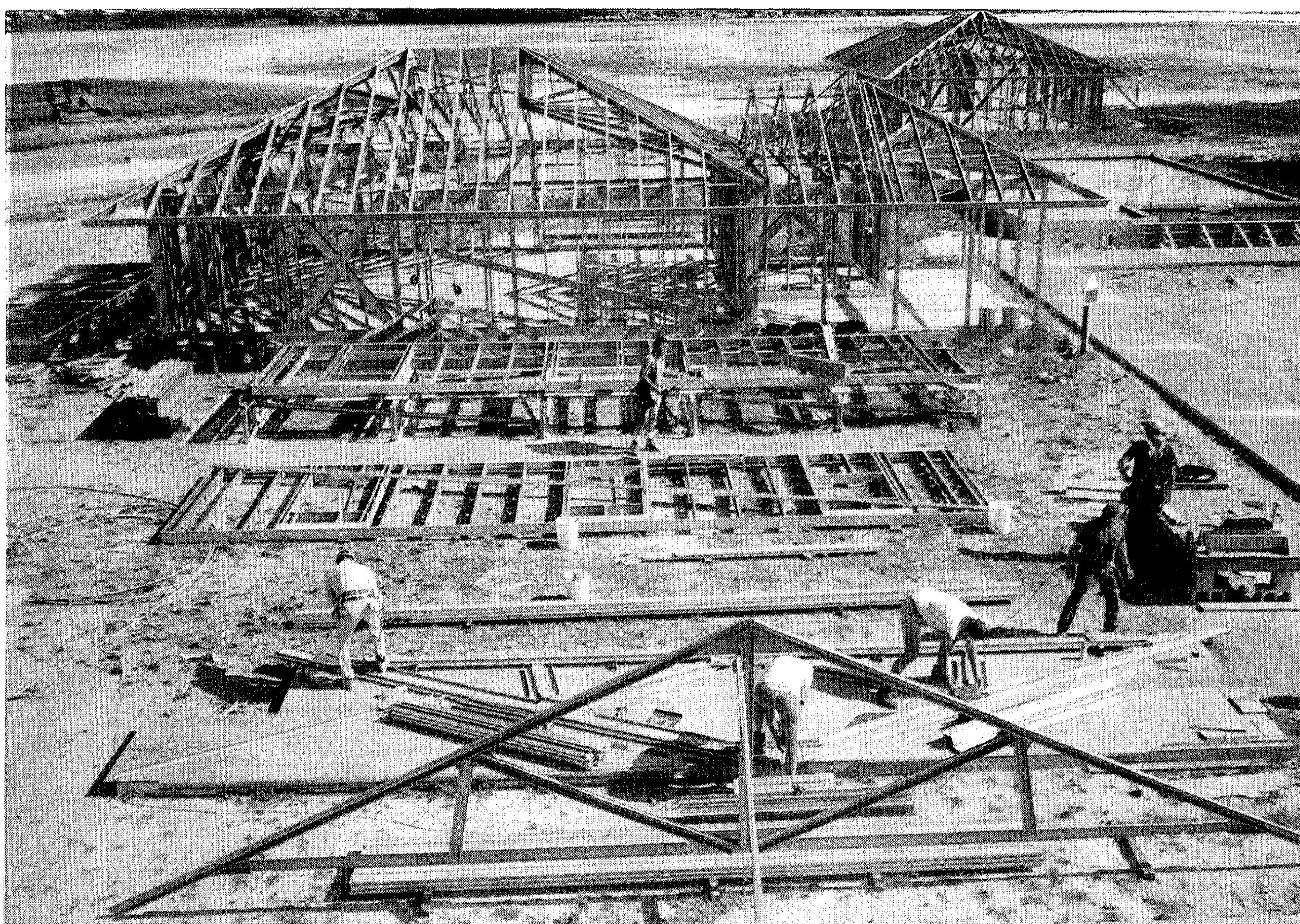
South West Steel Framing Alliance
(512) 472-3276

Texas Steel Framing Alliance
(512) 472-3276

LGSEA (Light Gauge Steel Engineers Assn.)
(202) 785-2022

And good luck with your steel framing projects!

Prescriptive Method for Residential Cold-Formed Steel Framing
Second Edition



Prescriptive Method for Residential Cold-Formed Steel Framing

Second Edition

August 1997

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Prescriptive Method for Residential Cold-Formed Steel Framing

Second Edition

Foreword

For centuries home builders in the United States have made wood their material of choice because of its satisfactory performance, abundant supply, and relatively low cost. However, recent increases and unpredictable fluctuations in the price of framing lumber, as well as concerns with its quality, are causing builders and other providers of affordable housing to seek alternative building products.

Use of cold-formed steel framing in the residential market has increased over the past several years. Its price stability, consistent quality, similarity to conventional framing, successes in the commercial market, and resistance to fire, rot, and termites have attracted the attention of many builders and designers. However, lack of prescriptive construction requirements has prevented this alternative material from gaining wider acceptance among home builders and code officials.

This publication was developed by the American Iron and Steel Institute with guidance from the AISI Prescriptive Methods Subcommittee of the Residential Advisory Group. The development of this publication was funded by the American Iron and Steel Institute, the U.S. Department of Housing and Urban Development (HUD), and the National Association of Home Builders (NAHB) through a 4-year research and development program that was conducted by the NAHB Research Center with assistance and input from steering, advisory, and engineering committees. These committees represented interests of steel manufacturers, steel producers, code officials, academics, researchers, professional engineers, and builders experienced in cold-formed steel framing. This document intended to provide designers, builders, and contractors with guidance on the use of cold-formed steel framing in the construction of one- and two-family residential dwelling. AISI believes the information contained in this publication substantially represents industry practice and related scientific and technical information, but the information is not intended to represent an official position of AISI or to restrict or exclude any other construction or design technique.

The second edition of the *Prescriptive Method for Residential Cold-Formed Steel Framing* facilitates the construction of steel-framed housing and thereby expands housing affordability through competition from new methods and materials. It also provides cold-formed steel suppliers and consumers with standardized requirements for steel framing materials that will enhance market acceptance and promote consistent user application. Finally, this report provides code officials and inspectors with the guidance necessary to perform their duties in the home construction process when cold-formed steel is utilized.

American Iron and Steel Institute
August 1997

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CONTENTS

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF FIGURES

LIST OF FIGURES (Continued)

Executive Summary

The *Prescriptive Method for Residential Cold-Formed Steel Framing (Prescriptive Method)* was developed as a guideline for the construction of one- and two-family residential dwellings using cold-formed steel framing. It provides a complete prescriptive approach to build typical homes with cold-formed steel framing. This document standardizes the basic cold-formed steel members, provides labeling guidelines, and gives minimum corrosion protection requirements. It also includes floor joist span tables, ceiling joist span tables, rafters span tables, wall stud tables, wall bracing requirements, and connection requirements. The requirements are supplemented with construction details where required. A commentary is available under separate cover and serves the following purposes:

- documentation of rationale and decisions behind various provisions;
- guidance on the use of the provisions; and
- documentation of engineering calculations and judgments.

This second edition includes improvements upon the previous edition in the following areas:

- Added and revised definitions;
- Expanded hole (web penetration) sizes for floor joists;
- Revised hole (web penetration) spacing requirements for studs;
- Wall bracing requirements for high wind and seismic conditions, (See Commentary);
- Roof Uplift (tie-down) requirements;
- New wall stud tables for 50 ksi steels;
- New header table for bottom story of a two-story building with center load bearing beam;
- New floor and wall anchoring details;
- Added details for non-load bearing walls; and,
- Ceiling joist tables not requiring web stiffeners.

The *Prescriptive Method* is consistent with the intent of current U.S. building code provisions, engineering standards, and industry specifications, but it is not written as a regulatory document. To the greatest extent possible, the *Prescriptive Method* is written in a style to facilitate code adoption.

INTRODUCTION

The *Prescriptive Method for Residential Cold-Formed Steel Framing (Prescriptive Method)* is provided as a guideline to facilitate the use of cold-formed steel framing in the construction of one- and two-family residential dwellings. The second edition of the *Prescriptive Method* expands on and enhances the requirements of the provisions of the first edition. It provides a complete prescriptive approach to build typical homes with cold-formed steel framing; therefore, engineering will not be necessary for most applications. The provisions in this document were developed by applying accepted engineering practices. It is intended to be compatible with building code provisions, but it is not written as a regulatory instrument. However, users of this document should verify its compliance with local code requirements. The user is advised to refer to the applicable building code requirements where the provisions of this document are not applicable or where engineered design is called out.

1.0 GENERAL

1.1 Purpose

The purpose of this document is to provide prescriptive requirements for the construction of residential buildings framed with cold-formed steel. These provisions include definitions, span tables, fastener schedules, and other related information appropriate for use by home builders, design professionals, and building code officials.

1.2 Approach

These requirements are based primarily on the American Iron and Steel Institute's (AISI) *Specification for the Design of Cold-Formed Steel Structural Members* [1] for member strength, the provisions for building loads from the American Society of Civil Engineers' (ASCE) *Minimum Design Loads for Buildings and Other Structures* [2], the *Standard Building Code* [3], the *Uniform Building Code* [4], and the *BOCA National Building Code* [5].

These provisions are intended to represent sound engineering and construction practice. This document is not intended to restrict the use of good judgment or exact engineering analysis of specific applications which may result in improved designs and economy. A commentary documenting the rationale for and the derivation of the requirements contained in this document is available under a separate cover [6].

1.3 Scope

These provisions apply to the construction of detached one- or two-family dwellings, townhouses, and other attached single-family dwellings not more than two stories in height using in-line framing practices. Steel-framed construction in accordance with this prescriptive method shall be limited by the applicability limits set forth in Table 1.1. The limitations are intended to define an appropriate use of this document for a majority of one- and two-family dwellings. Intermixing of these provisions with other construction materials, such as wood, in a single structure shall be in accordance with the applicable building code requirements for that material and the applicability limits set forth in Table 1.1.

Table 1.1
Applicability Limits

ATTRIBUTE	LIMITATION
General	
Building Dimension	Maximum width [1] is 36 feet (11 m) Maximum length [2] is 60 feet (18 m)
Number of Stories	2 story
Design Wind Speed	110 mph maximum (177 km/sec) fastest-mile wind speed [except as noted for wall bracing] [3]
Wind Exposure	Exposures C (open terrain) Exposures A/B (suburban/wooded)
Ground Snow Load	70 psf (3.35 kN/m^2) maximum ground snow load
Seismic Zone	Zone 4 maximum [except as noted for wall bracing] [3]
Floors	
Floor dead load	10 psf (0.48 kN/m^2) maximum
Floor live load First floor Second floor (sleeping rooms)	 40 psf (1.92 kN/m^2) maximum 30 psf (1.44 kN/m^2) maximum
Cantilever	24 inches (610 mm) maximum
Walls	
Wall dead load	10 psf (0.48 kN/m^2) maximum
Load bearing wall height	10 feet (3 m) maximum
Roofs	
Roof dead load	12 psf (0.48 kN/m^2) maximum total load [7 psf (0.34 kN/m^2) maximum for roof covering only]
Roof live load	70 psf (3.35 kN/m^2) maximum ground snow load
Ceiling dead load	5 psf (0.24 kN/m^2) maximum
Roof slope	3:12 to 12:12
Rake overhang	12 inches (305 mm) maximum
Soffit overhang	24 inches (610 mm) maximum
Attic live load (for attics with storage) Attic live load (for attics without storage)	20 psf (0.96 kN/m^2) maximum 10 psf (0.48 kN/m^2) maximum

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 mph = 1.61 km/hr = 0.447 m/sec, 1 foot = 0.3 m.

1 Building width is in the direction of horizontal framing members supported by the wall studs.
2 Building length is in the direction perpendicular to floor joists, ceiling joists, or roof trusses.
3 See the Commentary for additional guidance on wall bracing requirements in high wind and seismic conditions [6].

1.4 Definitions

Accepted Engineering Practice: An engineering approach that conforms with accepted principles, tests, technical standards, and sound judgment.

Approved: Approval by a code official or design professional.

Attic: The enclosed space between the ceiling joists of the top floor and the roof rafters of a building not intended for occupancy, but sometimes used for storage.

Axial Load: The longitudinal force acting on a member. Examples are the gravity loads carried by columns or studs.

Blocking: Solid block or piece of material placed between structural members to provide lateral bracing as in bridging and/or edge support for sheathing.

Bridging: Cross bracing or blocking placed between joists to provide lateral support.

Buckling: A kink, wrinkle, bulge, or otherwise loss of the original shape of a member due to compressive, bending, bearing, or shear loads.

Ceiling Joist: A horizontal structural framing member which supports a ceiling and attic loads.

C-Shape: A basic cold-formed steel shape used for structural framing members (such as studs, joists, headers, beams, girders, and rafters). The name comes from the member's "C" shaped cross-sectional configuration consisting of a web, flange and lip. It is also called a "C-section". Figure 1.1 shows this cross-section and defines the different parts of the C-Shape. Web depth measurements are taken to the outside of the flanges. Flange width measurements also use outside dimensions.

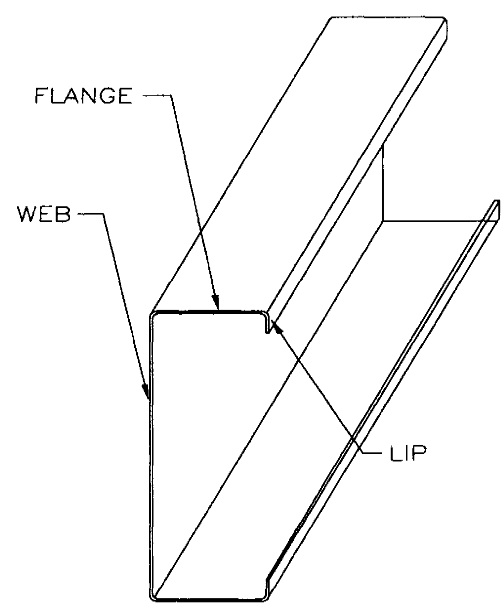

Figure 1.1 C-Shaped Member Configuration

Clip Angle: An L-shaped short piece of metal (normally with a 90 degree bend). It is typically used for connections.

Cold-forming: A process where light-gauge steel members are manufactured by (1) press-braking blanks sheared from sheets or cut length of coils or plates, or by (2) continuous roll forming of cold- or hot-rolled coils of sheet steel; both forming operations are performed at ambient room temperature, that is, without any addition of heat such as would be required for hot forming.

***Cripple Stud*:** A stud that is placed between a header and a window sill (or jamb) or a window sill and a bottom track to provide a backing to attach finishing and sheathing material.

Design Professional: An architect or engineer, registered or licensed to practice professional architecture or engineering, as defined by the statutory requirements of the laws of the state in which a project is to be constructed.

Endwall: The exterior wall of a building which is perpendicular to the roof ridge and parallel to floor framing, roof rafters or trusses. Normally the shorter dimension of a rectangular building's footprint.

***Facia*:** A track member applied to the rafter ends as an edge member for attachment of roof sheathing, exterior finishes, or gutter.

***Flange*:** The part of a C-Shape or track that is perpendicular to the web.

Flat Strap: Sheet steel cut to a specified width without any bends. Typically used for bracing and transfer of loads by tension.

***Floor Joist*:** A horizontal structural framing member that supports floor loads.

***Header*:** A horizontal built-up structural framing member used over wall or roof openings to transfer loads above the opening to adjacent vertical framing members.

***In-Line Framing*:** Framing method where all vertical and horizontal load carrying members are aligned. Refer to Figure 1.2.

***Jack Stud*:** A vertical structural member that does not span the full height of the wall and provides bearing for headers. Sometimes referred to as trimmer studs.

King Stud: A vertical structural member that spans the full height of the wall and supports vertical loads and lateral loads. Usually located at both ends of a header adjacent to the jack studs.

Lip: The part of a C-Shape which extends from the flange at the open end. The lip increases the strength characteristics of the member and acts as a stiffener to the flange.

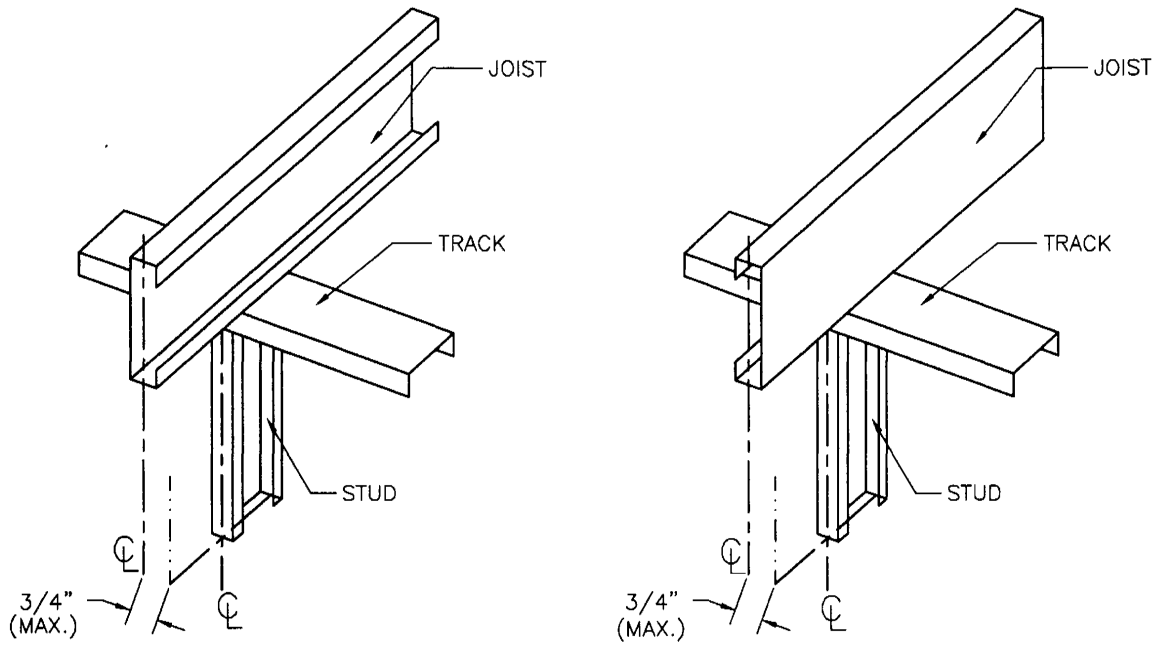

Figure 1.2 In-Line Framing Detail

Loads, Live and Dead: Dead loads are the weight of the walls, partitions, framing, floors, ceilings, roofs, and all other permanent construction entering into and becoming a part of a building. Live loads are transient and sustained loads usually created by people and furnishing, respectively.

Material Properties (steel): The chemical, mechanical, and physical properties of steel before or after the cold-forming process.

Material Thickness (steel): The base metal thickness excluding any protective coatings. Thickness is now commonly expressed in mils (1/1000 of an inch).

Metallic Coated Steel: Steel that has a metallic coating for protection against corrosion. The level of protection provided is measured by the weight of the metallic coating applied to the surface area of the steel. Typical metallic coatings are galvanizing, galvalume, or galfan which are zinc based.

Mil: A unit of measurement used in measuring the thickness of thin steel elements. One mil equals 1/1000 of an inch (e.g. 33 mil = 0.033 inch).

Multiple Span: The span made by a continuous member having intermediate supports.

Non-Load Bearing Walls (Non-structural walls): Refer to Walls.

Punchout (or hole) : An opening in the web of a steel framing member allowing for the installation of plumbing, electrical, and utilities. A punchout or hole may be made during the manufacturing process or in the field with a hand punch, hole saw, or other suitable tool.

Rafter: A structural framing member (usually sloped) which supports roof loads.

Rake Overhang: The horizontal projection of the roof measured from the outside face of a gable endwall to the outside edge of the roof.

Ridge: The horizontal line formed by the joining of the top edges of two sloping roof surfaces.

Seismic Zone: Seismic Zones designate areas with varying degrees of seismic risk and associated seismic design parameters (i.e. effective peak ground acceleration). Seismic Zones 1, 2, 3, and 4 correspond to effective peak ground acceleration of 0.1g, 0.2g, 0.3g, and 0.4g, respectively (1g is the acceleration of the earth's gravity at sea level).

Shearwall: A vertical wall assembly capable of resisting lateral forces to prevent racking from wind or seismic loads acting parallel to the plane of the wall.

Sidewall: The exterior wall of a building parallel to the roof ridge which supports roof rafters or trusses.

Single Span: The span made by one continuous structural member without any intermediate supports.

Span: The clear horizontal distance between bearing supports.

Structural Sheathing: The covering (e.g. plywood or oriented strand board) used directly over structural members (e.g. studs or joists) to distribute loads, brace walls, and generally strengthen the assembly.

Stud: Vertical structural element of a wall assembly which supports vertical loads and/or transfers lateral loads.

Track: Used for applications such as top and bottom plate for walls and band or rim joists for flooring systems. A track has a web and two flanges, but no lips. Track web depth measurements are taken to the inside of the flanges. Refer to Figure 1.3.

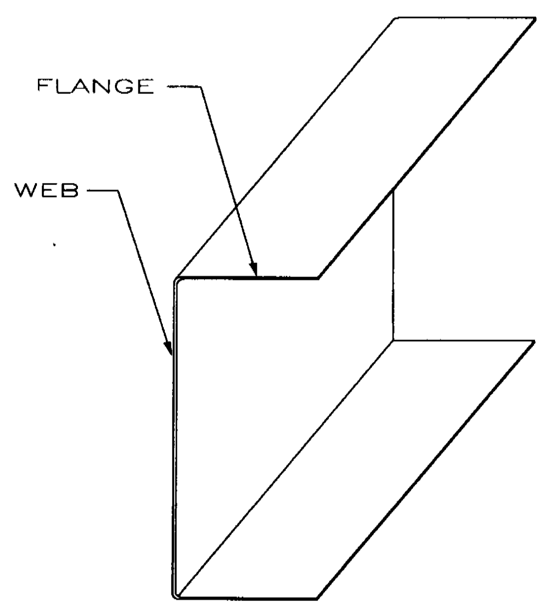

Figure 1.3 Track Section Configuration

Truss: An engineered structural component designed to efficiently carry its own weight and superimposed design loads. The truss members form a triangular structural framework.

Walls:

Structural or load bearing: Wall systems subject to loads that exceed the limits for a non-structural system (e.g. wall studs).

Non-Structural or non-load bearing: Wall systems that are limited to 10 psf (0.479 kN/m^2) maximum lateral (transverse) load and/or limited, exclusive of sheathing materials, to 100 pounds (450 N) per lineal foot (0.3 m) or 200 pounds (900 N) maximum superimposed vertical load per member (e.g. interior partitions).

Web: The part of a C-Shape or track that connects the two flanges.

Web Crippling: The localized permanent (inelastic) deformation of the web member subjected to concentrated load or reaction at bearing supports.

Web Stiffener: Additional material that is attached to the web to strengthen the member against web crippling. Also called a bearing stiffener.

Wind Exposure: Wind exposure is determined by site conditions that affect the actual wind speeds experienced at a given site. For the purpose of this document, Exposures A/B represent urban or suburban areas or wooded terrain and Exposure C represents open terrain with scattered obstructions.

***Wind Speed*:** Wind speed is the design wind speed related to winds that are expected to be exceeded once every 50 years at a given site (i.e. 50 year-return period). Wind speeds in this document are given in units of miles per hour (mph) by "fastest-mile" measurements.

Yield Strength: A characteristic of the basic strength of the steel material. It is the highest unit stress that the material can endure before permanent deformation occurs as measured by a tensile test in accordance with ASTM A 370 [7].

Figure 1.4 is provided as an overall view of residential steel framing and the basic components.

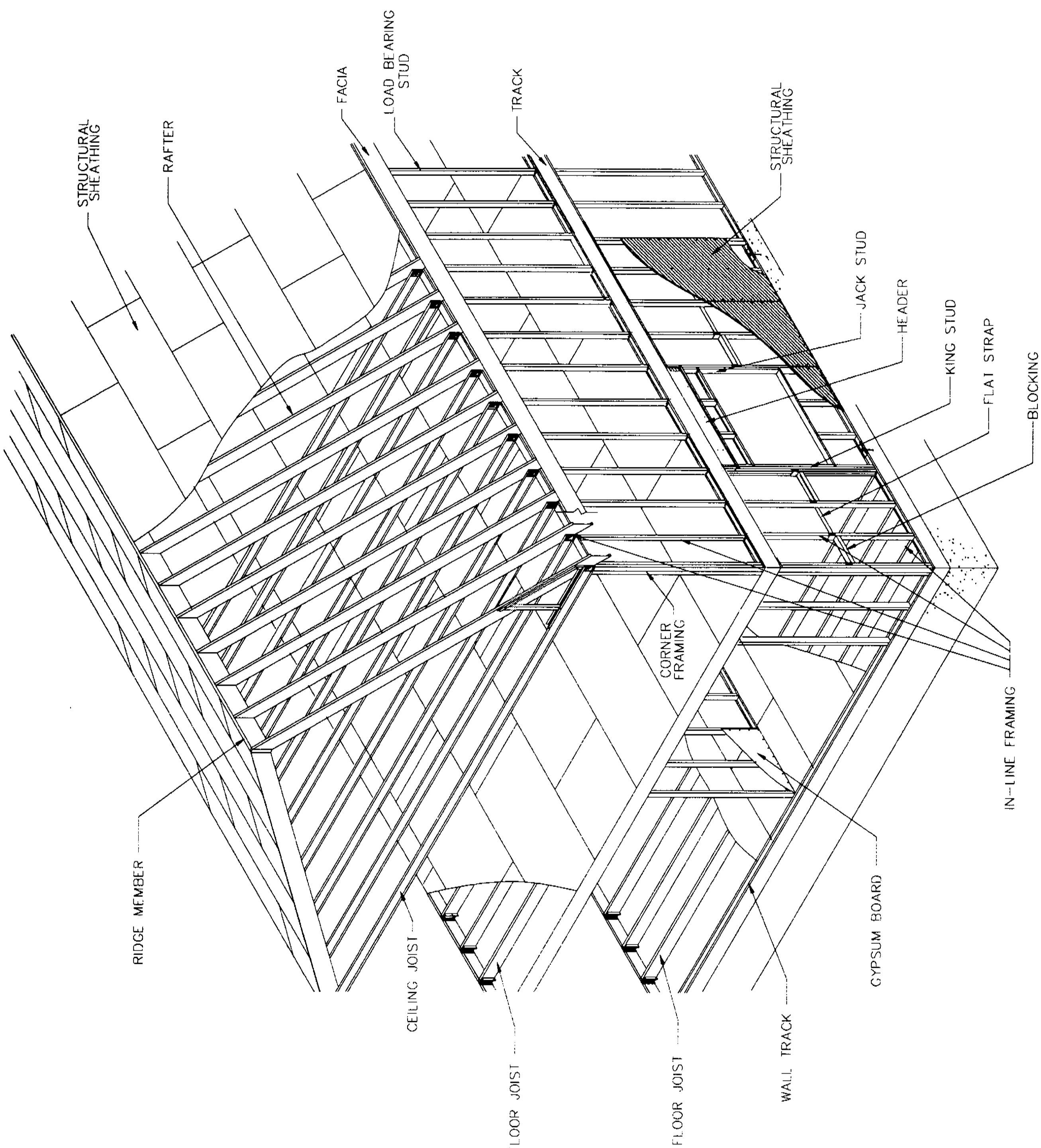

Figure 1.4 Schematic of Typical Steel Framed Building

2.0 MATERIALS, SHAPES, AND STANDARD SIZES

2.1 Types of Cold-Formed Steel

2.1.1 Structural Members

Load bearing steel framing members shall be cold-formed to shape from structural quality sheet steel complying with the requirements of one of the following:

1 ASTM A 653 [8]: Grades 33, 37, 40, & 50 (Class 1 and 3); or

2. ASTM A 792 [9]: Grades 33, 37, 40, & 50A; or

3. ASTM A 875 [10]: Grades 33, 37, 40, & 50 (Class 1 and 3); or

4. Steels that comply with ASTM A 653 [8], except for tensile and elongation requirements, shall be permitted provided the ratio of tensile strength to yield point is at least 1.08 and the total elongation is at least 10 percent for a two-inch gage length or 7 percent for an eight-inch gauge length.

2.1.2 Non-Structural Members

Non-structural members shall comply with ASTM C-645 [12] and Section 7.0.

2.2 Physical Dimensions

Cold-formed structural steel members shall comply with Figure 2.1 and the dimensional requirements specified in Table 2.1. In addition, tracks shall comply with Figure 2.2 and shall have a minimum of 1-1/4 inch (32 mm) flanges. Members with different geometrical shapes shall not be used with these provisions without the approval of a design professional. Dimensional Tolerances shall be in accordance with ASTM C955 [11] for load bearing members and ASTM C645 [12] for non-load bearing members.

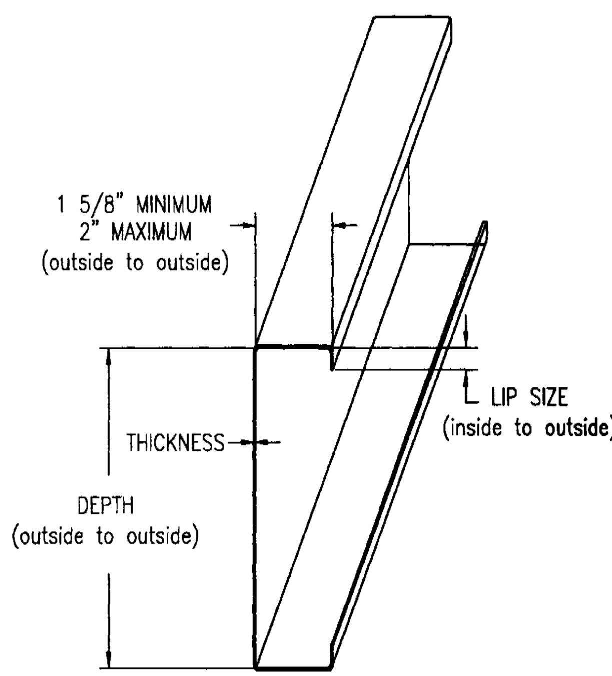

Figure 2.1 C-Shaped Member Dimensions

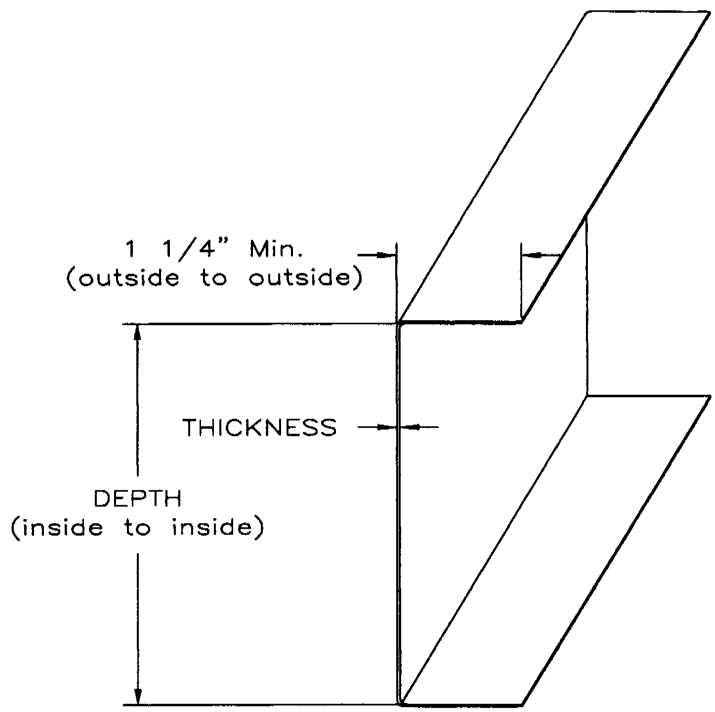

Figure 2.2 Track Section Dimensions

Table 2.1
Cold-Formed Steel Member Sizes

Nominal Member Size	Industry Designator[1]	Web Depth (inches)	Minimum Flange Width (inches)	Maximum Flange Width (inches)	Minimum Lip Size (inches)
2 x 4	350S162-t	3.5	1.625	2	0.5
2 x 6	550S162-t	5.5	1.625	2	0.5
2 x 8	800S162-t	8	1.625	2	0.5
2 x 10	1000S162-t	10	1.625	2	0.5
2 x 12	1200S162-t	12	1.625	2	0.5

For SI: 1 inch = 25.4 mm.

1 "t" is the uncoated material thickness in mils. "S" indicates a C-Shaped member for stud and joist applications. Track sections shall use the designator "T" instead of "S".

2.3 Uncoated Material Thickness

The material thickness of steel framing members in their end-use shall meet or exceed the minimum (uncoated) thickness values given in Table 2.2.

Table 2.2
Minimum Thickness of Cold-Formed Steel Members

Designation (mils)	Minimum Steel Thickness (inches)	Reference Gauge Number
18	0.018	25
27	0.027	22
33	0.033	20
43	0.043	18
54	0.054	16
68	0.068	14
97	0.097	12

For SI: 1 inch = 25.4 mm, 1 mil = 0.0254 mm.

2.4 Bend Radius

The maximum bend radius shall be the greater of 3/32 inch (2.4 mm) or two times the material thickness (2t).

2.5 Yield Strength

The yield strength of steel shall be determined in accordance with ASTM A370 [7]. Unless otherwise specified as 50 ksi (345 MPa), the minimum yield strength (or yield point) of cold-formed steel for C-Shapes, tracks, flat straps, and other members shall be 33 ksi (228 MPa).

2.6 Corrosion Protection

Cold-formed structural steel framing members identified in accordance with this document shall have a minimum metallic coating complying with Table 2.3.

Table 2.3
Minimum Coating Requirements

Steel Component	Reference ASTM Standard		
	A653 / A 653M [8]	A 792 / A 792M [9]	A 875 / A 875M [10]
Structural	G60	AZ50	GF60
Non- structural	G40	AZ50	GF45

Other approved metallic coatings shall be permitted provided the alternate coatings can be demonstrated to have a corrosion resistance that is equal to or greater than the corresponding hot-dipped galvanized coatings (i.e. G40 and G60) and provide protection at cut edges, scratches, etc., by cathodic or sacrificial protection.

The minimum coating designations shown in Table 2.3 assume normal exposure conditions and construction practices. Cold formed steel members used in buildings located in harsh environments (e.g. coastal areas) may require greater corrosion protection (e.g. G90).

Steel framing members shall be located within the building envelope and adequately shielded from direct contact with moisture from the ground or the outdoor climate.

2.6.1 Compatibility With Other Metals

Copper materials shall not be used in direct contact with metallic coated steel members or components. Metallic coated steel shall not be embedded in concrete, unless approved for that purpose.

2.7 Web Holes

Holes in webs (or punchouts) of floor and ceiling joists shall comply with the requirements of Figure 2.3 and Table 2.4. Holes in webs of studs, headers, rafters, and other structural steel members shall comply with the requirements of Figure 2.4 and Table 2.5. Holes shall be permitted only along the centerline of the web of the framing member. Holes with minimum edge (or end) distances violating the values shown in Tables 2.4 or 2.5 shall be patched in accordance with Section 2.8.

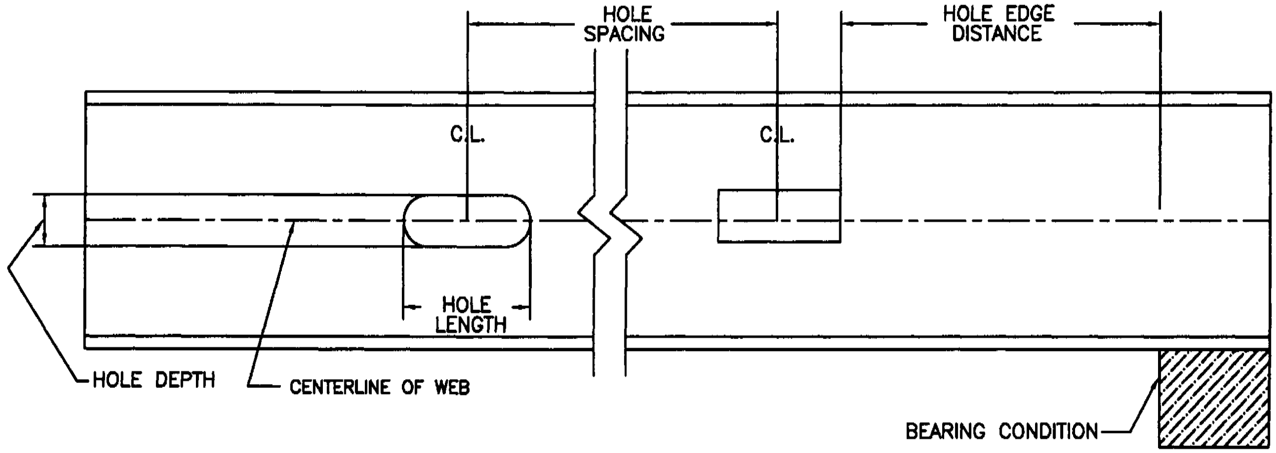

Figure 2.3 **Floor and Ceiling Joist Web Holes**

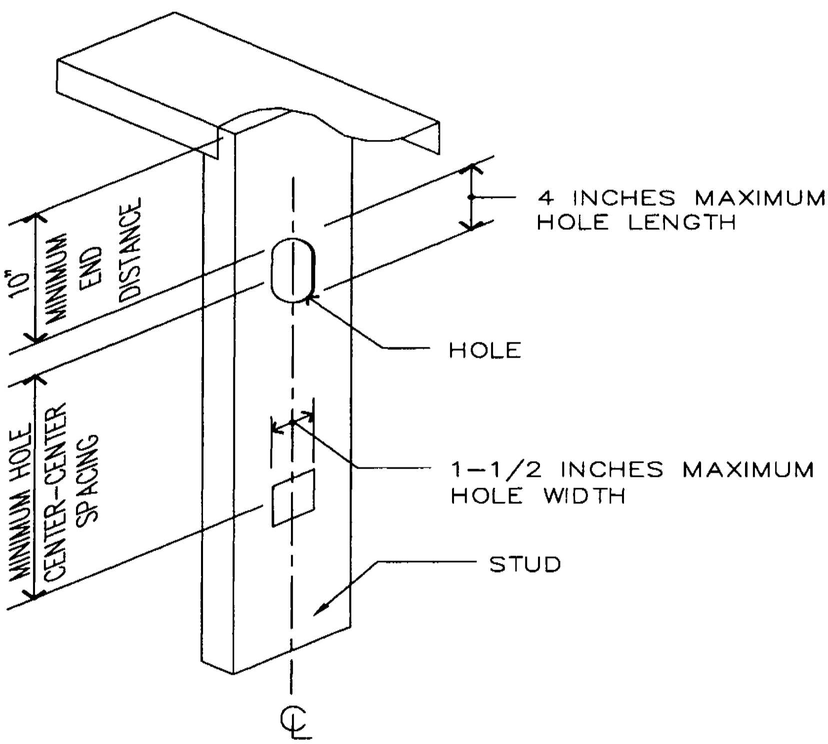

Figure 2.4 **Holes in Studs and Other Structural Members**

Table 2.4
Maximum Hole Dimensions and Spacing in Floor & Ceiling Joist Webs

Nominal Member Size	Maximum Hole Depth [1] (inches)	Maximum Hole Length [2] (inches)	Minimum Hole Spacing [3] (inches)	Minimum Edge Distance [4] (inches)
2 x 6 x 33	2	5.25	16.5	3
2 x 6 x 43				
2 x 6 x 54				
2 x 6 x 68				
2 x 6 x 97				
2 x 8 x 33	1.5	4	24	10
2 x 8 x 43	3	6	24	3.5
2 x 8 x 54				
2 x 8 x 68				
2 x 8 x 97				
2 x 10 x 43	1.5	4	24	10
2 x 10 x 54	4	6	24	3.5
2 x 10 x 68				
2 x 10 x 97				
2 x 12 x 43	1.5	4	24	10
2 x 12 x 54				
2 x 12 x 68	4.75	6	24	3.5
2 x 12 x 97				

For SI: 1 inch = 25.4 mm

1 The dimension of the hole measured across the depth of the joist web.
2 The dimension of the hole measured along the length of the joist.
3 Spacing is the center-to-center distance between holes.
4 Edge distance is measured from the edge of the hole to the edge of bearing support.

Table 2.5
Maximum Hole Dimensions and Spacing for Structural Members Other Than Floor & Ceiling Joists

Nominal Member Size	Maximum Hole Depth [1] (inches)	Maximum Hole Length [2] (inches)	Minimum Hole Spacing [3] (inches)	Minimum End Distance [4] (inches)
2 x 4 x 33	1.5	4	7	10
2 x 4 x 43				
2 x 4 x 54				
2 x 4 x 68				
2 x 4 x 97				
2 x 6 x 33	1.5	4	11	10
2 x 6 x 43				
2 x 6 x 54				
2 x 6 x 68				
2 x 6 x 97				
2 x 8 x 33	1.5	4	16	10
2 x 8 x 43				
2 x 8 x 54				
2 x 8 x 68				
2 x 8 x 97				
2 x 10 x 43	1.5	4	20	10
2 x 10 x 54				
2 x 10 x 68				
2 x 10 x 97				
2 x 12 x 43	1.5	4	24	10
2 x 12 x 54				
2 x 12 x 68				
2 x 12 x 97				

For SI: 1 inch = 25.4 mm

1 The dimension of the hole measured across the depth of the member.
2 The dimension of the hole measured along the length of the member.
3 Spacing is the center-to-center distance between holes.
4 End distance is measured from the edge of the hole to the end of the member.

2.8 Cutting, Notching, and Hole Patching

Flanges and lips of joists, studs, headers, rafters, ceiling joists, and other structural members shall not be cut or notched. Web holes violating the minimum edge (or end) distance, maximum hole depth, maximum hole length, or minimum spacing requirements set forth in Tables 2.4 and 2.5 shall be patched with a solid steel plate, stud, joist, or track section in accordance with Figures 2.5 or 2.6. The steel patch shall be of a thickness equivalent to or greater than the receiving member and shall extend a minimum of 1-inch (25 mm) beyond all edges of the hole. The steel patch shall be fastened to the web of the receiving member with #8 screws (minimum) spaced no greater than 1-inch (25 mm) center-to-center along the edges of the patch with minimum edge distance of 1/2 inch (13 mm).

Structural members shall be replaced when web holes exceed the following size limits:

a. the depth of the hole, measured across the web, exceeds half the depth of the web; and,

b. the length of the hole measured along the web, exceeds 6 inches (152 mm) or the depth of the web, whichever is greater.

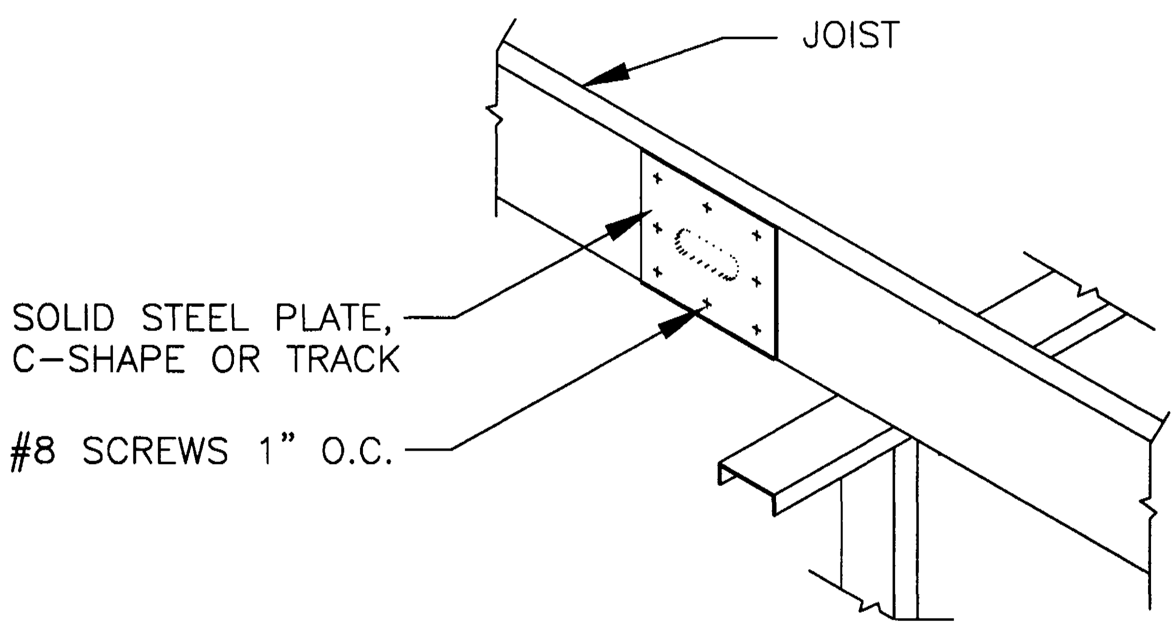

Figure 2.5 Joist Web Hole Patch

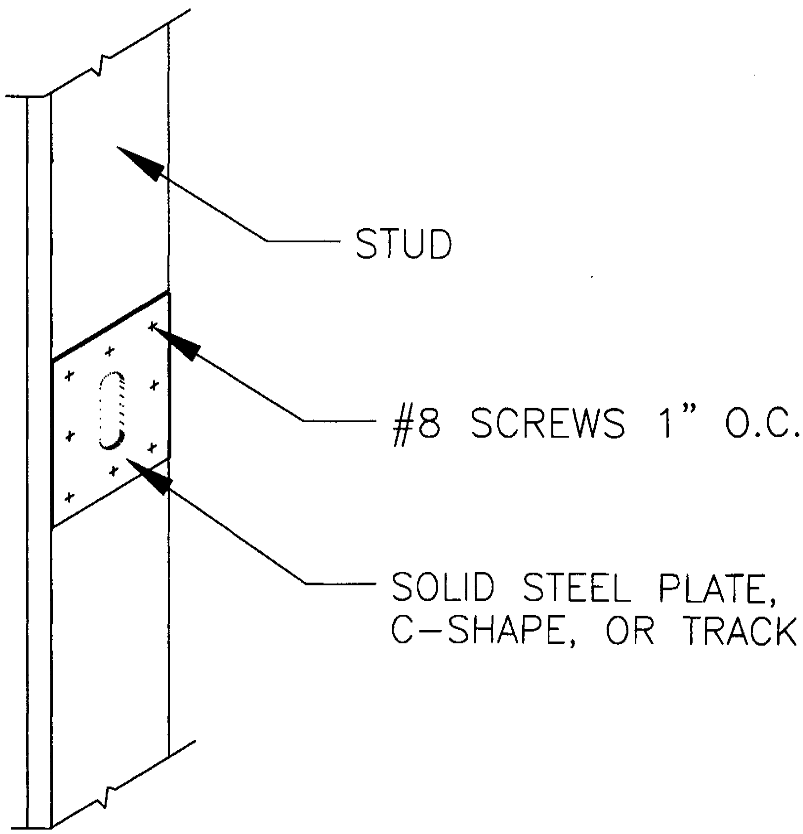

Figure 2.6 Stud Web Hole Patch

2.9 Bearing Stiffeners

A bearing stiffener (also referred to as web stiffener) shall be fabricated from a minimum 33 mil (0.836 mm) C-Shaped member or 43 mil (1.09 mm) track section. Each stiffener shall be fastened to the web of the member it is stiffening with a minimum of four #8 screws equally spaced as shown in Figure 2.7. Bearing stiffeners shall extend across the depth of the web and shall be installed on one side of the member.

2.10 Clip Angles

Clip angles shall be a minimum of 2 inches x 2 inches by 33 mil (51 mm x 51 mm x 0.84 mm), unless otherwise noted. All clip angle materials shall comply with Sections 2.1.1, 2.5, and 2.6.

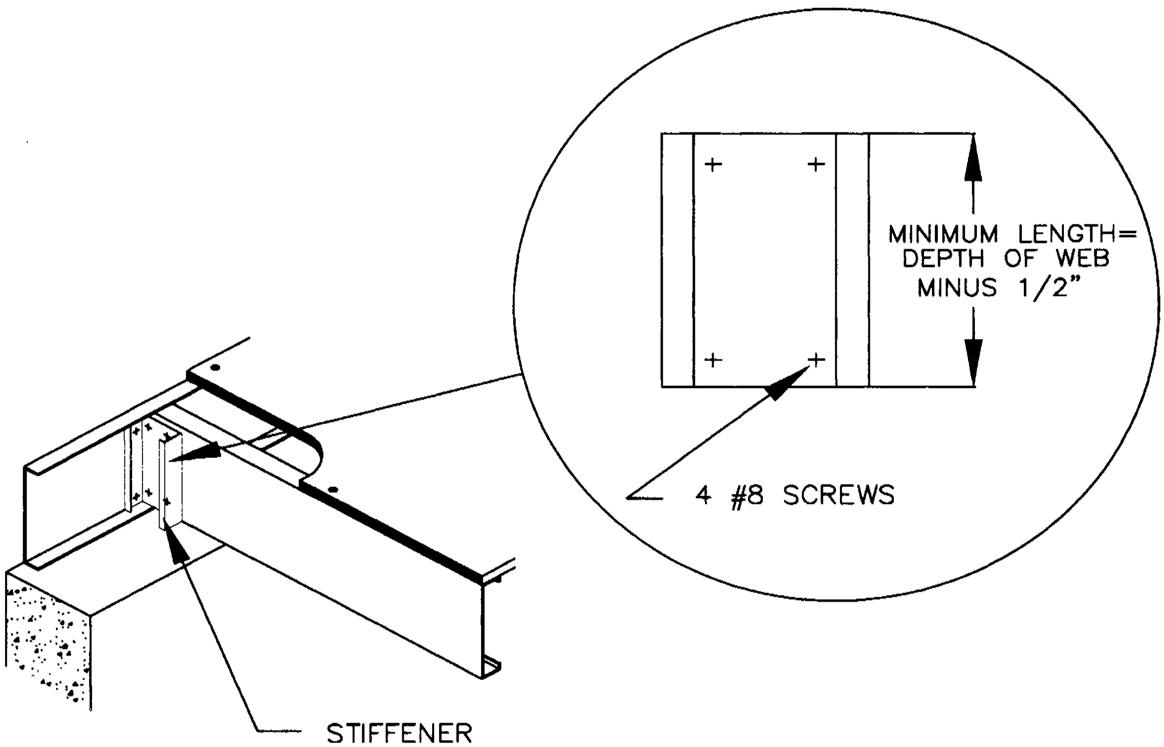

Figure 2.7 Bearing Stiffener

2.11 Fasteners

Fasteners shall comply with Sections 2.11.1 and 2.11.2. Other fastening techniques, such as the use of pneumatically driven fasteners, powder actuated fasteners, crimping, clinching, or welding, shall be permitted when approved.

2.11.1 Screws

For all connections, screws shall extend through the steel a minimum of three exposed threads. Screws shall penetrate individual components of connections without causing permanent separation between the components. Screws shall be installed in a manner such that the threads and/or holes are not stripped. All self-drilling tapping screws, on exterior building surfaces, shall have a Type II coating in accordance with ASTM B633 [13] or equivalent corrosion protection.

Screws for steel-to-steel connections shall be installed with a minimum edge distance and center to center spacing of 1/2 inch (13 mm), and shall be self-drilling tapping in compliance with SAE J78 [14]. The minimum screw size for steel to steel connections shall comply with Table 2.6.

Structural sheathing shall be attached to steel framing (i.e. studs and joists) with minimum #8 self-drilling tapping screws in compliance with SAE J78 [14]. Screws attaching structural sheathing to steel joists and wall framing shall have a minimum head diameter of 0.292 inch (7 mm) with countersunk heads, shall be installed with a minimum edge distance of 3/8 inch (9 mm) and shall comply with Table 2.6. Gypsum board shall be attached to steel joists or steel wall framing with minimum #6 screws conforming to ASTM C 954 [15] and shall be installed in accordance with the applicable building code requirements for interior wall and ceiling finishes.

Table 2.6
Minimum Screw Sizes For Steel-to-Steel and Structural Floor Sheathing-to-Steel Connections

Point Style	Minimum Screw Size	Total Thickness of Steel [1] (inches)
2	# 8	0.100 max.
2	# 10	0.110 max.
2	# 12	0.140 max.
3	# 8	0.140 max.
3	# 10	0.175 max.
3	# 12	0.210 max.

For SI: 1 inch = 25.4 mm.

1 The combined thickness of all connected steel members.

2.11.2 Bolts

Bolts shall meet or exceed the requirements of ASTM A307 [16]. Bolts shall be installed with nuts and washers. Center-to-center spacing of bolt holes connecting sheet metal material to concrete shall be a minimum of three bolt diameters. Distance from the center of the bolt hole to the edge of the connecting member shall not be less than one and one-half bolt diameters.

3.0 LABELLING

Load-bearing steel framing members shall have a legible label, stamp, stencil, or embossment, spaced at a minimum of 48 inches on center along the length of the member, with the following minimum information:

a. Manufacturer's identification;
b. Minimum uncoated steel thickness in decimal inches (example 0.043 in.);
c. Minimum coating designation; and,
d. Minimum yield strength in kips per square inch (ksi).

An example of an acceptable label : ABC 0.043 G60 33 ksi

4.0 FOUNDATION

The building foundation shall comply with the applicable building code. Steel framing shall be attached to the foundation structure according to the requirements of Sections 5 and 6 of this document. Foundation anchor bolts shall be located not more than 12 inches (305 mm) from corners or the termination of bottom tracks (e.g. at door openings or corners).

5.0 STEEL FLOOR FRAMING

5.1 Floor Construction

Cold-formed steel framing members shall comply with the provisions of Section 2.0. Steel floors shall be constructed in accordance with this section and Figure 5.1.

5.1.1 Applicability Limits

The applicability limits of Section 1.3 and Table 1.1 shall apply.

5.1.2 In-Line Framing.

Load bearing steel floor framing, wall framing, and ceiling/roof framing shall be constructed in-line with the vertical load bearing members (i.e. studs) located below. A maximum tolerance of 3/4 inch (19 mm) between the centerlines of the in-line members shall be permitted in accordance with Figure 1.2.

5.2 Floor to Foundation or Bearing Wall Connection

Cold-formed steel floor framing shall be anchored to foundations, wood sills, or load bearing walls in accordance with Table 5.1 and Figures 5.1 through 5.10. Fastening of steel joists to other framing members shall be in accordance with Table 5.2.

5.3 Allowable Joist Spans

The clear span of cold-formed steel floor joists shall not exceed the limits set forth in Table 5.3 for single spans and Table 5.4 for multiple spans. When continuous joist members are used for multiple spans, the interior bearing supports shall be located within two feet (0.6 m) of mid-span of the steel joists, and the individual spans shall not exceed the applicable spans in the table. Floor joists shall have a bearing support length of not less than 1.5 inches (38 mm) for exterior wall supports and 3.5 inches (89 mm) for interior wall supports. Bearing stiffeners shall be installed at each joist bearing location in accordance with Section 2.9. The thickness of joist tracks shall be a minimum of 33 mils (0.84 mm) thick except when used as part of floor header or trimmer in accordance with Section 5.7.

5.4 Joist Bracing

The top flanges of floor joists shall be laterally braced by the application of floor fastened to the joists in accordance with Table 5.2. Floor joists with spans that exceed 12 feet (3.7 m) shall have the bottom flanges laterally braced in accordance with one of the following:

1. Gypsum board installed with minimum #6 screws in accordance with the

applicable building code, or

2. Continuous steel strapping installed in accordance with Figure 5.1 and 5.2. Steel straps shall be at least 1-1/2 inches (38 mm) in width and 33 mils (0.84 mm) in thickness. Straps shall be fastened to the bottom flange of each joist with at least one #8 screw and shall be fastened to blocking with at least two #8 screws. Blocking or bridging (X-bracing) shall be installed between joists at a maximum spacing of 12 feet (3.7m) measured along the continuous strapping (perpendicular to the joist run). Blocking or bridging shall also be located at the termination of all straps.

5.5 Floor Cantilevers

Floor cantilevers for the second floor of a two-story building or the first floor of a one-story building shall not exceed 24 inches (610 mm) as illustrated in Figure 5.1. Cantilevers shall support interior floor loading only. Cantilevers, not exceeding 24 inches (610 mm) and supporting one floor and roof (first floor of a two story building), shall be permitted provided that all cantilevered joists are doubled (nested or back-to-back). The doubled cantilevered joists shall extend a minimum of 6 feet (1.8 m) toward the inside and shall be fastened with a minimum of two #8 screws spaced at 24 inches (610 mm) on center through the webs (for back-to-back) or flanges (for nested joists). Approved design is required for cantilevered areas supporting uniform live loads greater than 40 psf (1.92 kN/m^2).

5.6 Splicing

Joists and other structural members shall not be spliced without an approved design. Splicing of tracks shall conform with Figure 5.11.

5.7 Framing of Floor Openings

Openings in floors shall be framed with header and trimmer joists. Header joist spans shall not exceed 8 feet (2.4 m) in length. Header and trimmer joists shall be fabricated from joist and track sections, which shall be of a minimum size and thickness as the adjacent floor joists and shall be installed in accordance with Figures 5.1, 5.12, and 5.13. Each header joist shall be connected to trimmer joists with a minimum of four 2 inch x 2 inch (51 mm x 51 mm) clip angles. Each clip angle shall be fastened to both the header and trimmer joists with four #8 screws evenly spaced on each leg of the clip angle. The clip angles shall have a thickness not less than that of the floor joist.

5.8 Floor Trusses

Cold-formed steel floor trusses shall be designed, braced, and installed in accordance with an approved design. Truss members shall not be notched, cut, or altered in any manner unless by an approved design. All trusses shall be aligned with load carrying members (i.e. studs) in the wall. Refer to AISI publication RG-9518 [17] "*Design Guide For Cold-Formed Steel Trusses*" for additional guidance.

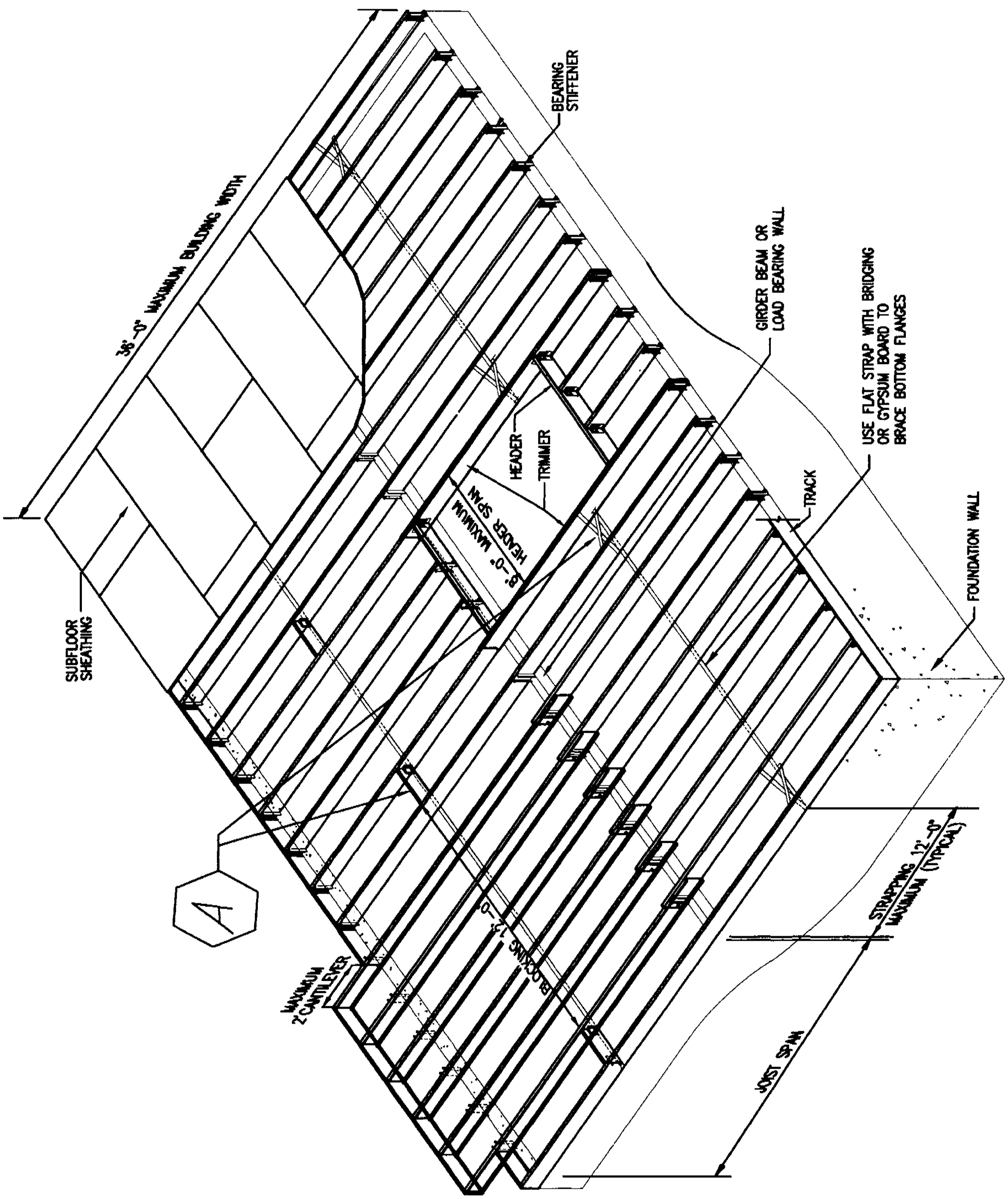

Figure 5.1 Steel Floor Construction

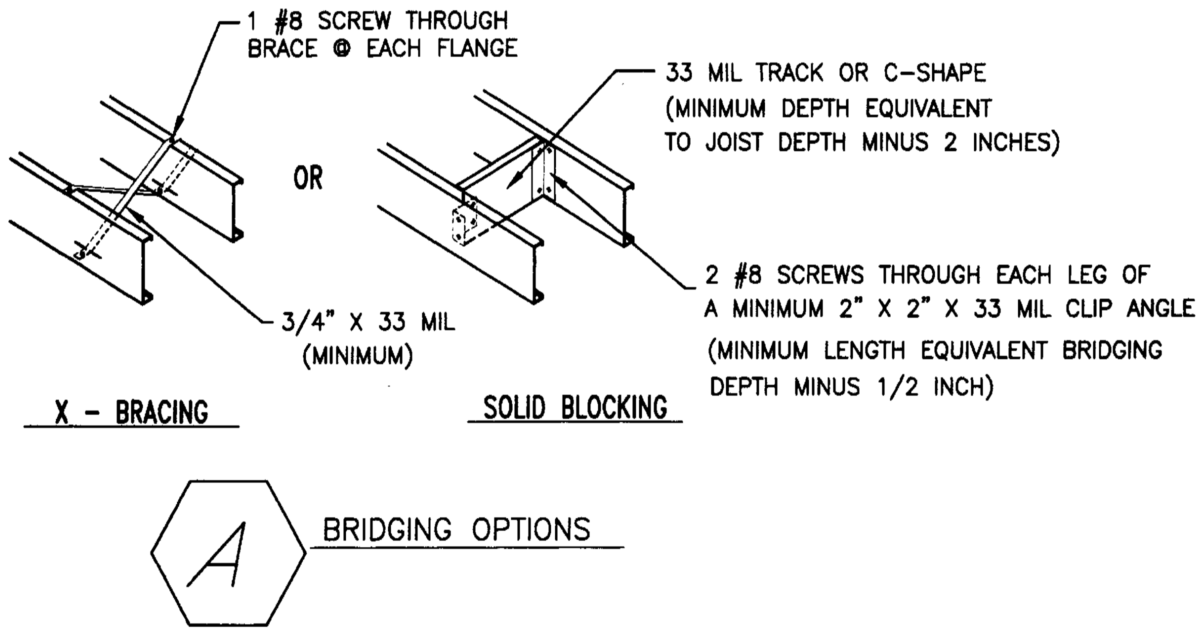

Figure 5.1 (cont'd) **Steel Floor Construction**

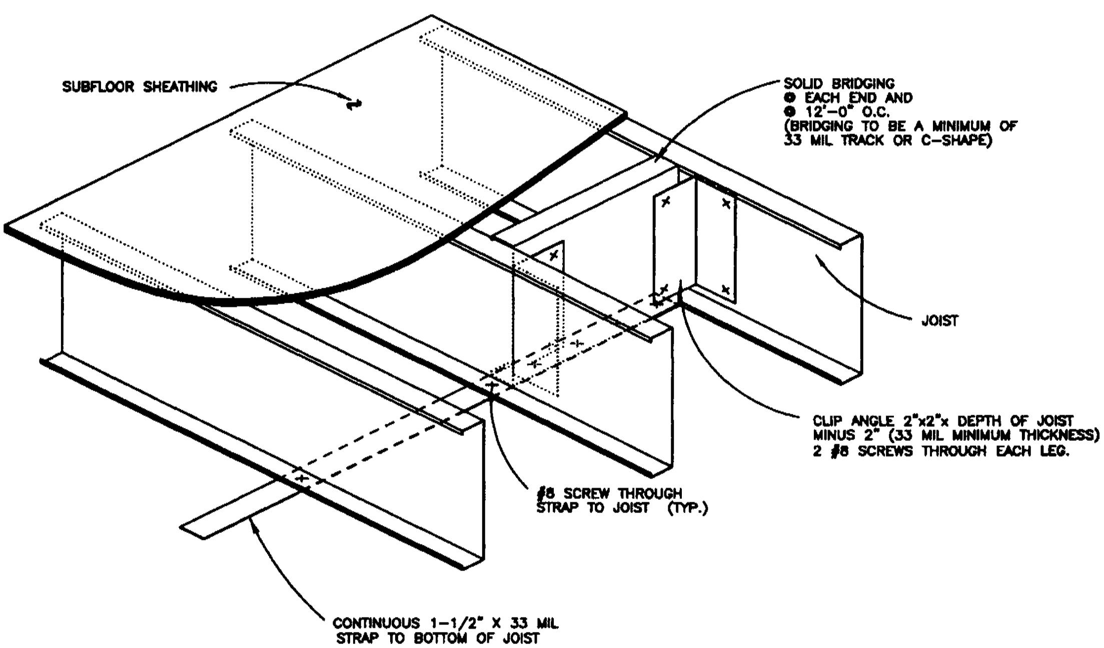

Figure 5.2 **Steel Floor Bracing**

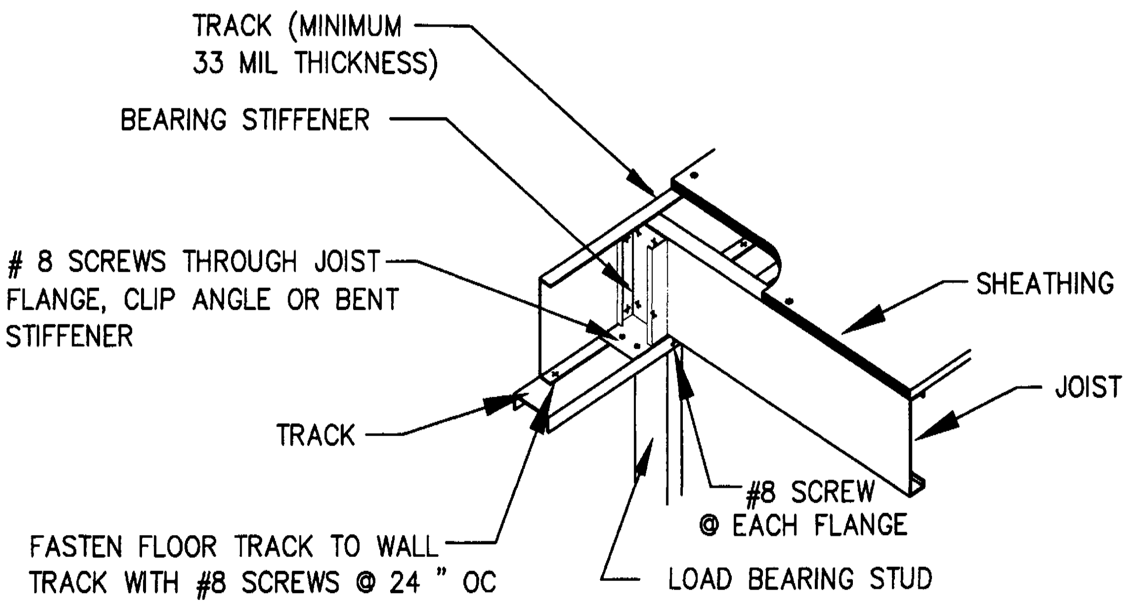

Figure 5.3 **Floor to Exterior Load Bearing Wall Connection**

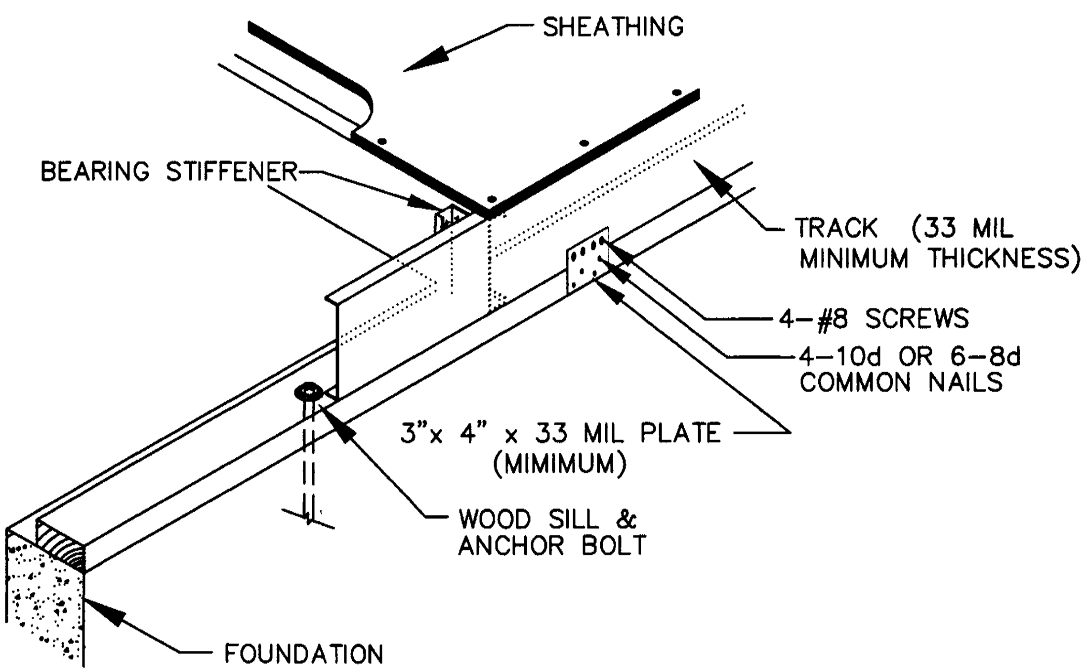

Figure 5.4 **Floor to Wood Sill Connection**

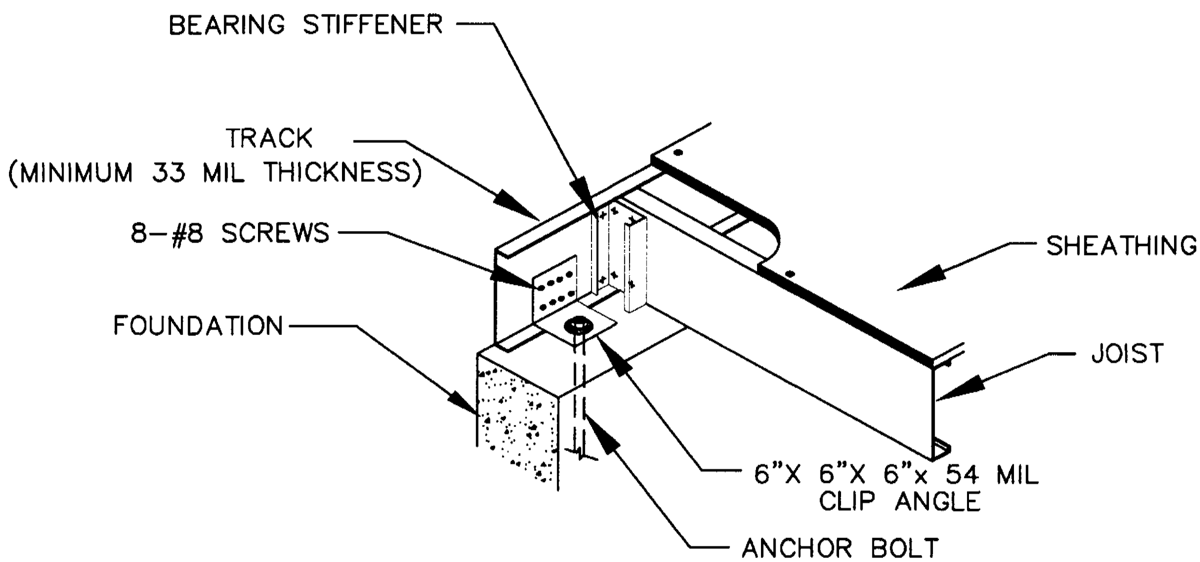

Figure 5.5 **Floor to Foundation Connection**

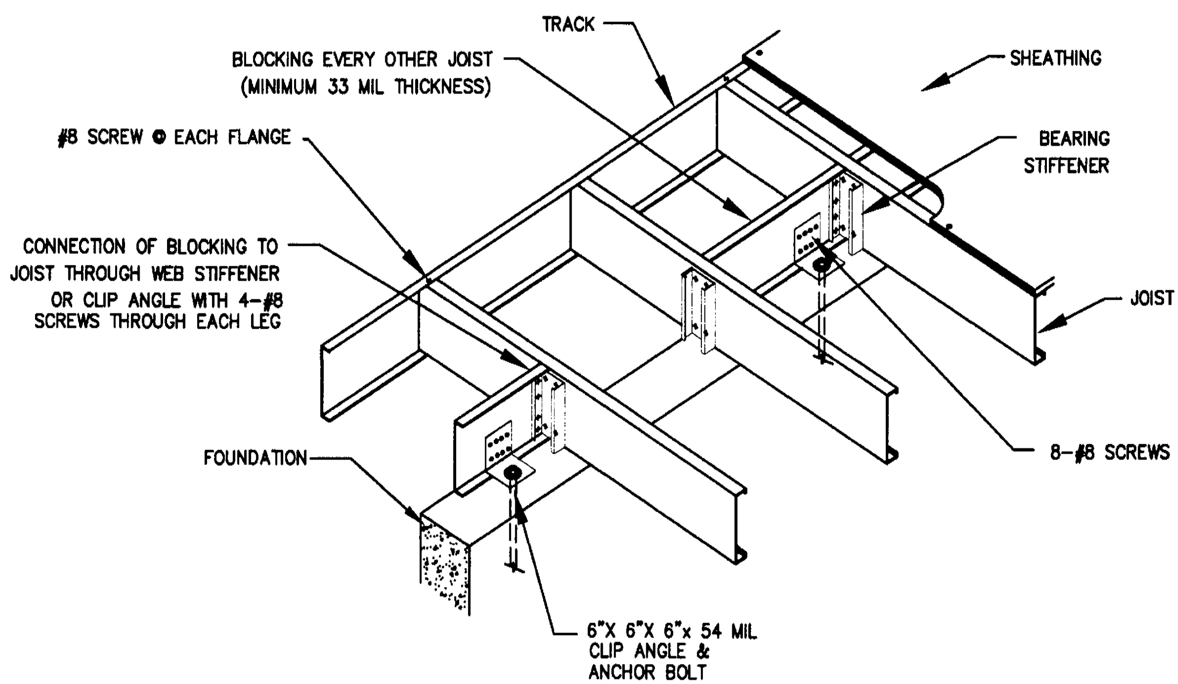

Figure 5.6 **Cantilevered Floor to Foundation Connection**

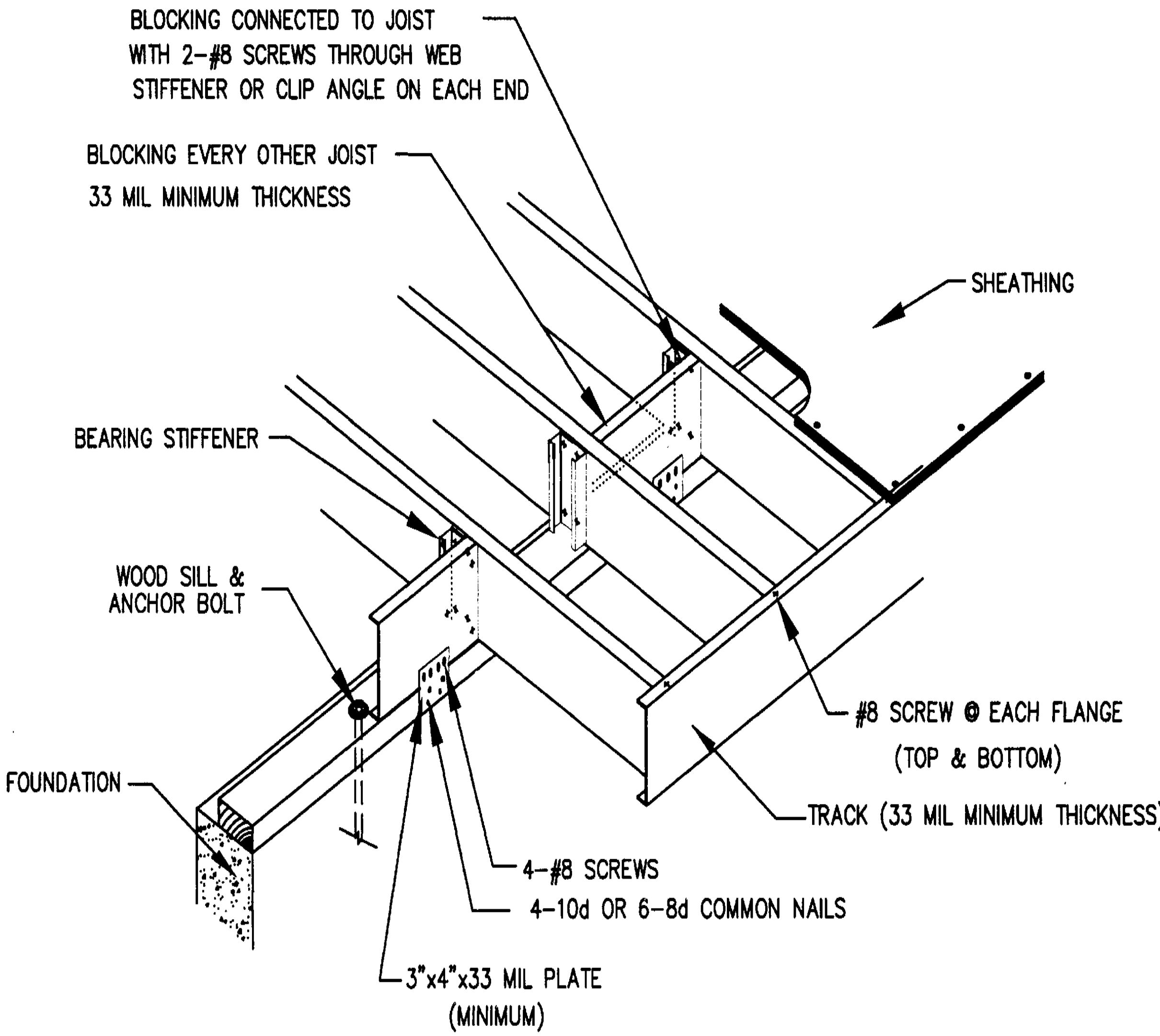

Figure 5.7 **Cantilevered Floor to Wood Sill Connection**

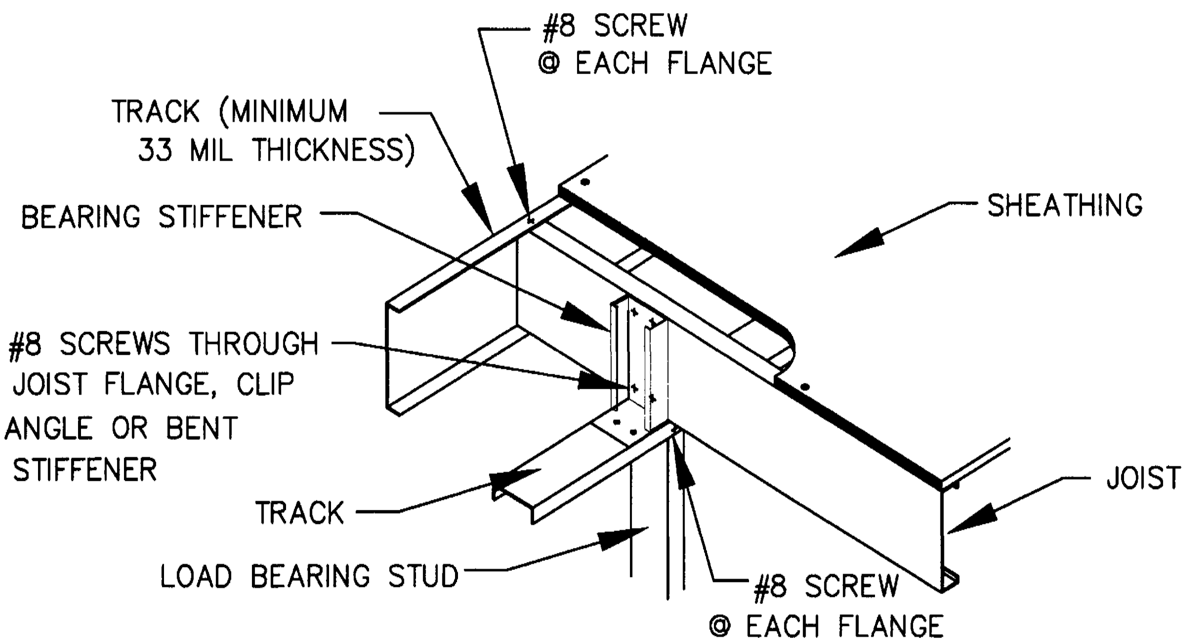

Figure 5.8 **Cantilevered Floor to Exterior Load Bearing Wall Connection**

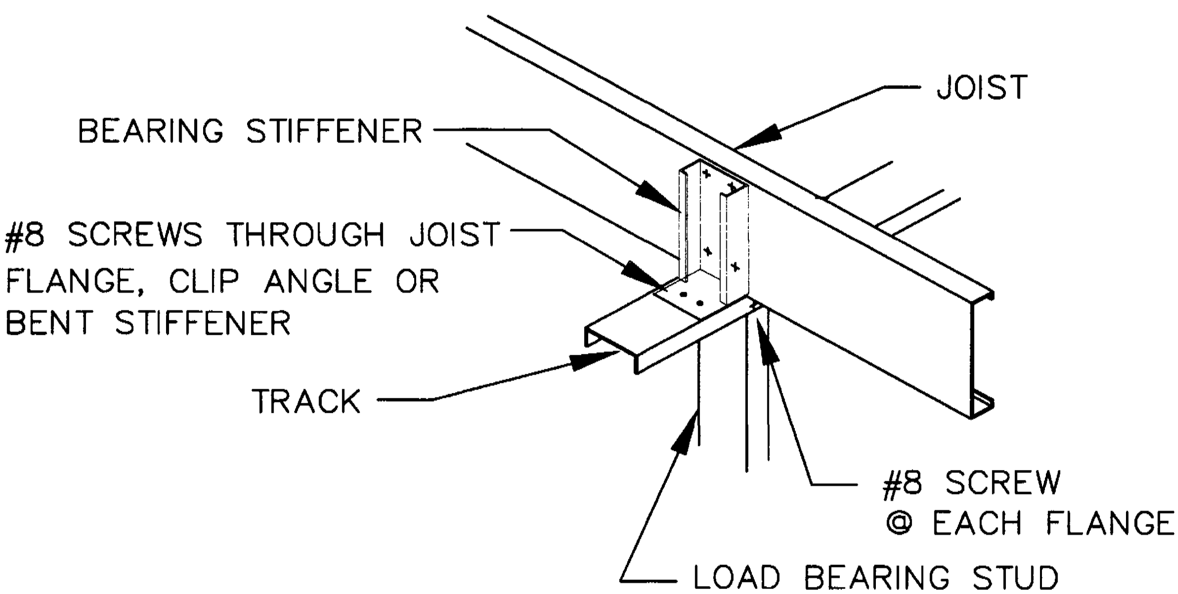

Figure 5.9 **Continuous Span Joist Supported on an Interior Load Bearing Wall**

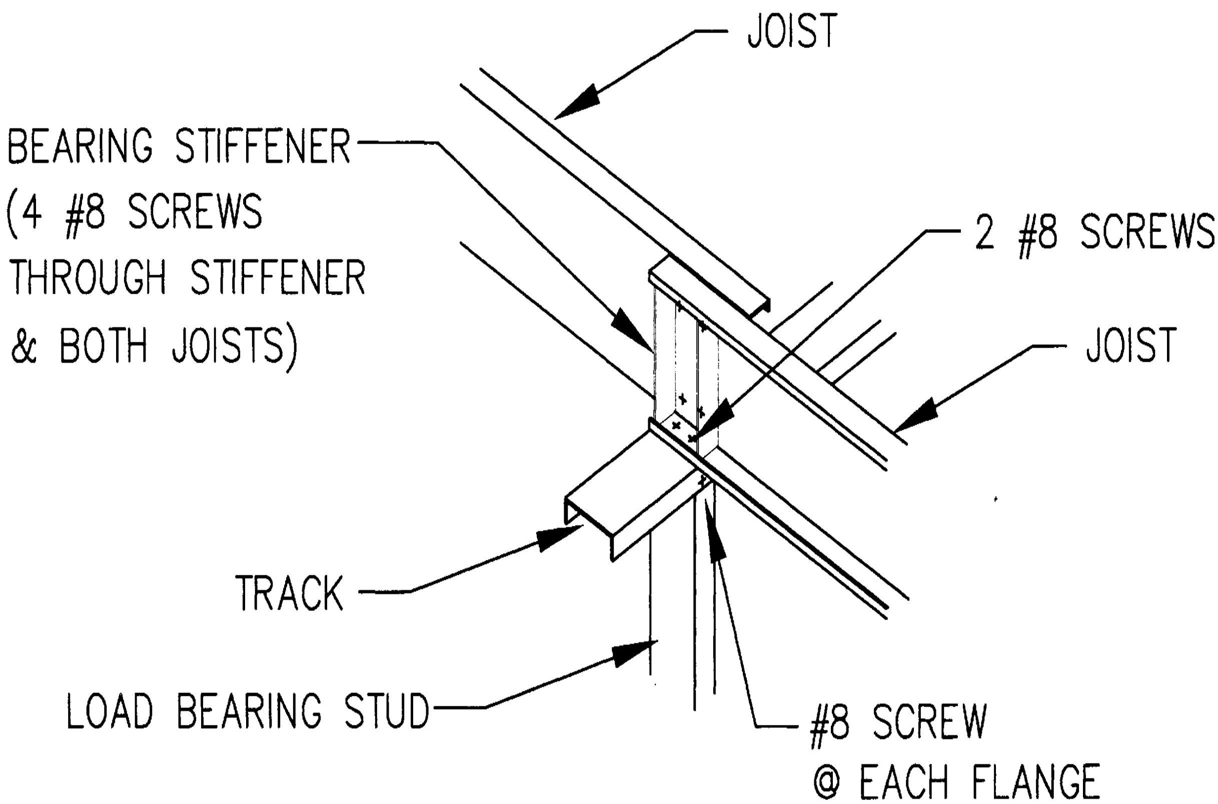

Figure 5.10 **Lapped Joist Supported on Interior Load Bearing Wall**

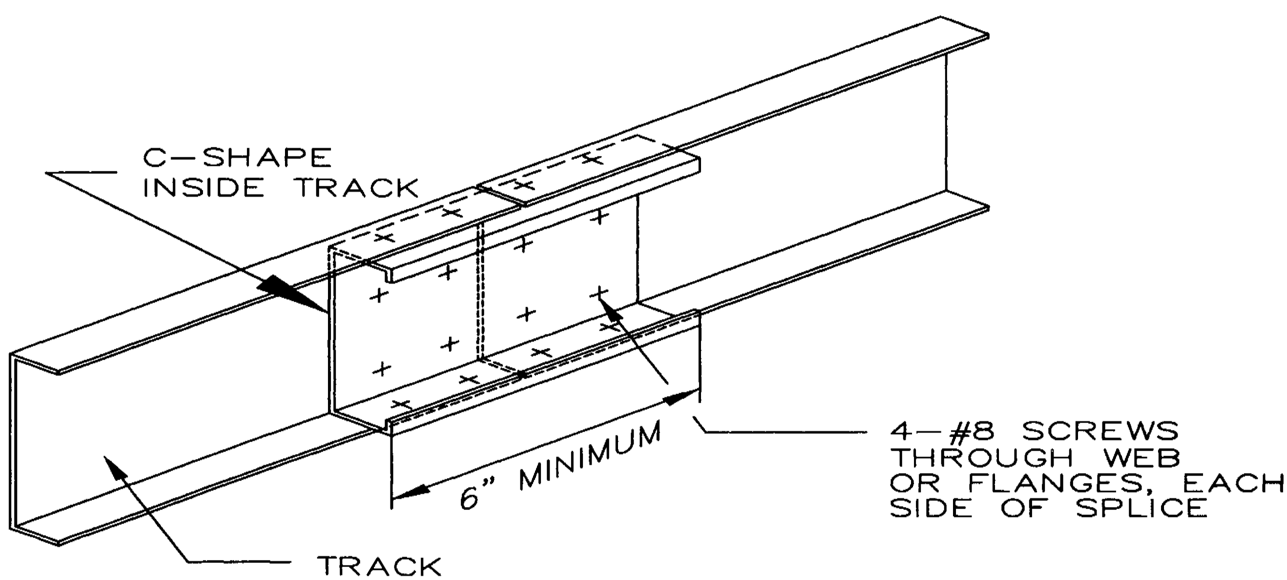

Figure 5.11 **Track Splice**

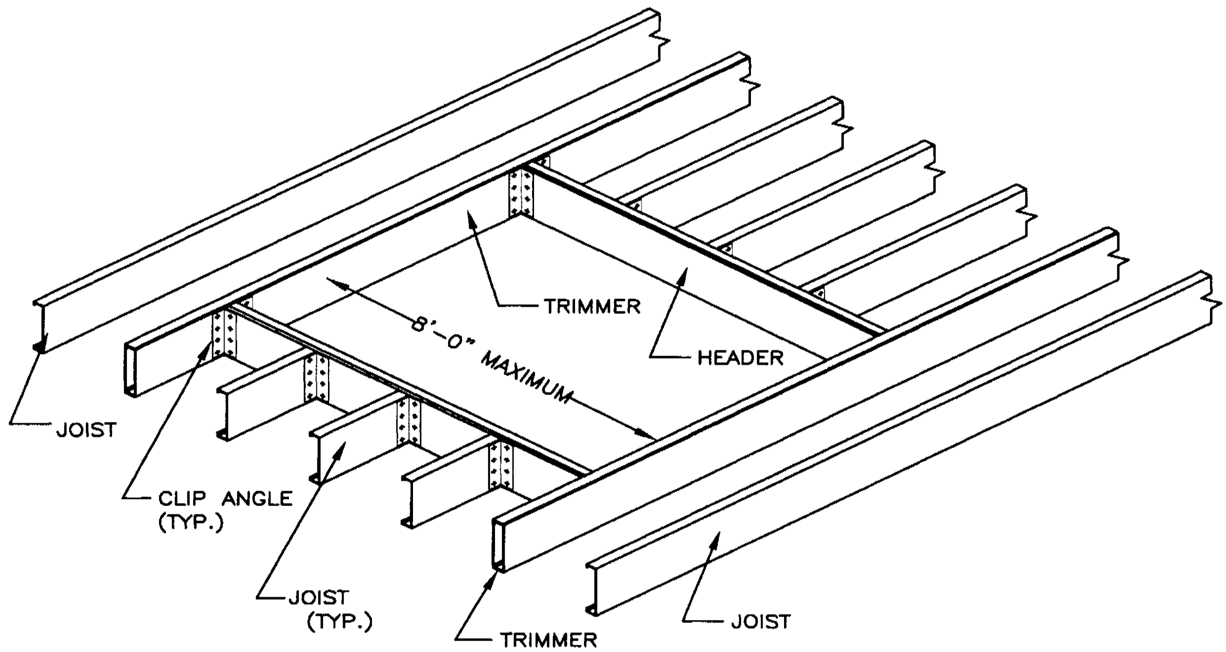

Figure 5.12 Floor Opening

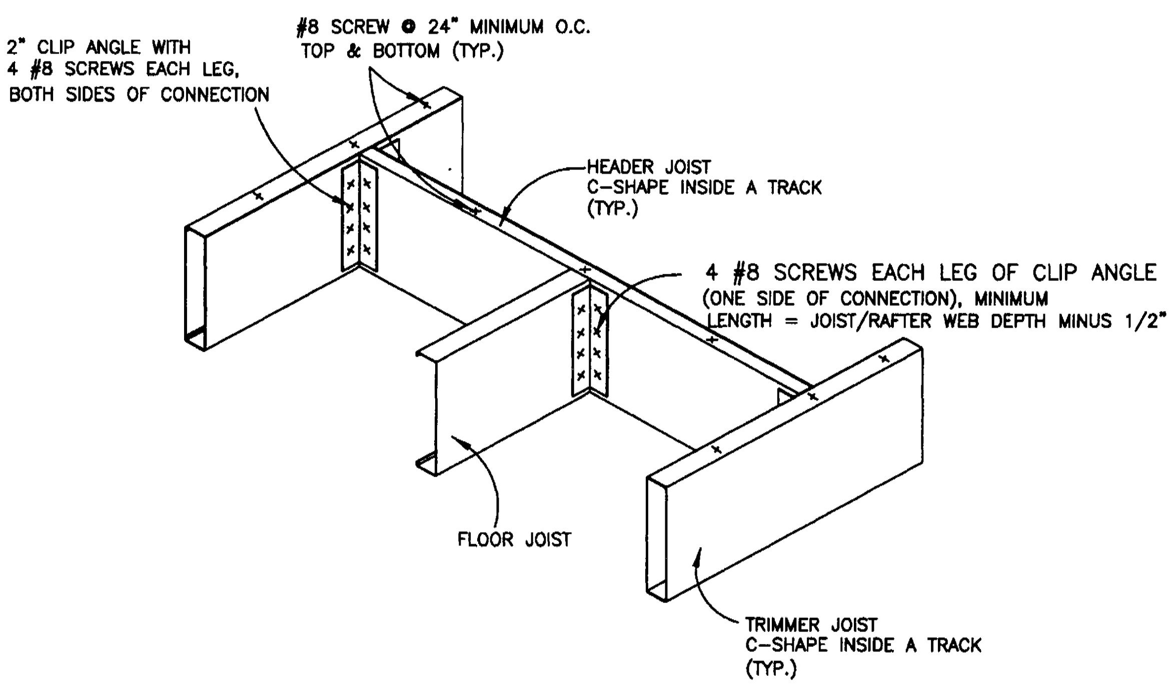

Figure 5.13 Floor Header to Trimmer Connection

Table 5.1
Floor to Foundation or Bearing Wall Connection Requirements

Framing Condition	Wind Speed (mph), Exposure, and Seismic Zones [1,2]		
	Up to 90 A/B or 70 C or Seismic Zones 0, 1, 2, & 3	Up to 110 A/B or 90 C or Seismic Zone 4	Up to 110 C
Floor joist to wall track of exterior steel load bearing wall per Figure 5.3	2 - #8 screws	3- #8 screws	4- #8 screws
Joist track or end joist to bearing wall top track per Figure 5.3	1- #8 screw at 24" o.c	1- #8 screw at 24" o.c.	1- #8 screw at 12" o.c.
Floor joist track or end joist to wood sill per Figure 5.4	Steel plate spaced at 4' o.c. with 4-No. 8 screws and 4-10d or 6-8d common nails	Steel plate spaced at 2' o.c. with 4-No. 8 screws and 4-10d or 6-8d common nails	Steel plate spaced at 1' o.c. with 4-No. 8 screws and 4-10d or 6-8d common nails
Floor joist track or end joist to foundation per Figure 5.5	1/2" minimum diameter anchor bolt and clip angle spaced at 6' o.c. with 8- #8 screws	1/2" minimum diameter anchor bolt and clip angle spaced at 4' o.c. with 8- #8 screws	1/2" minimum diameter anchor bolt and clip angle spaced at 2' o.c. with 8- #8 screws
Cantilevered joist to foundation per Figure 5.6	1/2" minimum diameter anchor bolt and clip angle spaced at 6' o.c. with 8- #8 screws	1/2" minimum diameter anchor bolt and clip angle spaced at 4' o.c. with 8- #8 screws	1/2" minimum diameter anchor bolt and clip angle spaced at 2' o.c. with 8- #8 screws
Cantilevered joist to wood sill per Figure 5.7	Steel plate spaced at 4' o.c. with 4 - # 8 screws and 4-10d or 6-8d common nails	Steel plate spaced at 2' o.c. with 4 - # 8 screws and 4-10d or 6-8d common nails	Steel plate spaced at 1' o.c. with 4 - # 8 screws and 4-10d or 6-8d common nails
Cantilevered joist to wall track per Figure 5.8	1/2" minimum diameter anchor bolt and clip angle spaced at 6' o.c. with 8- #8 screws	1/2" minimum diameter anchor bolt and clip angle spaced at 4' o.c. with 8- #8 screws	1/2" minimum diameter anchor bolt and clip angle spaced at 2' o.c. with 8- #8 screws

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 mph = 1.61 km/hr, 1 foot = 0.3m.

1 Use the highest of the wind speed and exposure or the seismic requirements for a given site.
2 All screw sizes shown are minimum

Table 5.2
Floor Fastening Schedule[1]

Description of Building Elements	Number and Size of Fasteners	Spacing of Fasteners
Floor joist to track of an interior load bearing wall per Figures 5.9 and 5.10	2 - #8 screws	Each joist
Floor joist to track at end of joist	2- #8 screws	One per flange or two per bearing stiffener
Subfloor sheathing to floor joists	#8 screws[2]	6 inches on center on edges and 10 inches on center at intermediate supports

For SI: 1 inch = 25.4 mm

1 All screw sizes shown are minimum.
2 Head styles shall be bugle-head, flat-head, or similar with a minimum head diameter of 0.29 inch (7 mm).

Table 5.3
Allowable Spans For Cold-Formed Steel Floor Joists[1,2,3,4]
Single Span
33 ksi Steel

Nominal Joist Size [5]	30 psf Live Load			40 psf Live Load		
	Spacing (inches)			Spacing (inches)		
	12	16	24	12	16	24
2 x 6 x 33	11'-7"	10'-7"	9'-1"	10'-7"	9'-7"	8'-1"
2 x 6 x 43	12'-8"	11'-6"	10'-0"	11'-6"	10'-5"	9'-1"
2 x 6 x 54	13'-7"	12'-4"	10'-9"	12'-4"	11'-2"	9'-9"
2 x 6 x 68	14'-6"	13'-2"	11'-6"	13'-2"	12'-0"	10'-6"
2 x 6 x 97	16'-1"	14'-7"	12'-9"	14'-7"	13'-3"	11'-7"
2 x 8 x 33	15'-8"	13'-3"	8'-10"	14'-0"	10'-7"	7'-1"
2 x 8 x 43	17'-1"	15'-6"	13'-7"	15'-6"	14'-1"	12'-3"
2 x 8 x 54	18'-4"	16'-8"	14'-7"	16'-8"	15'-2"	13'-3"
2 x 8 x 68	19'-8"	17'-11"	15'-7"	17'-11"	16'-3"	14'-2"
2 x 8 x 97	21'-10"	19'-10"	17'-4"	19'-10"	18'-0"	15'-9"
2 x 10 x 43	20'-6"	18'-8"	15'-3"	18'-8"	16'-8"	13'-1"
2 x 10 x 54	22'-1"	20'-1"	17'-6"	20'-1"	18'-3"	15'-11"
2 x 10 x 68	23'-8"	21'-6"	18'-10"	21'-6"	19'-7"	17'-1"
2 x 10 x 97	26'-4"	23'-11"	20'-11"	23'-11"	21'-9"	19'-0"
2 x 12 x 43	23'-5"	20'-3"	14'-1"	20'-11"	16'-10"	11'-3"
2 x 12 x 54	25'-9"	23'-4"	19'-7"	23'-4"	21'-3"	17'-6"
2 x 12 x 68	27'-8"	25'-1"	21'-11"	25'-1"	22'-10"	19'-11"
2 x 12 x 97	30'-9"	27'-11"	24'-5"	27'-11"	25'-4"	22'-2"

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 foot = 0.3m.

1 Table provides the maximum clear span in feet and inches.
2 Bearing stiffeners shall be installed at all support points and concentrated loads.
3 Deflection criteria: L/480 for live loads; L/240 for total loads.
4 Floor dead load = 10 psf (0.479 kN/m^2)
5 For actual size refer to Table 2.1.

Table 5.4
Allowable Spans For Cold-Formed Steel Floor Joists[1,2,3,4,5,6]
Multiple Spans
33 ksi Steel

Nominal Joist Size [7]	30 psf Live Load			40 psf Live Load		
	Spacing (inches)			Spacing (inches)		
	12	16	24	12	16	24
2 x 6 x 33	12'-10"	10'-6"	7'-10"	11'-0"	9'-0"	6'-7"
2 x 6 x 43	15'-8"	13'-6"	11'-0"	14'-0"	12'-1"	9'-10"
2 x 6 x 54	17'-7"	15'-3"	12'-5"	15'-9"	13'-8"	11'-2"
2 x 6 x 68	19'-6"	17'-2"	14'-0"	17'-8"	15'-4"	12'-6"
2 x 6 x 97	21'-7"	19'-7"	16'-8"	19'-7"	17'-10"	14'-11"
2 x 8 x 33	12'-9"	10'-2"	7'-1"	10'-9"	8'-6"	5'-8"
2 x 8 x 43	19'-5"	16'-8"	12'-6"	17'-5"	14'-3"	10'-8"
2 x 8 x 54	23'-0"	19'-11"	16'-3"	20'-6"	17'-9"	14'-6"
2 x 8 x 68	25'-10"	22'-5"	18'-3"	23'-2"	20'-0"	16'-4"
2 x 8 x 97	29'-4"	26'-7"	21'-11"	26'-7"	24'-0"	19'-7"
2 x 10 x 43	20'-3"	16'-5"	12'-1"	17'-3"	13'-11"	10'-2"
2 x 10 x 54	25'-6"	22'-1"	18'-0"	22'-10"	19'-9"	15'-6"
2 x 10 x 68	30'-6"	26'-5"	21'-7"	27'-4"	23'-8"	19'-3"
2 x 10 x 97	35'-4"	31'-9"	25'-11"	32'-1"	28'-5"	23'-2"
2 x 12 x 43	19'-8"	15'-9"	11'-3"	16'-7"	13'-3"	9'-0"
2 x 12 x 54	27'-8"	23'-9"	17'-10"	24'-9"	20'-4"	15'-2"
2 x 12 x 68	32'-7"	28'-3"	23'-0"	29'-2"	25'-3"	20'-7"
2 x 12 x 97	41'-3"	36'-7"	29'-10"	37'-5"	32'-9"	26'-9"

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 foot = 0.3m.

1 Table provides the maximum clear span in feet and inches to either side of the interior support.
2 Interior bearing supports for multiple span joists shall consist of structural (bearing) walls or beams.
3 Bearing stiffeners shall be installed at all support points and concentrated loads.
4 Deflection criteria: L/480 for live loads; L/240 for total loads.
5 Floor dead load = 10 psf (0.479 kN/m^2)
6 Interior supports shall be located within two feet (610 mm) of mid span provided that each of the resulting spans does not exceed the appropriate maximum span shown in the table above.
7 For actual size refer to Table 2.1.

6.0 STRUCTURAL STEEL WALL FRAMING

6.1 Wall Construction

Cold-formed steel structural walls shall be constructed in accordance with this section and Figure 6.1. Cold-formed steel framing members shall comply with the provisions of Section 2.0.

6.1.1 Applicability Limits

The applicability limits of section 1.3 and Table 1.1 shall apply.

6.1.1 In-Line Framing

Load bearing steel stud (interior and exterior) walls shall be located directly in-line with joists, trusses or rafters supported above with a maximum tolerance of 3/4-inch (19 mm) between their centerlines in accordance with Figure 1.2. Interior load bearing steel walls shall be supported on foundations or shall be located directly above a load bearing wall or floor girder.

6.2 Wall to Foundation or Floor Connection

Steel-framed walls shall be anchored to foundations or floors in accordance with Table 6.1 and Figures 6.2 and 6.3. Uplift connectors shall be provided in accordance with Section 6.10.

6.3 Load Bearing Walls

Load bearing walls shall be constructed in accordance with Figure 6.1. Steel studs shall be selected from Tables 6.2 through 6.7 for steels with minimum yield strength of 33 ksi (228 MPa) or Tables 6.8 through 6.13 for steels with minimum yield strength of 50 ksi (228 MPa). Fastening requirements shall be in accordance with Section 2.11 and Table 6.14. Tracks shall have a minimum steel thickness equivalent to or greater than the wall studs. Exterior walls with a minimum of 1/2-inch (13 mm) gypsum board installed in accordance with Table 6.14 on the interior surface and wood structural sheathing panels of minimum 7/16-inch (11 mm) thick oriented strand board or 15/32-inch (12 mm) thick plywood installed in accordance with Section 6.8.2 on the outside surface shall be permitted to use the next thinner stud size, from Tables 6.2 through 6.7, but not less than 33 mils (0.84 mm). Interior load bearing walls with a minimum of 1/2-inch (13 mm) gypsum board installed in accordance with Table 6.14 on both sides of the wall shall be permitted to use the next thinner stud from Tables 6.2 through 6.7, but not less than 33 mils (0.84 mm). Stud thickness for walls supporting one floor, roof and ceiling are based on a second floor live load of 30 psf (1.44 kN/m^2). Second floor live loads of 40 psf (1.92 kN/m^2) shall be permitted provided that the next higher snow load category is used to select the stud size from Tables 6.2 through 6.13.

6.4 Stud Bracing

The flanges of load bearing steel studs shall be laterally braced in accordance with one of the following methods:

1. Gypsum board or structural sheathing on both sides of load bearing walls installed in accordance with Table 6.14 and Figure 6.4.

2. Horizontal steel strapping shall be installed in accordance with Figure 6.5 on both sides at mid-height for 8-foot (2.4 m) walls, and third-heights for 9- and 10-foot (2.7 and 3.0 m) walls. Horizontal steel straps shall be at least 1-1/2 inches in width and 33 mils in thickness (38 mm x 0.84 mm). Straps shall be attached to the flanges of studs with at least one #8 screw. In-line blocking shall be installed between studs at the termination of all straps and at 12-foot (37 m) intervals along the strap; straps shall be fastened to the blocking with at least two #8 screws.

3. A combination of methods 1 and 2 in accordance with Figure 6.5.

Adequate temporary or permanent stud bracing shall be provided to resist loads during construction.

6.5 Splicing

Studs and other structural members shall not be spliced without an approved design. Splicing of tracks shall conform with Figure 6.7.

6.6 Corner Framing

Corner studs and the top track shall be installed in accordance with Figure 6.8. Other approved corner framing details shall be permitted.

6.7 Headers

Headers shall be installed above wall openings in all exterior walls and interior load bearing walls in accordance with Figures 6.9 and 6.10 and Tables 6.15 through 6.17. Header spans for house widths between those tabulated may be determined by interpolation. Headers shall be formed from two, equal sized C-shaped members in a back-to-back or box-type configuration. Steel tracks used to form the headers shall be of a minimum thickness of 33 mils (0.84 mm). The number of jack and king studs, installed on each side of the header, shall comply with Table 6.18. Jack, king, and cripple studs shall be of the same dimension and thickness as the adjacent wall studs. Headers shall be connected to king studs in accordance with Table 6.19. One-half of the total number of screws shall be applied to the header and one half to the king stud by use of C-shaped or track member in accordance with Figure 6.9 for box-type headers or a minimum 2-inch x 2-inch (51 mm x 51 mm) clip angle in accordance with Figure 6.10 for back-to-back headers. The clip angle, track, or C-shape shall extend the depth of the header minus 1/2-inch (13 mm) and shall have a minimum thickness not less than the wall studs. Jack and king studs shall be interconnected with structural sheathing in accordance with Figures 6.9 and 6.10. Headers are not required for openings in interior non-load bearing walls.

6.8 Wall Bracing

Exterior steel-framed walls shall be braced with diagonal steel straps or structural sheathing in accordance with Sections 6.8.1 or 6.8.2.

6.8.1 Strap Bracing (X-brace)

Diagonal steel straps or "X-braces" and their connections shall be designed and installed in accordance with an approved design.

6.8.2 Structural Sheathing

Structural sheathing shall be installed on all exterior wall surfaces in accordance with Figure 6.11 and Section 6.8.3. Structural sheathing panels shall consist of minimum 7/16-inch (11 mm) thick oriented strand board or 15/32-inch (12 mm) thick plywood. Full height structural sheathing shall extend from the bottom to the top of the wall without interruption by openings.

The minimum length of full height sheathing along exterior wall lines shall be determined in accordance with Table 6.20. The minimum percentage of full-height sheathing shall include only those sheathed wall sections between openings, which are a minimum of 48 inches (1.1 m) wide. The minimum percentage of full-height structural sheathing shall be multiplied by 1.10 for 9 foot (2.7m) high walls and multiplied by 1.20 for 10 foot (3.0 m) high walls. In addition, structural sheathing shall be:

1. installed with the long dimension parallel to the stud framing (i.e. vertical orientation) and shall cover the full vertical height of wall; and,

2. applied to each end (corners) of each of the exterior walls with a minimum 48 inch (1.2 m) wide panel.

In conditions where design wind speeds are in excess of 90 mph (144 km/hr) Exposure C or 100 mph (160 km/hr) Exposure A/B and in seismic Zone 3 or greater, the amount and type of structural sheathing shall be determined by accepted engineering practices. Additional guidance on wall bracing design and requirements for high wind and seismic conditions is found in the *Commentary* [6].

6.8.3 Structural Sheathing Fastening

All edges and interior areas of structural sheathing panels shall be fastened to framing members and tracks in accordance with Figure 6.11 and Table 6.14. The panels shall be installed with the long dimension parallel to the stud framing and shall extend the full vertical height of the wall.

6.9 Hold-down Requirements

In conditions where wind speeds are in excess of 90 mph (144 km/hr) Exposure C or 100 mph (160 km/hr) Exposure A/B, and in Seismic Zones 3 and 4, hold-down brackets shall be provided in accordance with an approved design.

6.10 Wind Uplift

In high wind conditions, an approved uplift connector (i.e. strap or bracket) shall be used to attach individual wall studs and king studs to floor joist tracks or directly to foundations below the wall in accordance with Figure 6.1 and Table 6.1. The wind uplift requirements only apply to walls directly connected to the roof, not to lower story walls of two-story construction. Uplift requirements for roof-to-wall connections are provided in Section 8.9.

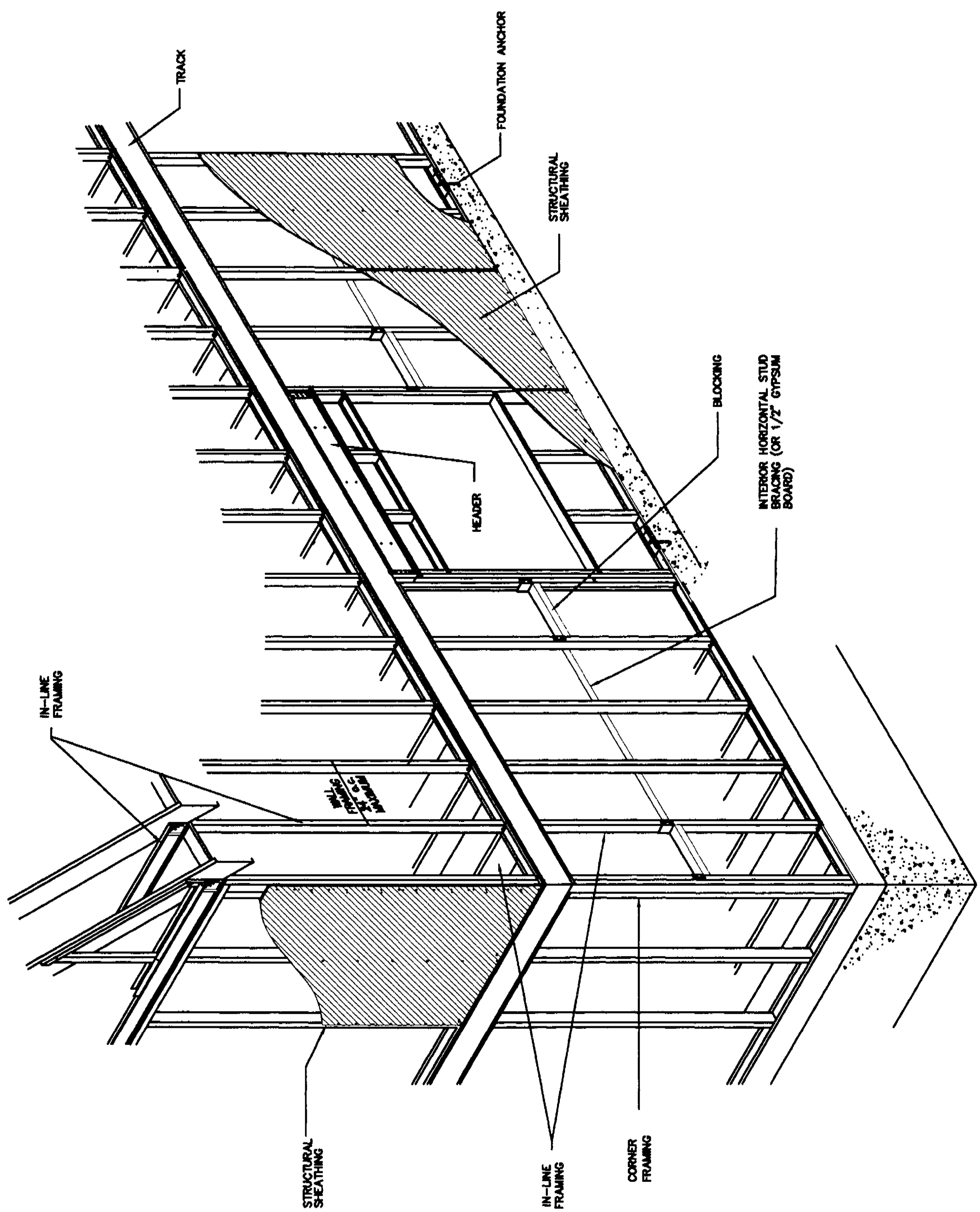

Figure 6.1 Steel Wall Construction

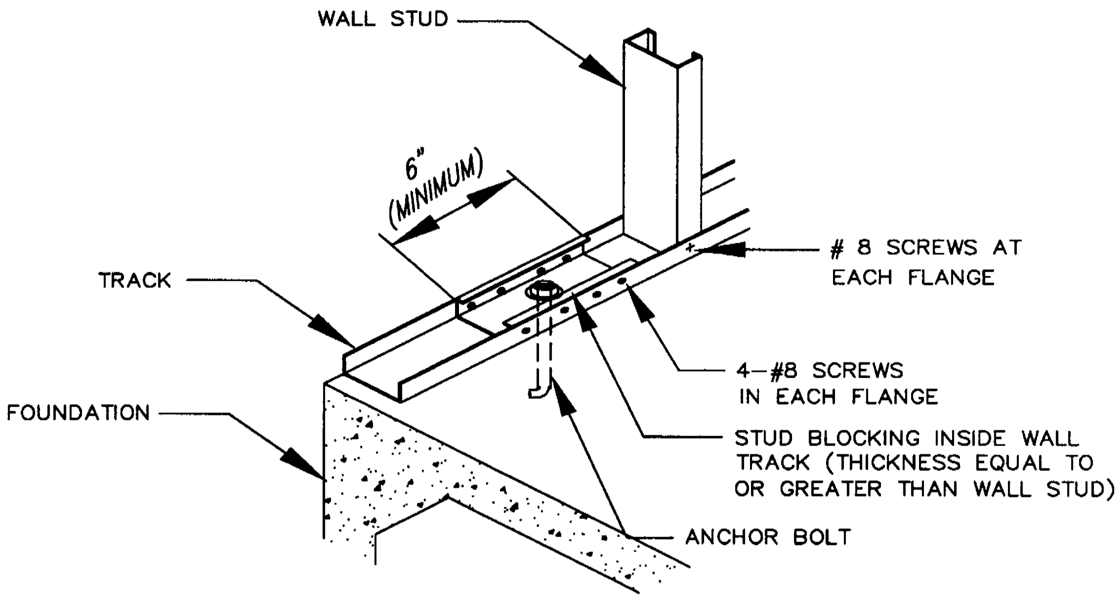

Figure 6.2 Wall to Foundation Connection

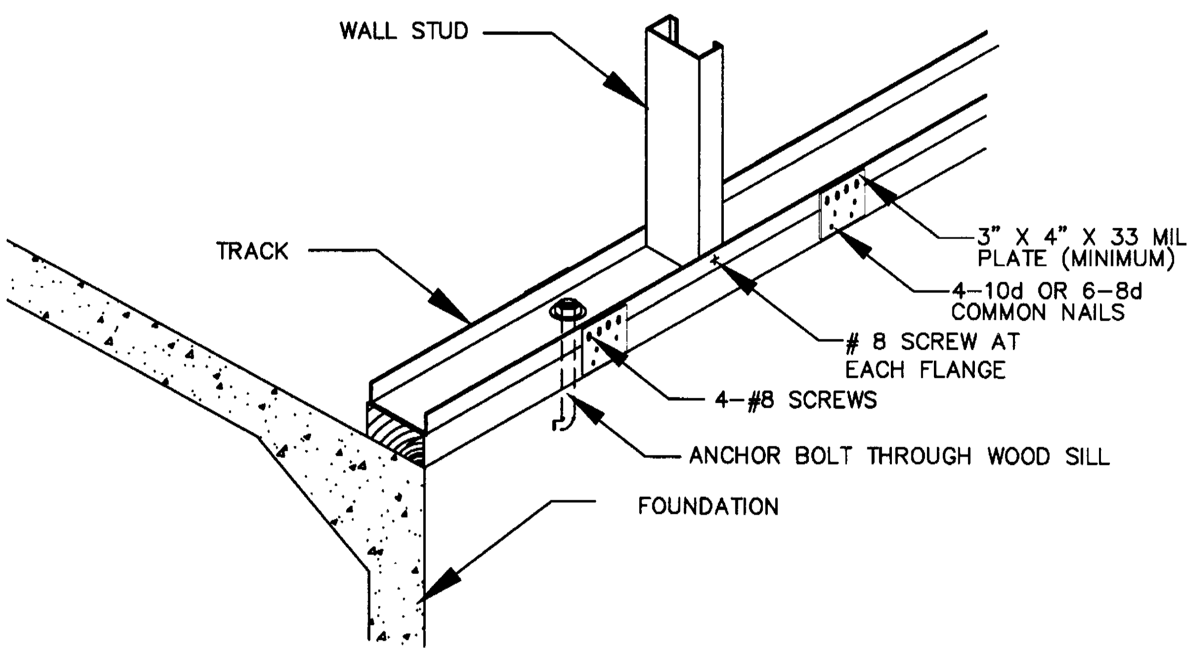

Figure 6.3 Wall to Wood Sill Connection

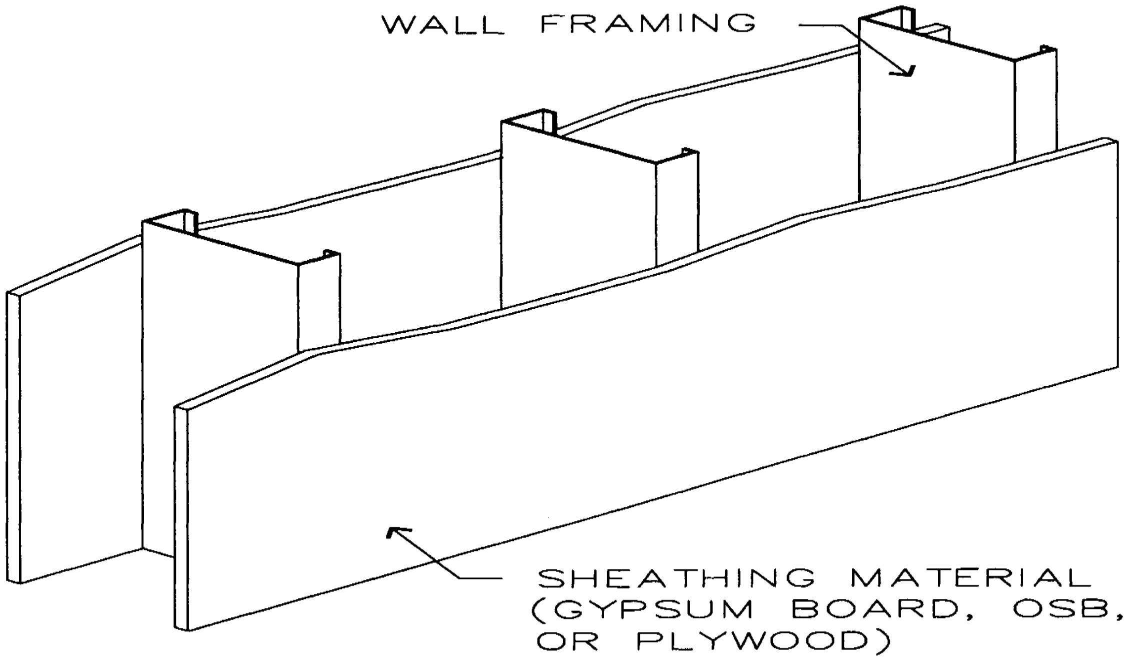

Figure 6.4 Stud Bracing with Sheathing Material Only

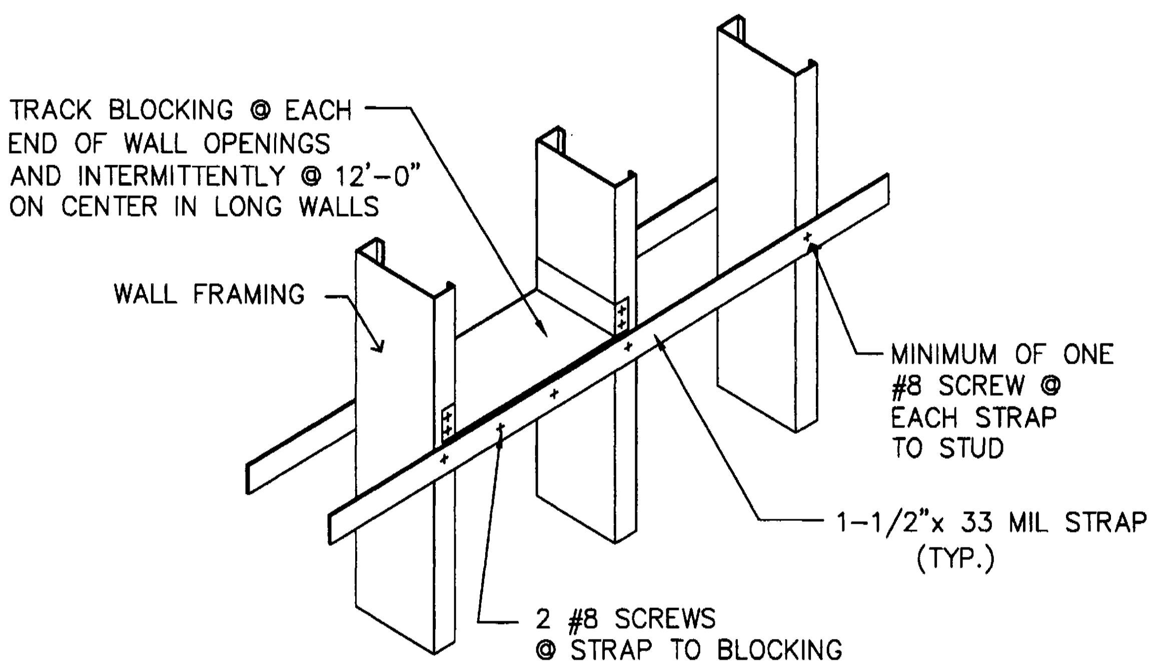

Figure 6.5 Stud Bracing with Strapping Only

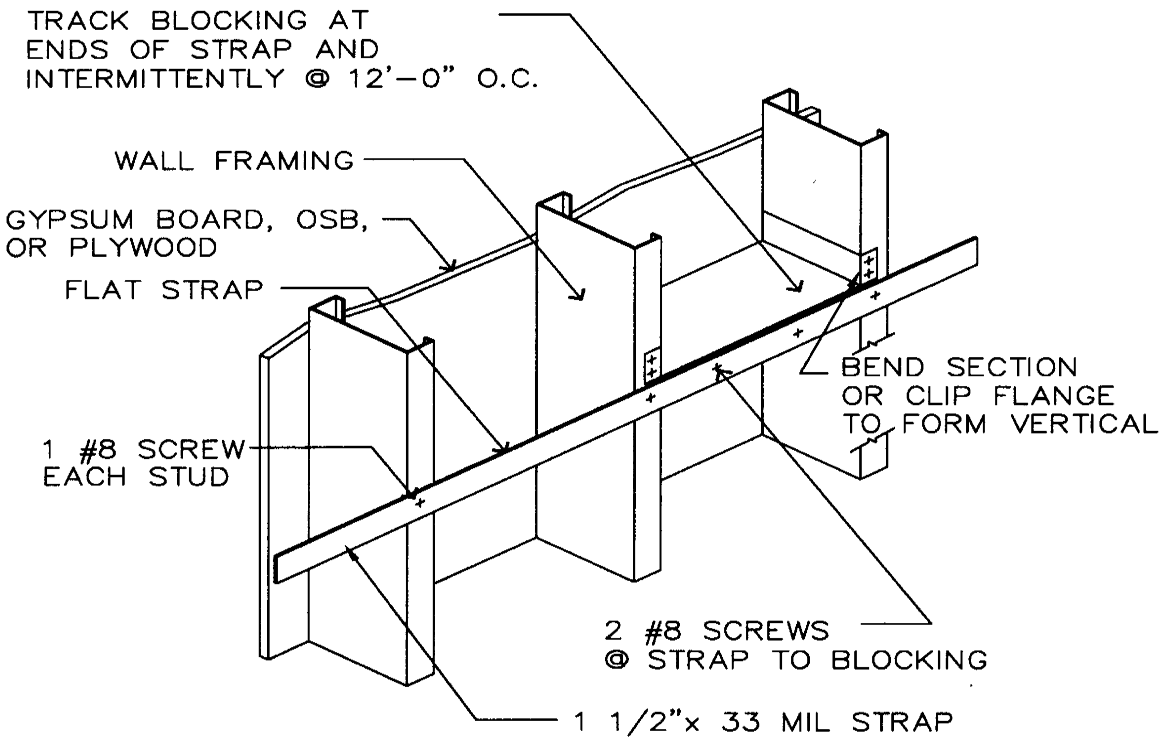

Figure 6.6 Stud Bracing with Strapping and Sheathing Material

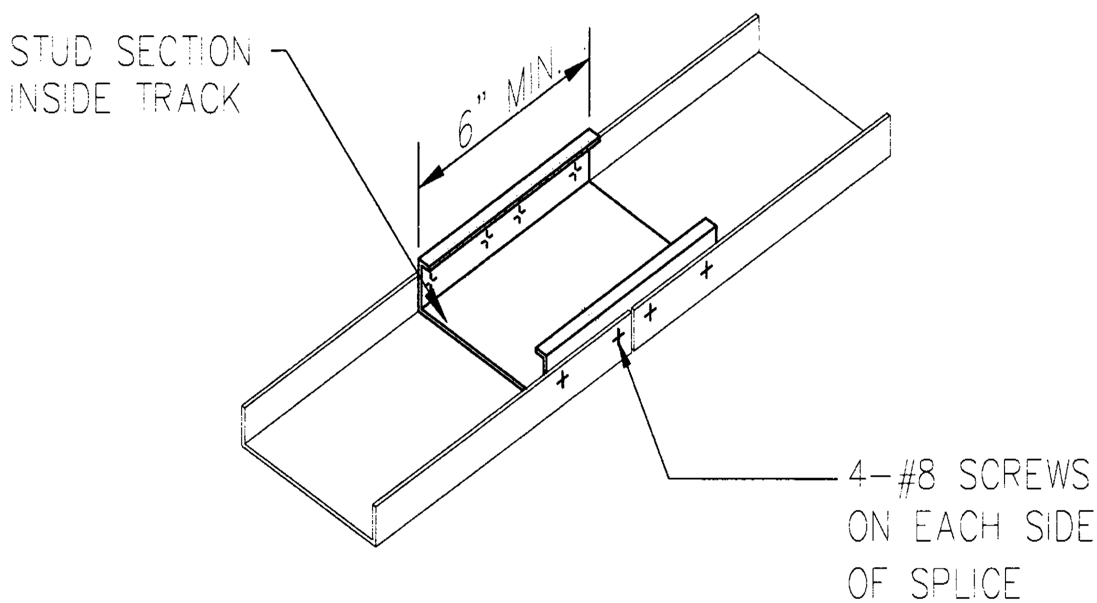

Figure 6.7 Track Splice

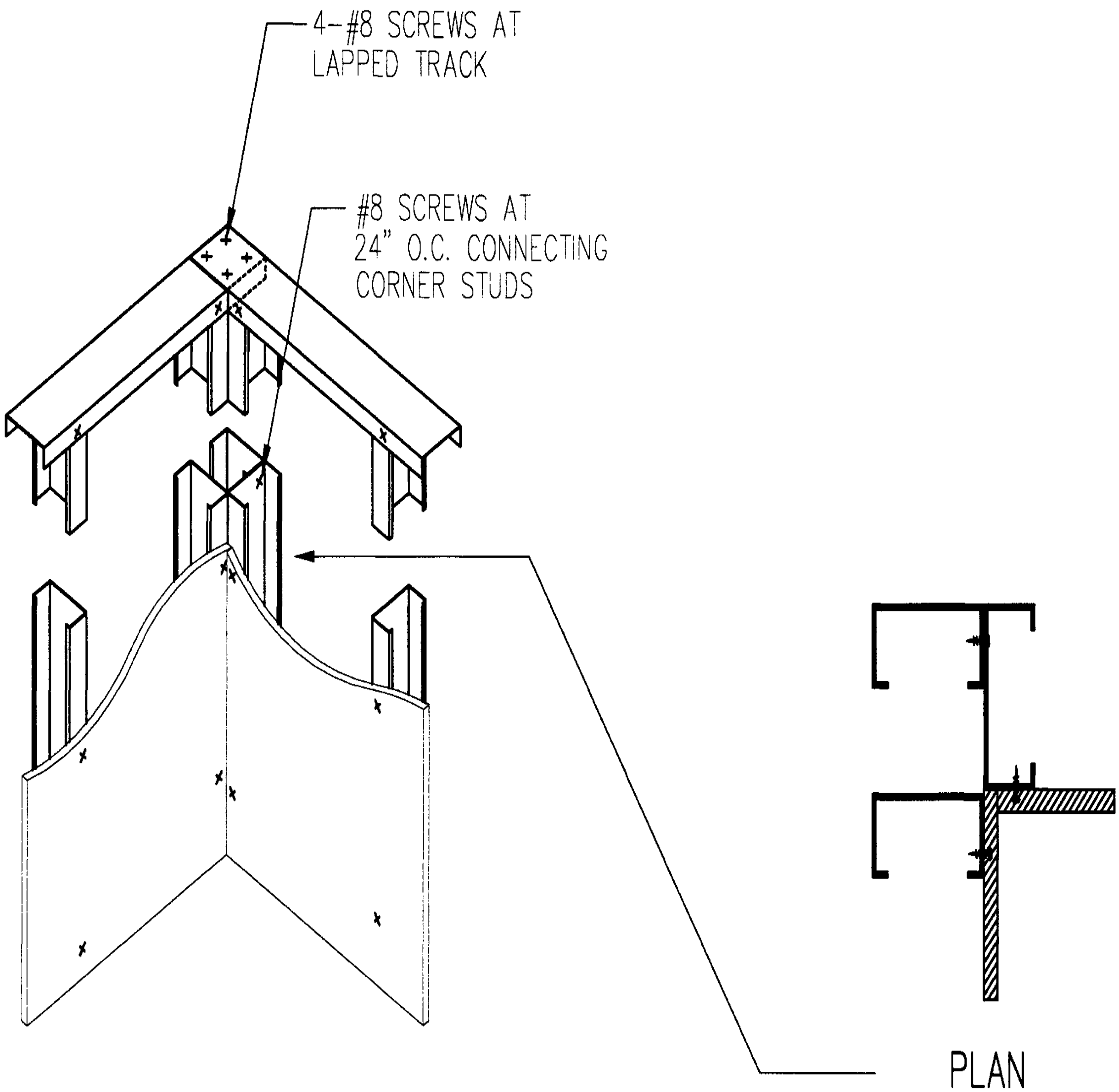

Figure 6.8 Corner Framing

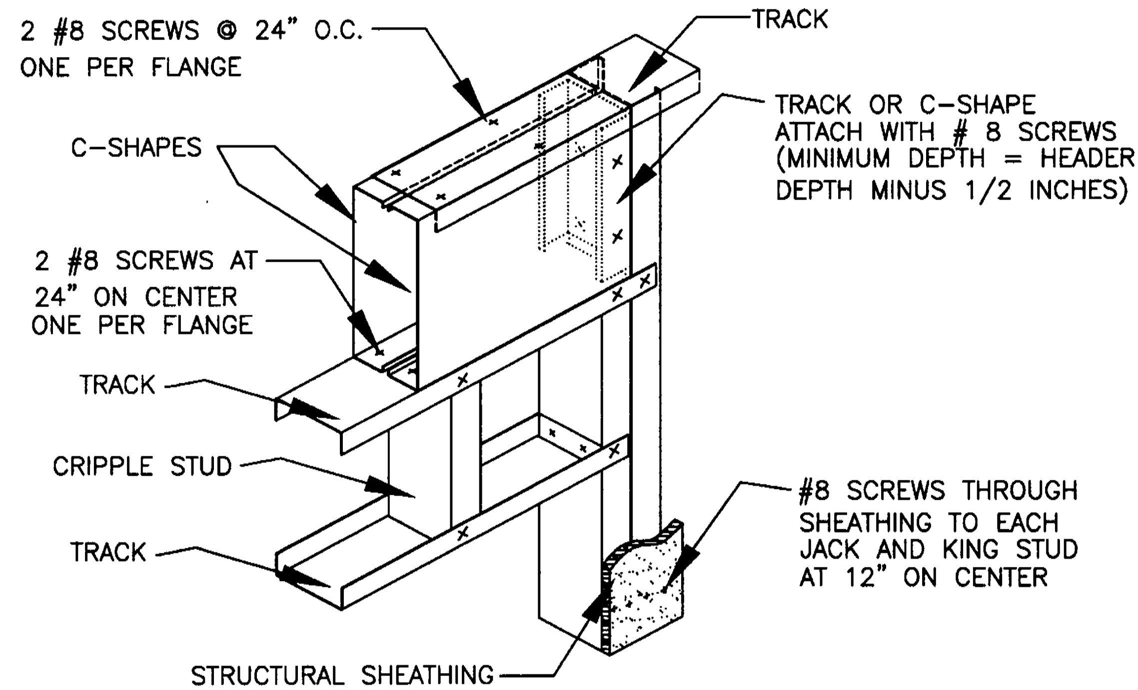

Figure 6.9 **Box-Beam Header Detail**

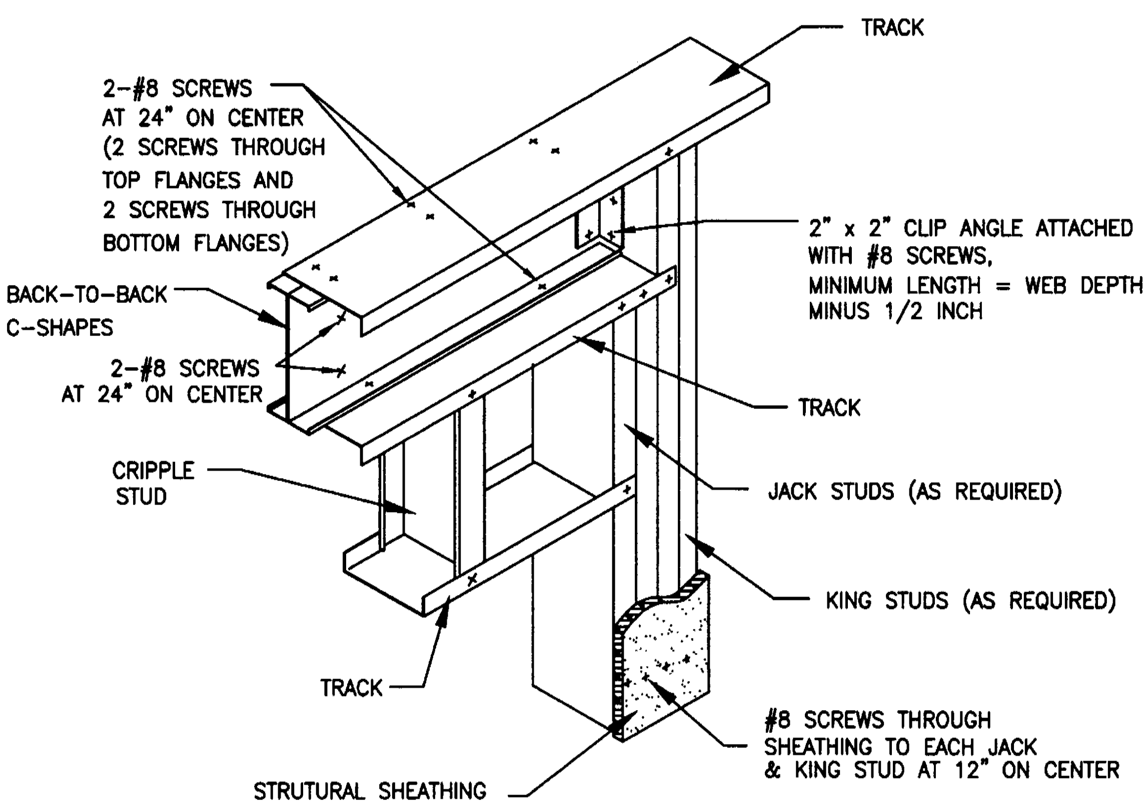

Figure 6.10 **Back-to-Back Header Detail**

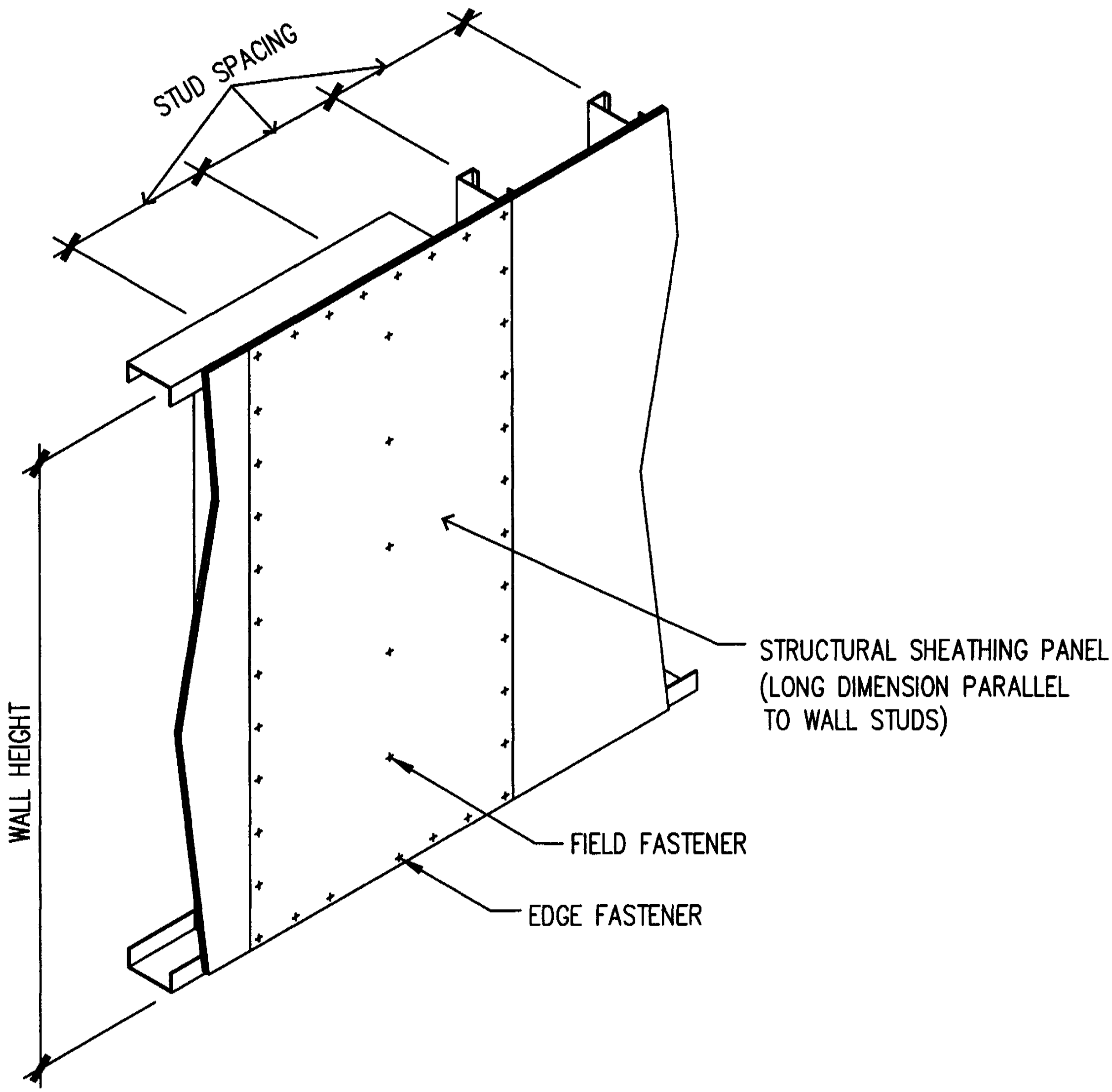

Figure 6.11 Structural Sheathing Fastening Pattern

Table 6.1
Wall to Foundation or Floor Connection Requirements

Framing Condition	Wind Speed (mph), Exposure, & Seismic Zones[1,2,3]			
	Up to 70 A/B or Seismic Zones 0, 1, 2	Up to 90 A/B 70 C or Seismic Zone 3	Up to 110 A/B or 90 C or Seismic Zone 4	Up to 110 C
Wall bottom track to floor joist or track	1 - #8 screw at 12" oc	1 - #8 screw at 12" oc	2 - #8 screw at 12" oc	2 - #8 screw at 12" oc
Wall bottom track to foundation per Figure 6.2	1/2" minimum diameter anchor bolt at 6' oc	1/2" minimum diameter anchor bolt at 4' oc	1/2" minimum diameter anchor bolt at 4' oc	1/2" minimum diameter anchor bolt at 4' oc
Wall bottom track to wood sill per Figure 6.3	Steel plate spaced at 4' oc, with 4 - #8 screws and 4 - 10d or 6 - 8d common nails	Steel plate spaced at 3' oc, with 4 - #8 screws and 4 - 10d or 6 - 8d common nails	Steel plate spaced at 2' oc, with 4 - #8 screws and 4 - 10d or 6 - 8d common nails	Steel plate spaced at 2' oc, with 4 - #8 screws and 4 - 10d or 6 - 8d common nails
Wind uplift connector capacity [3]	N/R	N/R	50 lbs. per foot of wall length	200 lbs. per foot of wall length

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 mph = 1.61 km/hr, 1 foot = 0.3 m, 1 lb. = 4.4 N.

1 Use the greater of the wind speed and exposure or the seismic requirements for a given site.
2 All screw sizes shown are minimum.
3 N/R = uplift connector not required. For 16-inch (406 mm) and 24-inch (610 mm) stud spacing, the uplift load shall be multiplied by 1.3 and 2.0, respectively. Uplift connectors are in addition to other connection requirements and shall be applied in accordance with Section 6.10.

Table 6.2
Steel Stud Thickness for 8' Walls Supporting Roof and Ceiling Only
(One Story or Second Floor of a Two Story Building)
33 ksi Steel

Wind Speed		Member Size[3]	Member Spacing (inches)	Stud Thickness (mils)[1,2]															
				Building Width (feet)[4,5]															
				24				28				32				36			
Exp. A/B	Exp. C			Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)			
				20	30	50	70	20	30	50	70	20	30	50	70	20	30	50	70
70 mph		2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
80 mph	70 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	43	33	33	43	43
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
90 mph	80 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	33	33	43	43	33	43	43	43	43	43	43	43
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
100 mph	90 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	54	43	43	54	54	43	43	54	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
110 mph	100 mph	2x4	16	33	33	43	43	33	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	68	54	54	68	68	54	54	68	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	43	33	33	33	43	33	33	43	43
	110 mph	2x4	16	43	43	43	43	43	43	43	43	43	43	43	54	43	43	43	54
			24	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	97
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 mph = 1.61 km/hr, 1 foot = 0.3 m.

1 Deflection criteria: L/240

2 Design load assumptions: Roof dead load is 12 psf (0.575 kN/m^2)
Attic live load is 10 psf (0.479 kN/m^2)

3 For actual sizes of members, refer to Table 2.1.

4 Building width is in the direction of horizontal framing members supported by the wall studs.

5 Exterior load bearing walls with a minimum of 1/2 inch (13 mm) gypsum board on the inside and 7/16 inch (11 mm) OSB or plywood on the outside, and interior load bearing walls with a minimum of 1/2 inch (13 mm) gypsum board on both sides may use the next thinner stud but not less than 33 mils (0.84 mm).

Table 6.3
Steel Stud Thickness for 8' Walls Supporting One Floor, Roof and Ceiling
(First Story of a Two Story Building)
33 ksi Steel

Wind Exposure		Member Size[3]	Member Spacing (inches)	Required Stud Thickness (mils)[1,2] Building Width (feet)[4,5,6]															
				24				28				32				36			
				Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)			
Exp. A/B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70	20	30	50	70
70 mph		2x4	16	33	33	33	33	33	33	33	33	33	33	33	43	33	33	33	43
			24	43	43	43	43	43	43	43	43	43	43	43	54	43	43	54	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	43	33	33	43	43	33	43	43	54
80 mph	70 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	43	33	33	43	43
			24	43	43	43	54	43	43	54	54	54	54	54	54	54	54	54	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
			24	33	33	33	33	33	33	33	43	33	33	43	43	43	43	43	54
90 mph	80 mph	2x4	16	33	33	33	33	33	33	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	68	54	54	68	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	43	43	43	43	43	43	43	43	43	54
100 mph	90 mph	2x4	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	54
			24	54	54	54	68	54	68	68	68	68	68	68	68	68	68	68	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	43	43	43	43	43	43	43	43	43	43	43	43	43	43	54
110 mph	100 mph	2x4	16	43	43	43	54	43	54	54	54	54	54	54	54	54	54	54	54
			24	68	68	68	68	68	68	97	97	97	97	97	97	97	97	97	97
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
			24	43	43	43	43	43	43	43	54	43	43	54	54	54	54	54	54
	110 mph	2x4	16	54	54	54	54	54	54	54	54	54	54	54	68	54	54	68	68
			24	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
		2x6	16	33	33	33	33	33	33	33	43	33	33	43	43	43	43	43	43
			24	43	43	54	54	54	54	54	54	54	54	54	54	54	54	54	54

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 mph = 1.61 km/hr, 1 foot = 0.3 m.

1 Deflection criteria: L/240

2 Design load assumptions:
Second floor dead load is 10 psf (0.48 kN/m^2) Attic live load is 10 psf (0.48kN/m^2)
Second floor live load is 30 psf (1.44 kN/m^2) Roof dead load is 12 psf (0.58 kN/m^2)

3 For actual sizes of members, refer to Table 2.1.

4 Building width is in the direction of horizontal framing members supported by the wall studs.

5 Exterior load bearing walls with a minimum of 1/2 inch (13 mm) gypsum board on the inside and 7/16 inch (11 mm) OSB or plywood on the outside, and interior load bearing walls with a minimum of 1/2 inch (13 mm) gypsum board on both sides may use the next thinner stud but not less than 33 mils (0.84 mm).

6 For second story floors with 40 psf live load, select the stud size from the next higher ground snow load column.

Table 6.4
Steel Stud Thickness for 9' Walls Supporting Roof and Ceiling Only
(One Story or Second Floor of a Two Story Building)
33 ksi Steel

Wind Exposure		Member Size[3]	Member Spacing (inches)	Required Stud Thickness (mils)[1,2]															
				Building Width (feet)[4,5]															
				24				28				32				36			
Exp. A/B	Exp. C			Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)			
				20	30	50	70	20	30	50	70	20	30	50	70	20	30	50	70
70 mph		2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
80 mph	70 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	33	33	43	43	33	43	43	43	43	43	43	43
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
90 mph	80 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	54	43	43	43	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
100 mph	90 mph	2x4	16	33	33	33	33	33	33	33	43	33	33	43	43	33	33	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
110 mph	100 mph	2x4	16	43	43	43	43	43	43	43	43	43	43	43	54	43	43	43	54
			24	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	97
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
	110 mph	2x4	16	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54
			24	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	54	43	43	43	54

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 mph = 1.61 km/hr, 1 foot = 0.3 m.

1 Deflection criteria: L/240

2 Design load assumptions: Roof dead load is 12 psf (0.575 kN/m^2)
Attic live load is 10 psf (0.479 kN/m^2)

3 For actual sizes of members, refer to Table 2.1.

4 Building width is in the direction of horizontal framing members supported by the wall studs.

5 Exterior load bearing walls with a minimum of 1/2 inch (13 mm) gypsum board on the inside and 7/16 inch (11 mm) OSB or plywood on the outside, and interior load bearing walls with a minimum of 1/2 inch (13 mm) gypsum board on both sides may use the next thinner stud but not less than 33 mils (0.84 mm).

Table 6.5
Steel Stud Thickness for 9' Walls Supporting One Floor, Roof and Ceiling
(First Story of a Two Story Building)
33 ksi Steel

Wind Exposure		Member Size[3]	Member Spacing (inches)	Required Stud Thickness (mils)[1,2] Building Width (feet)[4,5]															
				24				28				32				36			
				Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)			
Exp. A/B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70	20	30	50	70
70 mph		2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
			24	43	43	43	43	43	43	43	54	43	43	54	54	54	54	54	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	43	33	33	43	43	33	33	43	43
80 mph	70 mph	2x4	16	33	33	33	33	33	33	33	43	33	43	43	43	43	43	43	43
			24	43	54	54	54	54	54	54	54	54	54	54	54	54	54	68	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	43	33	33	43	43	43	43	43	43
90 mph	80 mph	2x4	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54	68	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	43	43	43	43	43	43	43	43	43	43	43	54
100 mph	90 mph	2x4	16	43	43	43	43	43	43	43	54	43	43	54	54	54	54	54	54
			24	68	68	68	68	68	68	68	68	68	68	68	97	68	68	97	97
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	54	43	43	54	54
110 mph	100 mph	2x4	16	54	54	54	54	54	54	54	54	54	54	54	68	54	54	68	68
			24	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
		2x6	16	33	33	33	33	33	33	33	43	33	33	43	43	33	43	43	43
			24	43	43	54	54	54	54	54	54	54	54	54	54	54	54	54	54
	110 mph	2x4	16	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
			24	97	97	97	97	97	97	97	--	97	97	--	--	--	--	--	--
		2x6	16	33	33	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	68	54	54	68	68

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 mph = 1.61 km/hr, 1 foot = 0.3 m.

1 Deflection criteria: L/240

2 Design load assumptions:
- Second floor dead load is 10 psf (0.48 kN/m^2)
- Second floor live load is 30 psf (1.44 kN/m^2)
- Attic live load is 10 psf (0.48 kN/m^2)
- Roof dead load is 12 psf (0.58 kN/m^2)

3 For actual sizes of members, refer to Table 2.1.

4 Building width is in the direction of horizontal framing members supported by the wall studs.

5 Exterior load bearing walls with a minimum of 1/2 inch (13 mm) gypsum board on the inside and 7/16 inch (11 mm) OSB or plywood on the outside, and interior load bearing walls with a minimum of 1/2 inch (13 mm) gypsum board on both sides may use the next thinner stud but not less than 33 mils (0.84 mm).

6 For second story floors with 40 psf live load, select the stud size from the next higher ground snow load column.

Table 6.6
Steel Stud Thickness for 10' Walls Supporting Roof and Ceiling Only
(One Story or Second Floor of a Two Story Building)
33 ksi Steel

Wind Exposure		Member Size[3]	Member Spacing (inches)	Required Stud Thickness (mils)[1,2]															
				Building Width (feet)[4,5]															
				24				28				32				36			
Exp. A/B	Exp. C			Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)			
				20	30	50	70	20	30	50	70	20	30	50	70	20	30	50	70
70 mph		2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	43	43	33	33	43	43	33	43	43	43
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
80 mph	70 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	54	43	43	43	54	43	43	54	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
90 mph	80 mph	2x4	16	33	33	33	43	33	33	43	43	33	33	43	43	33	33	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
100 mph	90 mph	2x4	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	54
			24	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	33	33	43	43	33	43	43	43	43	43	43	43
110 mph	100 mph	2x4	16	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	68
			24	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	54	43	43	54	54	43	43	54	54
	110 mph	2x4	16	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
			24	97	97	97	--	97	97	--	--	97	97	--	--	97	--	--	--
		2x6	16	33	33	33	43	33	33	43	43	33	33	43	43	33	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	68

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m², 1 mph = 1.61 km/hr, 1 foot = 0.3 m.

1. Deflection criteria: L/240
2. Design load assumptions: Roof dead load is 12 psf (0.58 kN/m²) Attic live load is 10 psf (0.48 kN/m²)
3. For actual sizes of members, refer to Table 2.1.
4. Building width is in the direction of horizontal framing members supported by the wall studs.
5. Exterior load bearing walls with a minimum of 1/2 inch (13 mm) gypsum board on the inside and 7/16 inch (11 mm) OSB or plywood on the outside, and interior load bearing walls with a minimum of 1/2 inch (13 mm) gypsum board on both sides may use the next thinner stud but not less than 33 mils (0.84 mm).

Table 6.7
Steel Stud Thickness for 10' Walls Supporting One Floor, Roof and Ceiling
(First Story of a Two Story Building)
33 ksi Steel

Wind Exposure Exp. A/B	Wind Exposure Exp. C	Member Size[3]	Member Spacing (inches)	Required Stud Thickness (mils)[1,2] — Building Width (feet)[4,5,6]: 24 — Ground Snow Load (psf)				28 — Ground Snow Load (psf)				32 — Ground Snow Load (psf)				36 — Ground Snow Load (psf)			
				20	**30**	**50**	**70**	**20**	**30**	**50**	**70**	**20**	**30**	**50**	**70**	**20**	**30**	**50**	**70**
70 mph		2x4	16	33	33	33	43	33	33	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	68	54	54	68	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	43	33	33	43	43	43	43	43	54
80 mph	70 mph	2x4	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	54
			24	54	54	68	68	68	68	68	68	68	68	68	68	68	68	68	97
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	43	43	43	43	43	43	43	43	43	43	43	54
90 mph	80 mph	2x4	16	43	43	43	43	43	43	54	54	43	54	54	54	54	54	54	54
			24	68	68	68	68	68	68	68	97	68	68	97	97	97	97	97	97
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	54	43	43	54	54
100 mph	90 mph	2x4	16	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54
			24	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	43	33	33	43	43
			24	43	43	43	54	43	54	54	54	54	54	54	54	54	54	54	54
110 mph	100 mph	2x4	16	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	97
			24	97	97	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		2x6	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	68	54	68	68	68	68	68	68	68
	110 mph	2x4	16	68	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
			24	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		2x6	16	43	43	43	43	43	43	43	43	43	43	43	54	43	43	54	54
			24	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68	97

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m², 1 mph = 1.61 km/hr, 1 foot = 0.3 m.

1 Deflection criteria: L/240

2 Design load assumptions:
Second floor dead load is 10 psf (0.48 kN/m²) — Roof dead load is 12 psf (0.58 kN/m²)
Second floor live load is 30 psf (1.44 kN/m²) — Attic live load is 10 psf (0.48 kN/m²)

3 For actual sizes of members, refer to Table 2.1.

4 Building width is in the direction of horizontal framing members supported by the wall studs.

5 Exterior load bearing walls with a minimum of 1/2 inch (13 mm) gypsum board on the inside and 7/16 inch (11 mm) OSB or plywood on the outside, and interior load bearing walls with a minimum of 1/2 inch (13 mm) gypsum board on both sides may use the next thinner stud but not less than 33 mils (0.84 mm).

6 For second story floors with 40 psf live load, select the stud size from the next higher ground snow load column.

Table 6.8
Steel Stud Thickness for 8' Walls Supporting Roof and Ceiling Only
(One Story or Second Floor of a Two Story Building)
50 ksi Steel

Wind Speed		Member Size[3]	Member Spacing (inches)	Stud Thickness (mils)[1,2]															
				Building Width (feet)[4]															
				24				28				32				36			
Exp. A/B	Exp. C			Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)			
				20	30	50	70	20	30	50	70	20	30	50	70	20	30	50	70
70 mph		2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
80 mph	70 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
90 mph	80 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
100 mph	90 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	43	43	33	33	43	43	33	43	43	43
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
110 mph	100 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	54	43	43	43	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
	110 mph	2x4	16	33	33	33	33	33	33	33	43	33	33	43	43	33	33	43	43
			24	43	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 mph = 1.61 km/hr, 1 foot = 0.3 m.

1 Deflection criteria: L/240

2 Design load assumptions: Roof dead load is 12 psf (0.575 kN/m^2)
Attic live load is 10 psf (0.479 kN/m^2)

3 For actual sizes of members, refer to Table 2.1.

4 Building width is in the direction of horizontal framing members supported by the wall studs.

Table 6.9
Steel Stud Thickness for 8' Walls Supporting One Floor, Roof and Ceiling
(First Story of a Two Story Building)
50 ksi Steel

Wind Exposure		Member Size[3]	Member Spacing (inches)	Required Stud Thickness (mils)[1,2]															
				Building Width (feet)[4]															
				24				28				32				36			
Exp. A/B	Exp. C			Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)			
				20	30	50	70	20	30	50	70	20	30	50	70	20	30	50	70
70 mph		2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
			24	33	33	33	43	33	33	43	43	43	43	43	43	43	43	43	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	43	33	33	43	43
80 mph	70 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
			24	33	43	43	43	43	43	43	43	43	43	43	43	43	33	33	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
			24	33	33	33	33	33	33	33	33	33	33	33	43	33	33	43	43
90 mph	80 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
			24	43	43	43	43	43	43	43	43	43	43	54	54	43	54	54	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	43	33	33	43	43
100 mph	90 mph	2x4	16	33	33	33	33	33	33	33	43	33	33	43	43	33	43	43	43
			24	43	43	43	54	43	54	54	54	54	54	54	54	54	54	54	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	43	33	33	43	43
110 mph	100 mph	2x4	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	68	54	54	68	68	68	68	68	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
			24	33	33	33	43	33	43	43	43	43	43	43	43	43	43	43	43
	110 mph	2x4	16	43	43	43	43	43	43	43	43	43	43	43	54	43	43	54	54
			24	54	68	68	68	68	68	68	68	68	68	68	68	68	68	68	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 mph = 1.61 km/hr, 1 foot = 0.3 m.

1 Deflection criteria: L/240

2 Design load assumptions:
Second floor dead load is 10 psf (0.48 kN/m^2) Attic live load is 10 psf (0.48 kN/m^2)
Second floor live load is 30 psf (1.44 kN/m^2) Roof dead load is 12 psf (0.575 kN/m^2)

3 For actual sizes of members, refer to Table 2.1

4 Building width is in the direction of horizontal framing members supported by the wall studs.

Table 6.10
Steel Stud Thickness for 9' Walls Supporting Roof and Ceiling Only
(One Story or Second Floor of a Two Story Building)
50 ksi Steel

Wind Exposure		Member Size[3]	Member Spacing (inches)	Required Stud Thickness (mils)[1,2]															
				Building Width (feet)[4]															
				24				28				32				36			
Exp. A/B	Exp. C			Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)			
				20	30	50	70	20	30	50	70	20	30	50	70	20	30	50	70
70 mph		2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
80 mph	70 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
90 mph	80 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	43	33	33	33	43	33	33	43	43
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
100 mph	90 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
110 mph	100 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	43	33	33	43	43
			24	43	43	54	54	43	54	54	54	54	54	54	54	54	54	54	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
	110 mph	2x4	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	68	54	54	54	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	43	33	33	43	43	33	33	43	43

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 mph = 1.61 km/hr, 1 foot = 0.3 m.

1 Deflection criteria: L/240

2 Design load assumptions: Roof dead load is 12 psf (0.575 kN/m^2)
Attic live load is 10 psf (0.479 kN/m^2)

3 For actual sizes of members, refer to Table 2.1.

4 Building width is in the direction of horizontal framing members supported by the wall studs.

Table 6.11
Steel Stud Thickness for 9' Walls Supporting One Floor, Roof and Ceiling
(First Story of a Two Story Building)
50 ksi Steel

Wind Exposure		Member Size[3]	Member Spacing (inches)	Required Stud Thickness (mils)[1,2] — Building Width (feet)[4]															
				24				28				32				36			
				Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)			
Exp. A/B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70	20	30	50	70
70 mph		2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	43	43	43	43	43	43	43	43	43	43	43
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
80 mph	70 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	43	43	43	54	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
90 mph	80 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	43	33	33	33	43	43
			24	43	43	43	43	43	43	43	54	43	54	54	54	54	54	54	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
100 mph	90 mph	2x4	16	33	33	33	43	33	33	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	43	33	33	43	43	43	43	43	43
110 mph	100 mph	2x4	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	54
			24	54	54	68	68	68	68	68	68	68	68	68	68	68	68	68	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
	110 mph	2x4	16	43	43	43	54	43	43	54	54	54	54	54	54	54	54	54	54
			24	68	68	68	68	68	68	68	68	68	68	97	97	68	97	97	97
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	54

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 mph = 1.61 km/hr, 1 foot = 0.3 m.

1 Deflection criteria: L/240

2 Design load assumptions:
Second floor dead load is 10 psf (0.48 kN/m^2) Attic live load is 10 psf (0.48 kN/m^2)
Second floor live load is 30 psf (1.44 kN/m^2) Roof dead load is 12 psf (0.575 kN/m^2)

3 For actual sizes of members, refer to Table 2.1.

4 Building width is in the direction of horizontal framing members supported by the wall studs.

Table 6.12
Steel Stud Thickness for 10' Walls Supporting Roof and Ceiling Only
(One Story or Second Floor of a Two Story Building)
50 ksi Steel

Wind Exposure		Member Size[3]	Member Spacing (inches)	Required Stud Thickness (mils)[1,2]															
				Building Width (feet)[4]															
				24				28				32				36			
Exp. A/B	Exp. C			Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)			
				20	30	50	70	20	30	50	70	20	30	50	70	20	30	50	70
70 mph		2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
80 mph	70 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	33	33	43	43	33	33	43	43
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
90 mph	80 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
100 mph	90 mph	2x4	16	33	33	33	33	33	33	33	33	33	33	33	43	33	33	33	43
			24	43	43	54	54	43	43	54	54	43	54	54	54	54	54	54	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
110 mph	100 mph	2x4	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	68	54	54	68	68	54	54	68	68	54	68	68	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	43	43	33	33	43	43	33	43	43	43
	110 mph	2x4	16	43	43	54	54	43	43	54	54	43	54	54	54	54	54	54	54
			24	68	68	68	68	68	68	68	97	68	68	68	97	68	68	97	97
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 mph = 1.61 km/hr, 1 foot = 0.3 m.

1 Deflection criteria: L/240

2 Design load assumptions: Roof dead load is 12 psf (0.575 kN/m^2)
Attic live load is 10 psf (0.479 kN/m^2)

3 For actual sizes of members, refer to Table 2.1.

4 Building width is in the direction of horizontal framing members supported by the wall studs.

Table 6.13
Steel Stud Thickness for 10' Walls Supporting One Floor, Roof and Ceiling
(First Story of a Two Story Building)
50 ksi Steel

Wind Exposure Exp. A/B	Wind Exposure Exp. C	Member Size[3]	Member Spacing (inches)	Required Stud Thickness (mils)[1,2] Building Width (feet)[4] 24, Ground Snow Load (psf) 20	24: 30	24: 50	24: 70	28: 20	28: 30	28: 50	28: 70	32: 20	32: 30	32: 50	32: 70	36: 20	36: 30	36: 50	36: 70
70 mph		2x4	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
			24	43	43	43	43	43	43	43	43	43	43	54	54	43	54	54	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	43	33	33	33	43
80 mph	70 mph	2x4	16	33	33	33	33	33	33	33	43	33	33	43	43	43	43	43	43
			24	43	43	54	54	54	54	54	54	54	54	54	54	54	54	54	54
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	43	33	33	43	43
90 mph	80 mph	2x4	16	33	33	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	68	68	54	68	68	68
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	43	33	43	43	43	43	43	43	43
100 mph	90 mph	2x4	16	43	43	43	43	43	43	43	43	43	43	43	54	43	43	54	54
			24	54	54	68	68	68	68	68	68	68	68	68	68	68	68	68	97
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43
110 mph	100 mph	2x4	16	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54	54
			24	68	68	97	97	97	97	97	97	97	97	97	97	97	97	97	97
		2x6	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	43
			24	43	43	43	43	43	43	43	43	43	43	43	54	43	43	54	54
	110 mph	2x4	16	54	54	54	54	54	54	54	54	54	54	68	68	54	68	68	68
			24	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97	97
		2x6	16	33	33	33	33	33	33	43	43	33	43	43	43	43	43	43	43
			24	43	43	54	54	54	54	54	54	54	54	54	54	54	54	54	54

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m², 1 mph = 1.61 km/hr, 1 foot = 0.3 m.

1 Deflection criteria: L/240

2 Design load assumptions:
Second floor dead load is 10 psf (0.48 kN/m²) Attic live load is 10 psf (0.48 kN/m²)
Second floor live load is 30 psf (1.44 kN/m²) Roof dead load is 12 psf (0.575 kN/m²)

3 For actual sizes of members, refer to Table 2.1.

4 Building width is in the direction of horizontal framing members supported by the wall studs.

Table 6.14
Wall Fastening Schedule

Connection	Number & Type of Fasteners	Spacing of Fasteners
Stud to top or bottom track	2 # 8 screws	Each end of stud, one per flange
Structural sheathing (oriented strand board or plywood) to framing	# 8 screws[1]	6" on edges 12" on intermediate supports
1/2" Gypsum board to framing	# 6 screws	12" oc.

For SI: 1 inch = 25.4 mm

1 Head styles shall be bugle-head, flat-head, or similar head with a minimum head diameter of 0.29 inches (8 mm).

Table 6.15a
Allowable Header Spans for
Headers Supporting Roof and Ceiling Only[1,2]
33 ksi

Nominal Member Size[3]	20 psf Ground Snow Load				30 psf Ground Snow Load			
	Building Width[4]				Building Width[4]			
	24'	28'	32'	36'	24'	28'	32'	36'
2-2 x 4 x 33	3'-11"	3'-8"	3'-5"	3'-3"	3'-8"	3'-5"	3'-2"	2'-10"
2-2 x 4 x 43	4'-9"	4'-5"	4'-2"	4'-0"	4'-5"	4'-2"	3'-11"	3'-9"
2-2 x 4 x 54	5'-4"	5'-0"	4'-9"	4'-6"	5'-0"	4'-8"	4'-5"	4'-2"
2-2 x 4 x 68	6'-0"	5'-7"	5'-3"	5'-0"	5'-7"	5'-3	4'-11"	4'-8"
2-2x 4 x 97	7'-1"	6'-8"	6'-3"	5'-11"	6'-8"	6'-2"	5'-10"	5'-7"
2-2x 6 x 33	3'-11"	3'-5"	3'-0"	2'-9"	3'-5"	3'-0"	2'-8"	2'-5"
2-2 x 6 x 43	6'-5"	6'-0"	5'-8"	5'-5"	6'-0"	5'-8"	5'-4"	5'-0"
2-2x 6 x 54	7'-3"	6'-10"	6'-5"	6'-1"	6'-9"	6'-4"	6'-0"	5'-8"
2-2 x 6 x 68	8'-2"	7'-8"	7'-2"	6'-10"	7'-7"	7'-2"	6'-9"	6'-4"
2-2 x 6 x 97	9'-9"	9'-1"	8'-7"	8'-2"	9'-1"	8'-6"	8'-0"	7'-7"
2-2 x 8 x 33	3'-0"	2'-8"	2'-4"	2'-1"	2'-7"	2'-3"	--	--
2-2 x 8 x 43	6'-8"	5'-10"	5'-2"	4'-8"	5'-10"	5'-1"	4'-6"	4'-1"
2-2x 8 x 54	9'-6"	8'-10"	8'-4"	7'-11"	8'-10"	8'-3"	7'-9"	7'-5"
2-2 x 8 x 68	10'-8"	10'-0"	9'-5"	8'-11"	9'-11"	9'-4"	8'-9"	8'-4"
2-2 x 8 x 97	12'-10"	11'-11"	11'-3"	10'-8"	11'-11"	11'-2"	10'-6"	10'-0"
2-2 x 10 x 43	5'-7"	4'-10"	4'-4"	3'-11"	4'-10"	4'-3"	3'-9"	3'-5"
2-2 x 10 x 54	10'-6"	9'-8"	8'-7"	7'-9"	9'-8"	8'-5"	7'-6"	6'-9"
2-2 x 10 x 68	12-7"	11'-9"	11'-1"	10'-6"	11'-9"	10'-12"	10'-4"	9'-10"
2-2 x 10 x 97	15'-2"	14'-2"	13'-4"	12'-8"	14'-1"	13'-2"	12'-5"	11'-10"
2-2 x 12 x 43	4'-9"	4'-2"	3'-8"	3'-4"	4'-2"	3'-8"	3'-3"	2'-11"
2-2 x 12 x 54	9'-6"	8'-3"	7'-4"	6'-7"	8'-3"	7'-3"	6'-5"	5'-9"
2-2 x 12 x 68	13'-5"	12'-7"	11'-10"	11'-3"	12'-6"	11'-9"	11'-1"	10'-6"
2-2 x 12 x 97	17'-5"	16'-3"	15'-4"	14'-7"	16'-3"	15'-2"	14'-4"	13'-7"

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 foot = 0.3 m.

1 Deflection criteria: L/360 for live loads, L/240 for total loads.
2 Design load assumptions:
Roof dead load is 7 psf (0.335 kN/m^2)
Ceiling dead load is 5 psf (0.24 kN/m^2)
Attic live load is 10 psf (0.479 kN/m^2)
3 Refer to Table 2.1 for actual size.
4 Building width is in the direction of horizontal framing members supported by the header.

Table 6.15b
Allowable Header Spans for
Headers Supporting Roof and Ceiling Only[1,2]
33 ksi

Nominal Member Size[3]	50 psf Ground Snow Load				70 psf Ground Snow Load			
	Building Width[4]				Building Width[4]			
	24'	28'	32'	36'	24'	28'	32'	36'
2-2 x 4 x 33	3'-0"	2'-7"	2'-4"	2'-1"	2'-4"	2'-1"	--	--
2-2 x 4 x 43	3'-10"	3'-7"	3'-4"	3'-2"	3'-5"	3'-2"	3'-0"	2'-9"
2-2 x 4 x 54	4'-3"	4'-0"	3'-9"	3'-7"	3'-10"	3'-7"	3'-4"	3'-2"
2-2 x 4 x 68	4'-10"	4'-6"	4'-3"	4'-0"	4'-3"	4'-0"	3'-9"	3'-7"
2-2x 4 x 97	5'-8"	5'-4"	5'-0"	4'-9"	5'-1"	4'-9"	4'-5"	4'-3"
2-2x 6 x 33	2'-6"	2'-2"	--	--	--	--		
2-2 x 6 x 43	5'-2"	4'-10"	4'-4"	3'-11"	4'-5"	3'-10"	3'-5"	3'-1"
2-2x 6 x 54	5'-10"	5'-5"	5'-1"	4'-10"	5'-2"	4'-10"	4'-7"	4'-4"
2-2 x 6 x 68	6'-6"	6'-1"	5'-9"	5'-6"	5'-10"	5'-5"	5'-1"	4'-10"
2-2 x 6 x 97	7'-10"	7'-3"	6'-10"	6'-5"	6'-11"	6'-6"	6'-1"	5'-9"
2-2 x 8 x 33	--	--	--	--	--	--	--	--
2-2 x 8 x 43	4'-3"	3'-9"	3'-4"	3'-0"	3'-4"	2'-11"	2'-7"	2'-4"
2-2x 8 x 54	7'-7"	7'-1"	6'-7"	5'-11"	6'-9"	5'-10"	5'-3"	4'-8"
2-2 x 8 x 68	8'-6"	8'-0"	7'-6"	7'-2"	7'-7"	7'-1"	6'-8"	6'-4"
2-2 x 8 x 97	10'-3"	9'-7"	9'-0"	8'-7"	9'-1"	8'-6"	8'-0"	7'-7"
2-2 x 10 x 43	3'-7"	3'-1"	2'-9"	2'-6"	2'-10"	2'-6"	2'-2"	--
2-2 x 10 x 54	7'-1"	6'-2"	5'-6"	4'-11"	5'-7"	4'-11"	4'-4"	3'-11"
2-2 x 10 x 68	10'-1"	9'-5"	8'-10"	8'-5"	8'-11"	8'-4"	7'-11"	7'-6"
2-2 x 10 x 97	12'-1"	11'-4"	10'-8"	10'-1"	10'-9"	10'-1"	9'-6"	9'-0"
2-2 x 12 x 43	3'-1"	2'-8"	2'-4"	2'-2"	2'-5"	2'-1"	--	--
2-2 x 12 x 54	6'-1"	5'-4"	4'-9"	4'-3"	4'-10"	4'-2"	3'-9"	3'-4"
2-2 x 12 x 68	10'-9"	10'-1"	9'-6"	8'-6"	9'-7"	8'-5"	7'-6"	6'-9"
2-2 x 12 x 97	13'-11"	13'-0"	12'-3"	11'-8"	12'-5"	11'-7"	10'-11"	10'-4"

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 foot = 0.3 m.

1 Deflection criteria: L/360 for live loads, L/240 for total loads.
2 Design load assumptions:
Roof dead load is 7 psf (0.335 kN/m^2)
Ceiling dead load is 5 psf (0.24 kN/m^2)
Attic live load is 10 psf (0.479 kN/m^2)
3 Refer to Table 2.1 for actual size
4 Building width is in the direction of horizontal framing members supported by the header.

Table 6.16a
Allowable Header Spans for
Headers Supporting One Floor, Roof and Ceiling[1,2]
33 ksi

Nominal Member Size[3]	20 psf Ground Snow Load				30 psf Ground Snow Load			
	Building Width[4]				Building Width[4]			
	24'	28'	32'	36'	24'	28'	32'	36'
2-2 x 4 x 33	2'-3"	--	--	--	2'-2"	--	--	--
2-2 x 4 x 43	3'-4"	3'-1"	2'-11"	2'-9"	3'-3"	3'-1"	2'-11"	2'-8"
2-2 x 4 x 54	3'-9"	3'-6"	3'-4"	3'-2"	3'-8"	3'-6"	3'-3"	3'-1"
2-2 x 4 x 68	4'-2"	3'-11"	3'-9"	3'-6"	4'-1"	4'-0"	3'-8"	3'-6"
2-2x 4 x 97	4'-11"	4'-8"	4'-5"	4'-2"	4'-11"	4'-7"	4'-4"	4'-2"
2-2x 6 x 33	--	--	--	--	--	--	--	--
2-2 x 6 x 43	4'-2"	3'-9"	3'-4"	3'-0"	4'-1"	3'-8"	3'-3"	3'-0"
2-2x 6 x 54	5'-1"	4'-9"	4'-6"	4'-3"	5'-0"	4'-8"	4'-5"	4'-3"
2-2 x 6 x 68	5'-8"	5'-4"	5'-1"	4'-10"	5'-7"	5'-3"	5'-0"	4'-9"
2-2 x 6 x 97	6'-9"	6'-4"	6'-0"	5'-9"	6'-8"	6'-4"	6'-0"	5'-8"
2-2 x 8 x 33	--	--	--	--	--	--	--	--
2-2 x 8 x 43	3'-3"	2'-10"	2'-7"	2'-4"	3'-2"	2'-9"	2'-6"	2'-3"
2-2x 8 x 54	6'-5"	5'-8"	5'-1"	4'-7"	6'-3"	5'-7"	5'-0"	4'-6"
2-2 x 8 x 68	7'-5"	7'-0"	6'-7"	6'-4"	7'-4"	6'-11"	6'-6"	6'-3"
2-2 x 8 x 97	8'-11"	8'-4"	7'-11"	7'-7"	8'-9"	8'-3"	7'-10"	7'-5"
2-2 x 10 x 43	2'-8"	2'-5"	2'-2"	2'-0"	2'-8"	2'-4"	2'-1"	2'-0"
2-2 x 10 x 54	5'-4"	4'-9"	4'-3"	3'-10"	5'-3"	4'-8"	4'-2"	3'-9"
2-2 x 10 x 68	8'-9"	8'-3"	7'-10"	7'-5"	8'-8"	8'-2"	7'-8"	7'-4"
2-2 x 10 x 97	10'-6"	9'-11"	9'-4"	8'-11"	10'-5"	9'-9"	9'-3"	8'-10"
2-2 x 12 x 43	2'-4"	2'-1"	--	--	2'-3"	--	--	--
2-2 x 12 x 54	4'-7"	4'-1"	3'-8"	3'-4"	4'-6"	4'-0"	3'-7"	3'-3"
2-2 x 12 x 68	9'-3"	8'-2"	7'-4"	6'-8"	9'-0"	8'-0"	7'-2"	6'-6"
2-2 x 12 x 97	12'-1"	11'-5"	10'-9"	10'-3"	12'-0"	11'-3"	10'-8"	10'-2"

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 foot = 0.3 m.

1 Deflection criteria: L/360 for live loads, L/240 for total loads.
2 Design load assumptions: Roof dead load is 7 psf (0.335 kN/m^2)
Ceiling dead load is 5 psf (0.24 kN/m^2)
Attic live load is 10 psf (0.479 kN/m^2)
Second floor live load is 30 psf (1.437 kN/m^2)
Second floor dead load is 10 psf (0.479 kN/m^2)
Second floor wall dead load is 10 psf (0.479 kN/m^2)
3 Refer to Table 2.1 for actual size.
4 Building width is in the direction of horizontal framing members supported by the header.

Table 6.16b
Allowable Header Spans for
Headers Supporting One Floor, Roof and Ceiling [1,2]
33 ksi

Nominal Member Size[3]	50 psf Ground Snow Load				70 psf Ground Snow Load			
	Building Width[4]				Building Width[4]			
	24'	28'	32'	36'	24'	28'	32'	36'
2-2 x 4 x 33	-	-	-	-	-	-	-	-
2-2 x 4 x 43	3'-1"	2'-11"	2'-8"	2'-5"	2'-10"	2'-6"	2'-3"	2'-1"
2-2 x 4 x 54	3'-6"	3'-3"	3'-1"	3'-0"	3'-3"	3'-0"	2'-10"	2'-9"
2-2 x 4 x 68	3'-11"	3'-8"	3'-6"	3'-4"	3'-7"	3'-5"	3'-2"	3'-1"
2-2x 4 x 97	4'-8"	4'-4"	4'-2"	3'-11"	4'-3"	4'-0"	3'-10"	3'-7"
2-2x 6 x 33	-	-	-	-	-	-	-	-
2-2 x 6 x 43	3'-8"	3'-3"	2'-11"	2'-8"	3'-2"	2'-9"	2'-6"	2'-3"
2-2x 6 x 54	4'-9"	4'-6"	4'-3"	4'-0"	4'-4"	4'-1"	3'-11"	3'-8"
2-2 x 6 x 68	5'-4"	5'-0"	4'-9"	4'-6"	4'-11"	4'-7"	4'-4"	4'-2"
2-2 x 6 x 97	6'-4"	6'-0"	5'-8"	5'-5"	5'-10"	5'-6"	5'-3"	4'-11"
2-2 x 8 x 33	--	--	--	--	--	--	--	--
2-2 x 8 x 43	2'-10"	2'-6"	2'-3"	--	2'-5"	2'-2"	--	--
2-2x 8 x 54	5'-8"	5'-0"	4'-6"	4'-1"	4'-10"	4'-3"	3'-10"	3'-5"
2-2 x 8 x 68	7'-0"	6'-7"	6'-2"	5'-11"	6'-5"	6'-0"	5'-8"	5'-5"
2-2 x 8 x 97	8'-4"	7'-10"	7'-5"	7'-1"	7'-8"	7'-3"	6'-10"	6'-6"
2-2 x 10 x 43	2'-4"	2'-1"	--	--	--	--	--	--
2-2 x 10 x 54	4'-9"	4'-2"	3'-9"	3'-5"	4'-0"	3'-6"	3'-2"	2'-10"
2-2 x 10 x 68	8'-3"	7'-9"	7'-4"	6'-10"	7'-7"	7'-1"	6'-5"	5'-9"
2-2 x 10 x 97	9'-10"	9'-3"	8'-9"	8'-4"	9'-1"	8'-7"	8'-1"	7'-8"
2-2 x 12 x 43	--	--	--	--	--	--	--	--
2-2 x 12 x 54	4'-0"	3'-7"	3'-2"	2'-11"	3'-5"	3'-0"	2'-9"	2'-5"
2-2 x 12 x 68	8'-2"	7'-2"	6'-5"	5'-10"	6'-11"	6'-1"	5'-6"	4'-11"
2-2 x 12 x 97	11'-4"	10'-8"	10'-1"	9'-8"	10'-6"	9'-0"	9'-4"	8'-10"

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 foot = 0.3 m.

1 Deflection criteria: L/360 for live loads, L/240 for total loads.

2 Design load assumptions: Roof dead load is 7 psf (0.335 kN/m^2)
Ceiling dead load is 5 psf (0.24 kN/m^2)
Attic live load is 10 psf (0.479 kN/m^2)
Second floor live load is 30 psf (1.437 kN/m^2)
Second floor dead load is 10 psf (0.479 kN/m^2)
Second floor wall dead load is 10 psf (0.479 kN/m^2)

3 Refer to Table 2.1 for actual size.

4 Building width is in the direction of horizontal framing members supported by the header.

Table 6.17a
Allowable Header Spans for
Headers Supporting One Floor, Roof and Ceiling[1,2]
First story of a two-story building with center load bearing Beam
33 ksi

Nominal Member Size[3]	20 psf Ground Snow Load				30 psf Ground Snow Load			
	Building Width[4]				Building Width[4]			
	24'	28'	32'	36'	24'	28'	32'	36'
2-2 x 4 x 33	2'-10"	2'-6"	2'-3"	-	2'-7"	2'-3"	-	-
2-2 x 4 x 43	3'-9"	3'-6"	3'-4"	3'-2"	3'-7"	3'-4"	3'-2"	3'-0"
2-2 x 4 x 54	4'-2"	4'-0"	3'-9"	3'-7"	4'-0"	3'-9"	3'-7"	3'-5"
2-2 x 4 x 68	4'-8"	4'-5"	4'-2"	4'-0"	4'-6"	4'-2"	4'-0"	3'-10"
2-2x 4 x 97	5'-6"	5'-3"	5'-0"	4'-9"	5'-3"	5'-0"	4'-9"	4'-6"
2-2x 6 x 33	2'-5"	2'-2"	-	-	2'-2"	-	-	-
2-2 x 6 x 43	3'-6"	5'-1"	4'-9"	4'-3"	4'-10"	4'-3"	3'-10"	3'-6"
2-2x 6 x 54	5'-8"	5'-4"	5'-1"	4'-10"	5'-5"	5'-1"	4'-10"	4'-7"
2-2 x 6 x 68	6'-5"	6'-0"	5'-9"	5'-6"	6'-1"	5'-9"	5'-5"	5'-2"
2-2 x 6 x 97	7'-8"	7'-2"	6'-10"	6'-6"	7'-3"	6'-10"	6'-6"	6'-2"
2-2 x 8 x 33	-	-	-	-	-	-	-	-
2-2 x 8 x 43	4'-2"	3'-8"	3'-3"	3'-0"	3'-8"	3'-3"	2'-11"	2'-8"
2-2x 8 x 54	7'-5"	7'-0"	6'-6"	6'-0"	7'-1"	6'-6"	5'-10"	5'-4"
2-2 x 8 x 68	8'-4"	7'-11"	7'-6"	7'-1"	7'-11"	7'-6"	7'-1"	6'-9"
2-2 x 8 x 97	10'-0"	9'-9"	9'-0"	8'-6"	9'-6"	9'-0"	8'-6"	8'-1"
2-2 x 10 x 43	3'-5"	3'-0"	2'-9"	2'-6"	3'-1"	2'-9"	2'-6"	2'-3"
2-2 x 10 x 54	6'-10"	6'-0"	5'-6"	5'-0"	6'-2"	5'-5"	4'-11"	4'-5"
2-2 x 10 x 68	9'-10"	9'-4"	8'-10"	8'-5"	9'-4"	8'-10"	8'-4"	8'-0"
2-2 x 10 x 97	11'-10"	11'-2"	10'-7"	10'-1"	11'-3"	10'-7"	10'-1"	9'-7"
2-2 x 12 x 43	2'-11"	2'-7"	2'-4"	2'-1"	2'-8"	2'-4"	-	-
2-2 x 12 x 54	5'-10"	5'-2"	4'-8"	4'-3"	5'-3"	4'-8"	4'-2"	3'-10"
2-2 x 12 x 68	10'-6"	10'-0"	9'-5"	8'-6"	9'-12"	9'-5"	8'-5"	7'-8"
2-2 x 12 x 97	13'-8"	12'-10"	12'-2"	11'-8"	13'-0"	12'2"	11'-7"	11'-1"

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 foot = 0.3 m.

1 Deflection criteria: L/360 for live loads, L/240 for total loads.
2 Design load assumptions: Roof dead load is 7 psf (0.335 kN/m^2)
Ceiling dead load is 5 psf (0.24 kN/m^2)
Attic live load is 10 psf (0.479 kN/m^2)
Second floor live load is 30 psf (1.437 kN/m^2)
Second floor dead load is 10 psf (0.479 kN/m^2)
Second floor wall dead load is 10 psf (0.479 kN/m^2)
3 Refer to Table 2.1 for actual size.
4 Building width is in the direction of horizontal framing members supported by the header.

Table 6.17b
Allowable Header Spans for
Headers Supporting One Floor, Roof and Ceiling [1,2]
First story of a two-story building with center load bearing Beam
33 ksi

Nominal Member Size [3]	50 psf Ground Snow Load				70 psf Ground Snow Load			
	Building Width [4]				Building Width [4]			
	24'	28'	32'	36'	24'	28'	32'	36'
2-2 x 4 x 33	2'-2"	-	-	-	-	-	-	-
2-2 x 4 x 43	3'-3"	3'-1"	2'-11"	2'-8"	3'-0"	2'-9"	2'-6"	2'-3"
2-2 x 4 x 54	3'-8"	3'-5"	3'-3"	3'-1"	3'-5"	3'-2"	3'-0"	2'-10"
2-2 x 4 x 68	4'-1"	3'-10"	3'-8"	3'-6"	3'-9"	3'-7"	3'-4"	3'-2"
2-2x 4 x 97	4'-10"	4'-7"	4'-4"	4'-1"	4'-6"	4'-3"	4'-0"	3'-10"
2-2x 6 x 33	-	-	-	-	-	-	-	-
2-2 x 6 x 43	4'-0"	3'-7"	3'-2"	2'-11"	3'-5"	3'-1"	2'-9"	2'-6"
2-2x 6 x 54	4'-11"	4'-8"	4'-5"	4'-2"	4'-7"	4'-4"	4'-1"	3'-11"
2-2 x 6 x 68	5'-7"	5'-3"	4'-11"	4'-9"	5'-2"	4'-10"	4'-7"	4'-4"
2-2 x 6 x 97	6'-8"	6'-3"	5'-11"	5'-7"	6'-2"	5'-9"	5'-6"	5'-2"
2-2 x 8 x 33	-	-	-	-	-	-	-	-
2-2 x 8 x 43	3'-1"	2'-9"	2'-5"	2'-3"	2'-8"	2'-4"	-	-
2-2x 8 x 54	6'-2"	5'-5"	4'-11"	4'-5"	5'-3"	4'-8"	4'-2"	3'-9"
2-2 x 8 x 68	7'-3"	6'-10"	6'-6"	6'-2"	6'-9"	6'-4"	6'-0"	5'-8"
2-2 x 8 x 97	8'-8"	8'-2"	7'-9"	7'-5"	8'-1"	7'-7"	7'-2"	6'-10"
2-2 x 10 x 43	2'-7"	2'-3"	2'-1"	-	2'-3"	-	-	-
2-2 x 10 x 54	5'-1"	4'-6"	4'-1"	3'-8"	4'-5"	3'-11"	3'-6"	3'-2"
2-2 x 10 x 68	8'-7"	8'-1"	7'-8"	7'-3"	7'-11"	7'-6"	7'-0"	6'-4"
2-2 x 10 x 97	10'-3"	9'-8"	9'-2"	8'-9"	9'-6"	9'-0"	8'-6"	8'-1"
2-2 x 12 x 43	2'-3"	-	-	-	-	-	-	-
2-2 x 12 x 54	4'-5"	3'-11"	3'-6"	3'-2"	3'-9"	3'-4"	3'-0"	2'-8"
2-2 x 12 x 68	8'-10"	7'-10"	7'-0"	6'-4"	7'-7"	6'-9"	6'-0"	5'-5"
2-2 x 12 x 97	11'-10"	11'-2"	10'-7"	10'-1"	11'-0"	10'-4"	9'-9"	9'-4"

For SI: 1 inch = 25.4 mm, 1 psf = 0.0479 kN/m^2, 1 foot = 0.3 m.

1 Deflection criteria: L/360 for live loads, L/240 for total loads.
2 Design load assumptions: Roof dead load is 7 psf (0.335 kN/m^2)
Ceiling dead load is 5 psf (0.24 kN/m^2)
Attic live load is 10 psf (0.479 kN/m^2)
Second floor live load is 30 psf (1.437 kN/m^2)
Second floor dead load is 10 psf (0.479 kN/m^2)
Second floor wall dead load is 10 psf (0.479 kN/m^2)
3 Refer to Table 2.1 for actual size.
4 Building width is in the direction of horizontal framing members supported by the header.

Table 6.18
Total Number of Jack and King Studs Required at Each End of an Opening

Size of Opening	24" o.c. Stud Spacing		16" o.c. Stud Spacing	
	No. of Jack Studs	No. of King Studs	No. of Jack Studs	No. of King Studs
Up to 3'-6"	1	1	1	1
> 3'-6" to 5'-0"	1	2	1	2
> 5'-0" to 5'-6"	1	2	2	2
> 5'-6" to 8'-0"	1	2	2	2
> 8'-0" to 10'-6"	2	2	2	3
> 10'-6" to 12'-0"	2	2	3	3
> 12'-0" to 13'-0"	2	3	3	3
> 13'-0" to 14'-0"	2	3	3	4
> 14'-0" to 16'-0"	2	3	3	4
> 16'-0" to 18'-0"	3	3	4	4

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m.

Table 6.19
Number of Screws Required for Header to King Stud Connection

Header Span	Wind Speed (mph), Exposure & Seismic Zones [1,2,3]			
	Up to 70 A/B or Zones 0, 1, 2,3 or 4	Up to 90 A/B or 70 C	Up to 100 A/B or 90C	Up to 110 C
≤ 4'	4 - #8 screws	4 - #8 screws	6 - #8 screws	8 - #8 screws
> 4' to 8'	4 - #8 screws	4 - #8 screws	8 - #8 screws	12 - #8 screws
> 8' to 12'	4 - #8 screws	6 - #8 screws	10 - #8 screws	16 - #8 screws
> 12' to 16'	4 - #8 screws	8 - #8 screws	12 - #8 screws	20 - #8 screws

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m, 1 mph = 1.61 km/hr.

1 For headers located on the first floor of a two-story building, the total number of screws may be reduced by 2 screws, but the total number of screws shall be no less than 4.
2 For roof slopes of 6:12 or greater, the required number of screws may be reduced by 1/2, but the total number of screws shall be no less than 4.
3 All screw sizes shown are minimums.

Table 6.20
Minimum Percentage of Full Height Structural Sheathing Along Exterior Wall Lines[1,2,3,4]

Wall Condition	Roof Slope	Wind Speed (mph) and Exposure			
		Up To 70 C or 90 A/B or Seismic Zones 0, 1, & 2		Up To 90 C or 100 A/B	
		Endwall	Sidewall	Endwall	Sidewall
One-Story or Second Floor of Two-Story Construction	3:12	30%	30%	30%	30%
	6:12	30%	30%	40%	30%
	9:12	45%	30%	75%	50%
	12:12	60%	40%	100%	70%
First Floor of Two-Story Construction	3:12	50%	35%	80%	55%
	6:12	55%	40%	90%	60%
	9:12	75%	50%	Design Required	
	12:12	95%	65%		

For SI: 1 mph = 49 m/sec, 1 inch = 25.4 mm, 1 foot = 304.8 mm

1 Sidewalls shall be those walls parallel to the ridge and endwalls shall be those walls perpendicular to the ridge. If sidewalls are shorter in length than endwalls, then the higher percentage value shall be used for both walls.

2 Linear interpolation shall be permitted for values of the roof slope and wind speeds other than shown.

3 A 48-inch-wide (1219 mm) panel of structural sheathing shall be located at each end of a wall or as near thereto as possible. Individual segments of wall (i.e. between openings) with full-height sheathing shall be at least 48 inches (1219 mm) in length to count toward the length of full-height sheathing required by the tabulated percentages.

4 Percentages are given as percentages of the total wall length. For example, a 48-foot (14.6 m) long wall that requires 30% of full-height sheathing would result in 0.30x48 = 14.4 feet (4.4 m) of wall with full-height sheathing. In addition to the remainder of the wall without openings, areas above or below openings would also be sheathed.

7.0 NON-STRUCTURAL WALLS

7.1 Non-Load Bearing Studs

Non-load bearing steel framing shall comply with ASTM C 645 [12] and shall have a minimum base metal thickness of 18 mils (0.45 mm).

7.2 Construction Details

Figure 7.1 is provided for informational purposes only. Alternate framing details may be used when appropriate.

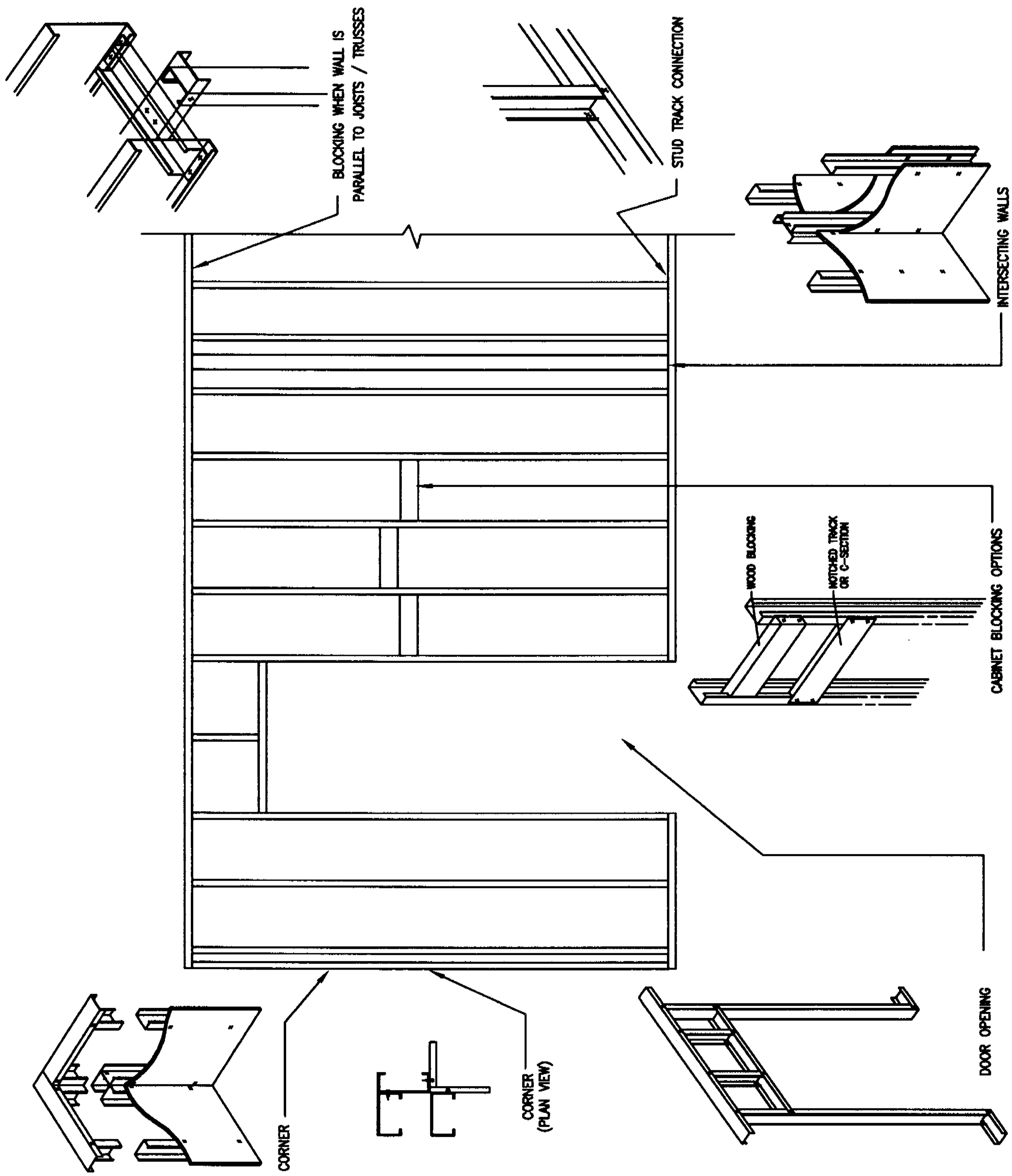

Figure 7.1 Typical Interior Non-Load Bearing Wall Detail

8.0 STEEL ROOF FRAMING

8.1 Roof Construction

Steel roof systems constructed in accordance with this section shall consist of both ceiling joists and rafters in accordance with Figures 8.1 through 8.7 or trusses in accordance with Section 8.8. Steel roof framing materials shall comply with the provisions of Section 2.0. Connections shall comply with Tables 8.1 through 8.3 and with other requirements in this section.

8.1.1 Applicability Limits

The applicability limits of Section 1.3 and Table 1.1 shall apply.

8.1.2 In-line Framing

Ceiling joists shall be located directly in-line with load bearing studs below with a maximum tolerance of 3/4-inch (19 mm) between the centerlines of the stud and the ceiling joist.

8.2 Allowable Ceiling Joist Spans

The maximum clear span of cold-formed steel ceiling joists shall be determined in accordance with Figure 8.1 and Tables 8.4 through 8.11. Ceiling joists shall have a minimum bearing length of 1-1/2 inch (38 mm) and shall be connected to rafters (heel joint) in accordance with Figure 8.2 and Table 8.2. When continuous joists are used across interior bearing supports, the interior bearing supports shall be located within 2 feet (610 mm) of mid-span of the ceiling joist, and the individual spans shall not exceed the applicable spans in Tables 8.4 through 8.11. Where required in Tables 8.4 through 8.11, bearing stiffeners shall be installed at each bearing and concentrated load location in accordance with Section 2.9 and Figure 8.4. When the attic is to be used as an occupied space, the ceiling joists shall be designed in accordance with Section 5.0.

8.3 Ceiling Joist Bracing

The bottom flanges of steel ceiling joists shall be laterally braced by the application of gypsum board installed with minimum #6 screws in accordance with applicable building code requirements or with 1-1/2 inch x 33 mil (38 mm x 0.84 mm) continuous steel strapping installed perpendicular to the joist run at a maximum spacing of 4 feet (1.2 m). Straps shall be fastened to the bottom flange at each joist with at least one #8 screw and shall be fastened to blocking with at least two #8 screws. Blocking or bridging (X-bracing) shall be installed between joists at a maximum spacing of 12 feet (3.7m) measured along a line of continuous strapping (perpendicular to the joist run). Blocking or bridging shall also be located at the termination of all straps.

The top flanges of steel ceiling joists shall be laterally braced with a minimum 33 mil (0.84 mm) C-shaped member, 33 mil (0.84 mm) track section, or 1-1/2 inch x 33 mil (38 mm x 0.84 mm) continuous steel strapping as required in Tables 8.4 through 8.11. Lateral bracing shall be installed perpendicular to the ceiling joist run in accordance with Figure 8.1. C-shaped members (i.e. studs), tracks, or straps shall be fastened to the top flange at each joist with at least one #8 screw and shall be fastened to blocking with at least two #8 screws. Blocking or bridging (X-bracing) shall be installed between joists in-line with strap bracing at a maximum spacing of 12 feet (3.7 m) measured perpendicular to the joists, and at the termination of all straps. The third point bracing span values from Tables 8.4 through 8.11 shall be used for straps installed at closer spacings than third point bracing, or when sheathing is applied to the top of the ceiling joists.

8.4 Allowable Rafter Spans

The horizontal projection of the rafter span, as shown in Figure 8.1, shall not exceed the limits set forth in Table 8.12. Wind speeds shall be converted to equivalent ground snow load in accordance with Table 8.13. Rafter spans shall be selected based on the higher of the ground snow load or the equivalent snow load converted from the wind speed. When used to achieve reduced rafter sizes, a rafter support brace shall be a minimum of 2 x 4 x 33 mil C-shaped member with maximum length of 8 feet (2.4 m) and shall be connected to a ceiling joist and rafter with 4 # 10 screws at each end.

Rafters shall be connected to a parallel ceiling joist to form a continuous tie between exterior walls in accordance with Figure 8.1, Figure 8.2 and Table 8.2. Rafters shall be connected to a ridge member with a minimum 2-inch x 2-inch (51 mm x 51 mm) clip angle fastened with minimum #10 screws to the ridge member in accordance with Figure 8.3 and Table 8.3. The clip angle shall have a steel thickness equivalent to or greater than the rafter thickness and shall extend the depth of the rafter member. The ridge member shall be fabricated from a C-shaped member and a track section, which shall have a minimum size and steel thickness equivalent to or greater than the adjacent rafters and shall be installed in accordance with Figure 8.3. The rafter member shall extend the full depth of the sloped rafter cut.

8.4.1 Roof Overhangs

Roof overhangs shall not exceed 24 inches (610 mm) in accordance with Figure 8.1.

8.5 Rafter Bottom Flange Bracing.

The bottom flanges of steel rafters shall be continuously braced with a minimum 33 mil (0.84 mm) C-shaped member, 33 mil (0.84 mm) track section, or 1-1/2 inch x 33 mil (38 mm x 0.836 mm) steel strapping at a maximum spacing of 8 feet (2.4 m) as measured parallel to the rafters. Bracing shall be installed in accordance with Figure 8.1. The C-shaped member, track section, or straps shall be fastened to the bottom flange of each rafter with at least one #8 screw and shall be fastened to blocking with at least two #8 screws. Blocking or bridging (X-bracing) shall be installed between rafters in-line with the continuous bracing at a maximum spacing of 12 feet (3.7 m) measured perpendicular to the rafters. The ends of continuous bracing shall be fastened to blocking or anchored to a stable building component with at least two #8 screws.

8.6 Splicing

Rafters and other structural members shall not be spliced with the exception of ceiling joist splices over load bearing walls. Splices in ceiling joists shall be supported at interior bearing points and shall be constructed in accordance with Figure 8.5. Spliced ceiling joists shall be connected with the same number and size of screws on each side of the splice as required for the ceiling joist to rafter connection (Table 8.2). Splicing of tracks used as a facia connected to the ends of rafters shall conform with Figure 5.11.

8.7 Framing of Openings

Openings in roof and ceilings shall be framed with headers and trimmers between ceiling joists or rafters. Header joist spans shall not exceed 4 feet (1.2 m). Header and trimmer joists shall be fabricated from joist and track members having a minimum size and thickness at least equivalent to the adjacent ceiling joists or rafters and shall be installed in accordance with Figures 8.6 and 8.7. Each header joist shall be connected to trimmer joist with a minimum of four 2-inch x 2-inch (51 x 51 mm) clip angles. Each clip angle shall be fastened to both the header and trimmer joists with four #8 screws, evenly spaced, through each leg of the clip angle. The clip angles shall have a steel thickness not less than that of the ceiling joist or rafter.

8.8 Roof Trusses

Trusses shall be engineered and installed in accordance with the applicable building code requirements and good practices. Roof bracing shall be installed in accordance with the truss design. All trusses shall be aligned with load carrying members (i.e. studs) in the wall. Refer to AISI publication RG-9518 [17] for additional guidance.

8.9 Roof Tie-Downs

In high wind conditions, an approved uplift connector (i.e. strap or bracket) shall be used to attach individual ceiling joists or rafters to a wall stud below. Approved uplift connectors shall meet or exceed the uplift loads specified in Table 8.14.

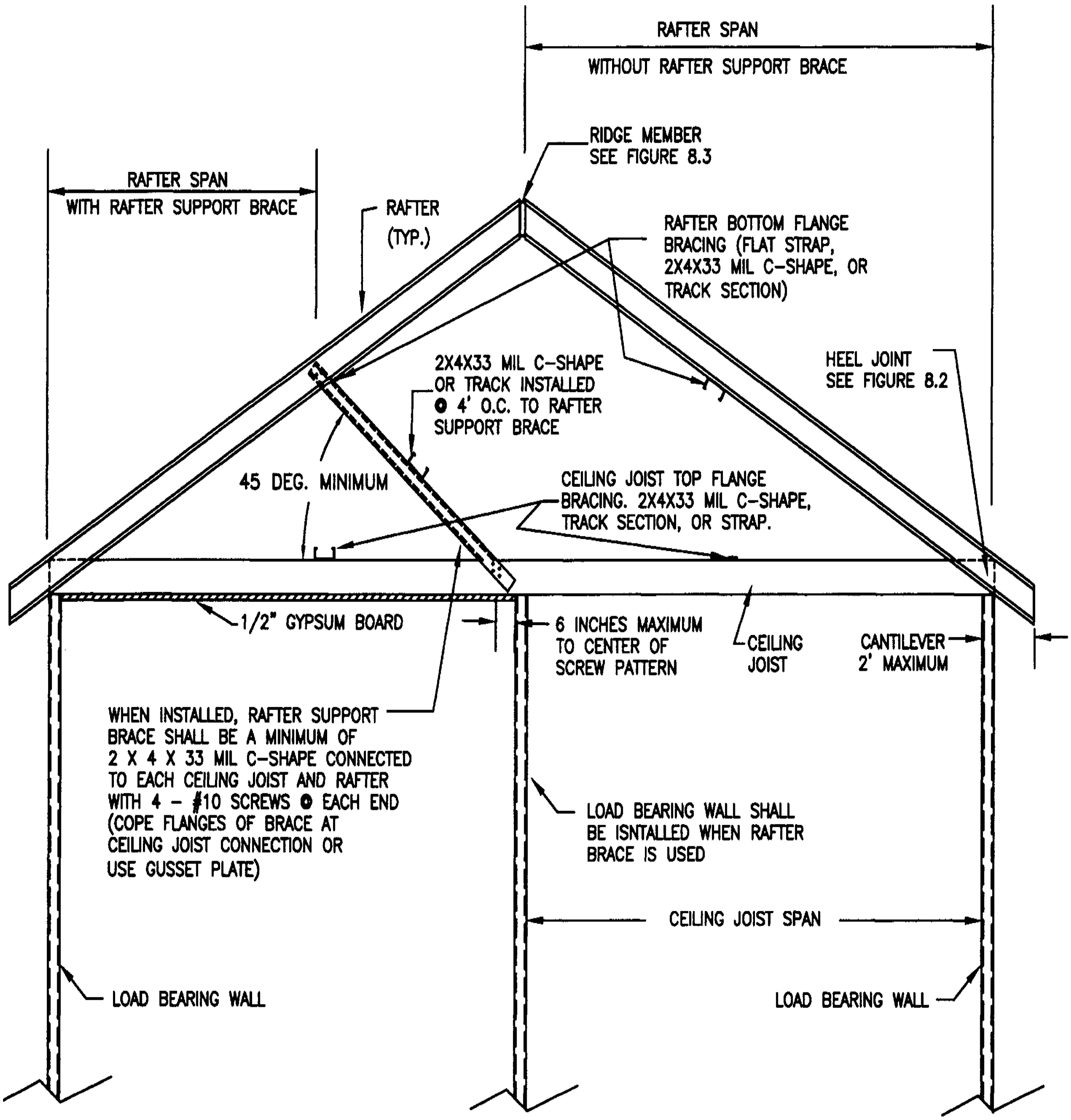

Figure 8.1 Steel Roof Construction

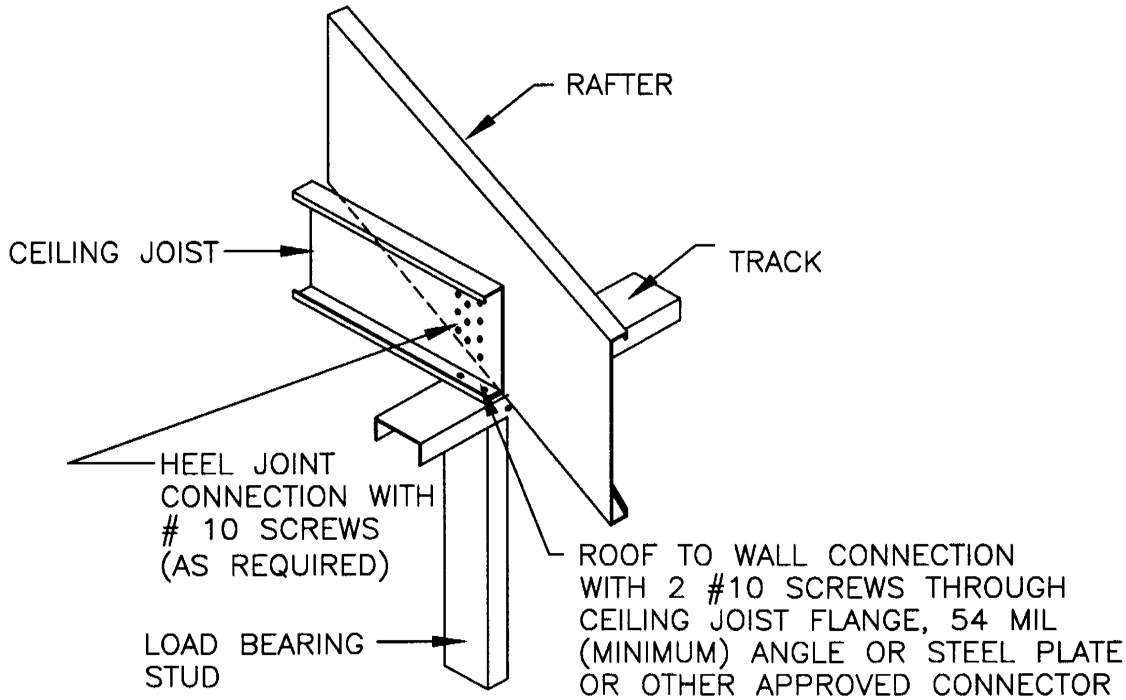

Figure 8.2 Heel Joint Connection

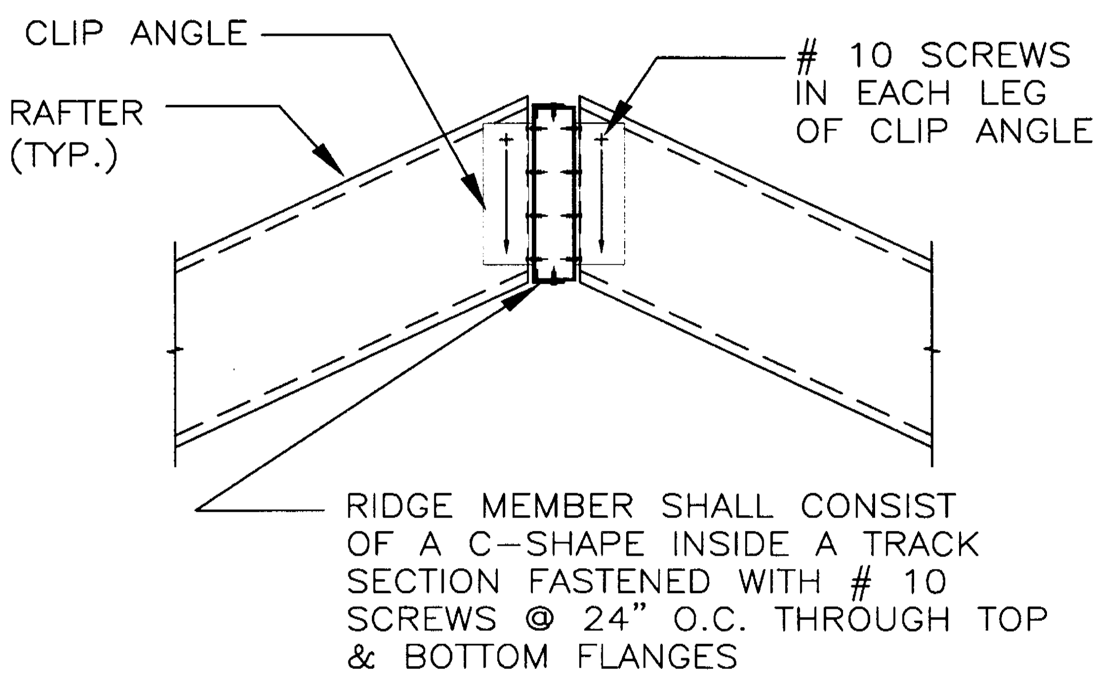

Figure 8.3 Ridge Member Connection

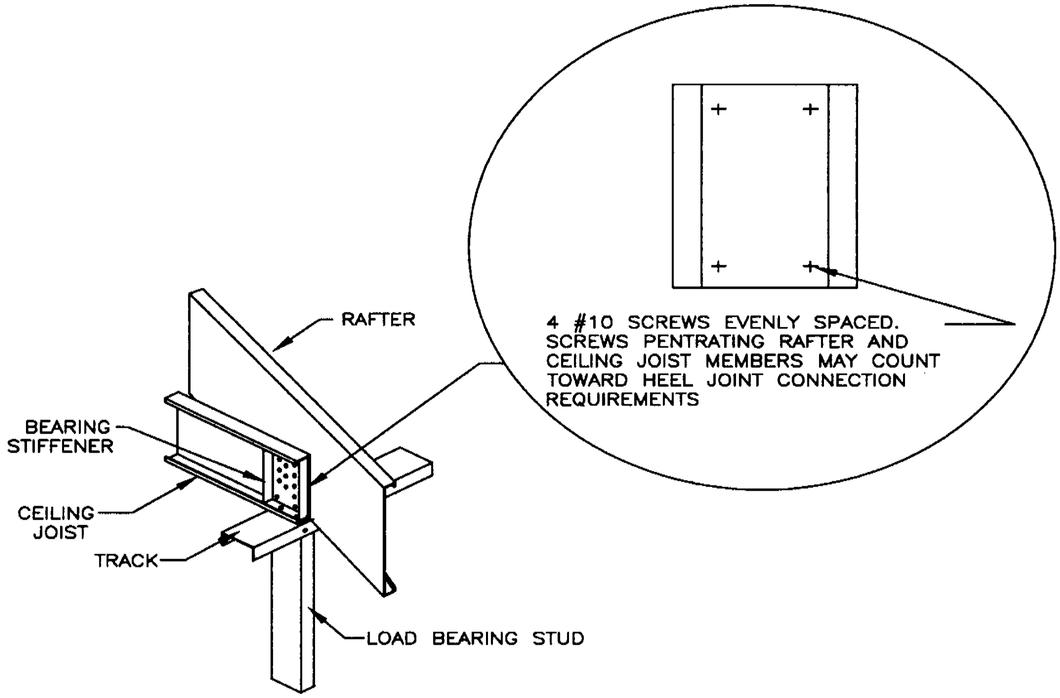

Figure 8.4 Bearing Stiffener

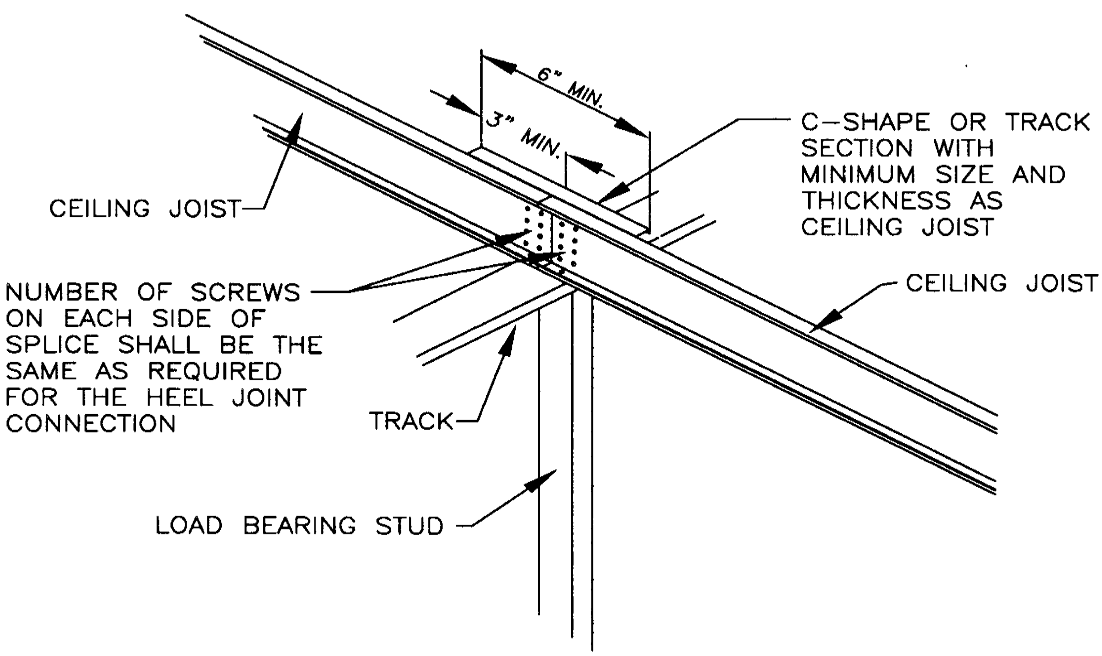

Figure 8.5 Spliced Ceiling Joists

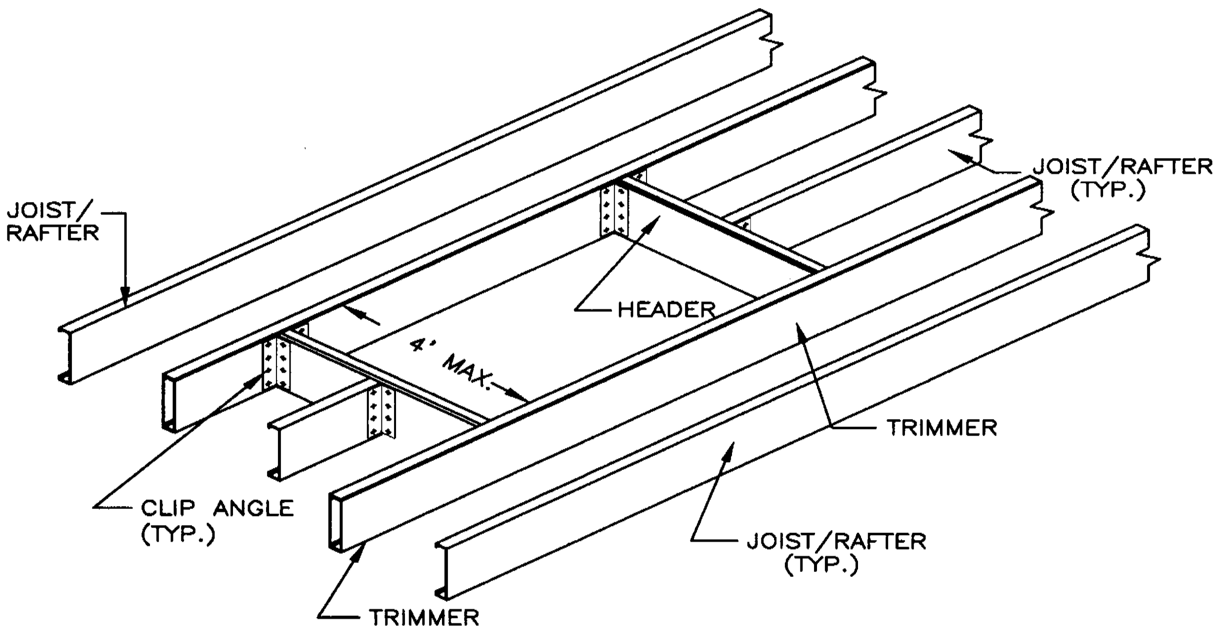

Figure 8.6 Roof or Ceiling Opening

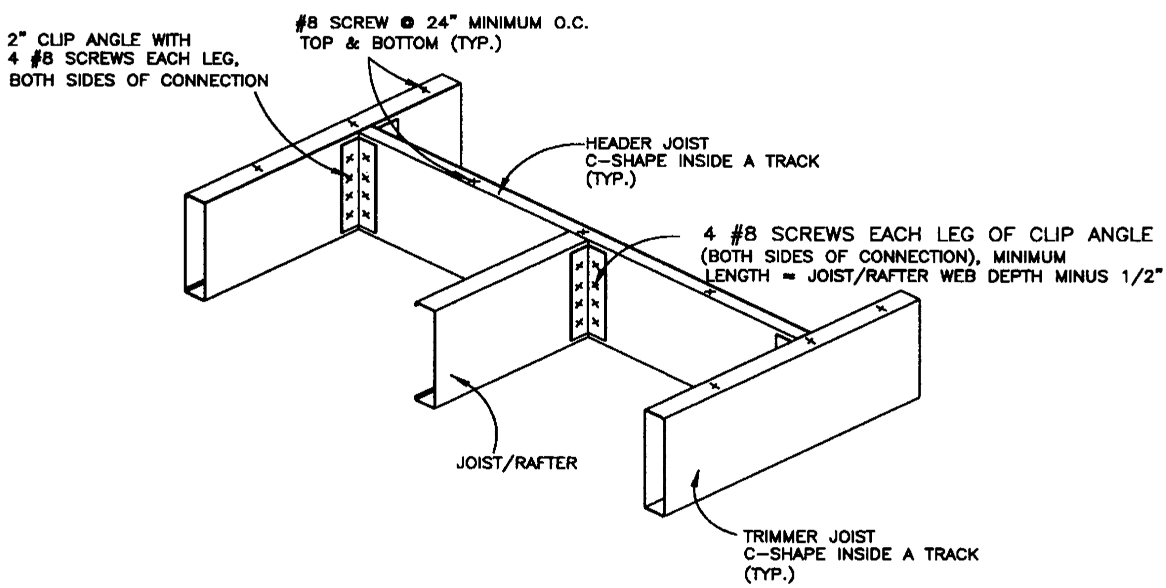

Figure 8.7 Header to Trimmer Detail

Table 8.1
Roof Framing Fastening Schedule

Description of Building Elements	Number and Size of Fasteners	Number and Spacing of Fasteners
Ceiling joist to top track of load bearing wall[1]	2 - No. 10 screws	Each joist
Roof sheathing (oriented strand board or plywood) to rafters	No. 8 screws	6" o.c. on edges and 12" o.c. at interior supports. (6" o.c. at gable end truss)
Truss to bearing wall [1]	2 - No. 10 screws	Each truss
Gable end truss to endwall top track	No. 10 screws	12" oc.
Rafter to ceiling joist or ridge member	Minimum No. 10 screws	See Tables 8.2 and 8.3

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m, 1 psf = 0.0479 kN/m^2.

1 Screws shall be applied through the flanges of the truss or ceiling joist or a 54 mil clip angle shall be used with 2 # 10 screws in each leg. See Section 8.10 for additional requirements to resist uplift forces.

Table 8.2
Number of Screws Required For Ceiling Joist to Rafter Connections[1]

Roof Slope	Building Width (feet)															
	24'				28'				32'				36'			
	Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)				Ground Snow Load (psf)			
	20	30	50	70	20	30	50	70	20	30	50	70	20	30	50	70
3/12	5	6	9	12	6	7	10	13	7	8	12	15	8	9	13	17
4/12	4	5	7	9	5	6	8	10	6	6	9	12	6	7	10	13
5/12	4	4	6	7	4	5	7	9	5	5	8	10	5	6	9	11
6/12	3	4	5	7	4	4	6	8	4	5	7	9	4	5	7	10
7/12	3	3	5	6	3	4	5	7	4	4	6	8	4	5	7	9
8/12	3	3	4	5	3	3	5	6	3	4	5	7	4	4	6	8
9/12	2	3	4	5	3	3	4	6	3	4	5	6	3	4	6	7
10/12	2	3	4	5	3	3	4	5	3	3	5	6	3	4	5	7
11/12	2	3	4	4	3	3	4	5	3	3	5	6	3	4	5	6
12/12	2	3	3	4	2	3	4	5	3	3	4	6	3	4	5	6

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m, 1 psf = 0.0479 kN/m^2.

1 Screws shall be # 10 minimum.

Table 8.3
Number of Screws Required at Each Leg of Clip Angle
For Rafter to Ridge Member Connection[1]

Building Width (feet)	Ground Snow Load (psf)			
	0 to 20	21 to 30	31 to 50	51 to 70
24	2	3	4	4
28	2	3	4	5
32	3	3	4	5
36	3	4	5	6

For SI: 1 foot = 0.3 m, 1 psf = 0.0479 kN/m^2.

1 Screws shall be #10 minimum.

Table 8.4
Allowable Spans For Cold-Formed Steel Ceiling Joists (33 ksi)
Single Spans With Bearing Stiffeners
10 Lbs. per Sq. Ft. Live Load (No Attic Storage) [1,2,3]

Nominal Joist Size [4]	Lateral Support of Top (Compression) Flange					
	Unbraced		Mid-Span Bracing		Third-Point	
	Spacing (inches)		Spacing (inches)		Spacing (inches)	
	16	24	16	24	16	24
2 x 4 x 33	9'-2"	8'-3"	11'-9"	10'-1"	11'-9"	10'-4"
2 x 4 x 43	9'-11"	8'-10"	12'-10"	11'-2"	12'-10"	11'-2"
2 x 4 x 54	10'-8"	9'-6"	13'-9"	12'-0"	13'-9"	12'-0"
2 x 4 x 68	11'-7"	10'-4"	14'-8"	12'-10"	14'-8"	12'-10"
2 x 4 x 97	13'-7"	12'-0"	16'-2"	14'-1"	16'-2"	14'-1"
2 x 6 x 33	10'-5"	9'-5"	14'-5"	12'-8"	16'-4"	13'-10"
2 x 6 x 43	11'-2"	10'-1"	15'-7"	13'-10"	18'-0"	15'-5"
2 x 6 x 54	12'-0"	10'-9"	16'-7"	14'-9"	19'-5"	16'-8"
2 x 6 x 68	12'-11"	11'-7"	17'-8"	15'-10"	20'-11"	18'-1"
2 x 6 x 97	14'-11"	13'-2"	19'-10"	17'-8"	23'-2"	20'-3"
2 x 8 x 33	11'-8"	10'-6"	16'-5"	14'-9"	19'-5"	16'-7"
2 x 8 x 43	12'-6"	11'-3"	17'-6"	15'-10"	21'-2"	18'-7"
2 x 8 x 54	13'-4"	11'-11"	18'-7"	16'-9"	22'-7"	20'-0"
2 x 8 x 68	14'-3"	12'-9"	19'-8"	17'-8"	23'-11"	21'-4"
2 x 8 x 97	16'-2"	14'-5"	21'-10"	19'-6"	26'-3"	23'-6"
2 x 10 x 43	13'-4"	12'-1"	18'-9"	16'-11"	22'-11"	20'-6"
2 x 10 x 54	14'-2"	12'-9"	19'-10"	17'-10"	24'-2"	21'-9"
2 x 10 x 68	15'-2"	13'-7"	21'-0"	18'-11"	25'-6"	23'-0"
2 x 10 x 97	17'-1"	15'-2"	23'-2"	20'-9"	27'-11"	25'-1"
2 x 12 x 43	14'-1"	12'-8"	19'-10"	17'-11"	24'-3"	21'-6"
2 x 12 x 54	15'-0"	13'-5"	20'-11"	18'-11"	25'-7"	23'-1"
2 x 12 x 68	15'-11"	14'-4"	22'-2"	19'-11"	27'-0"	24'-4"
2 x 12 x 97	17'-10"	15'-11"	24'-4"	21'-10"	29'-4"	26'-5"

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m, 1 psf = 0.0479 kN/m^2.

1 Bearing stiffeners shall be installed at all bearing and concentrated load locations.
2 Deflection criteria: L/240 for total loads.
3 Ceiling dead load = 5 psf (0.24 kN/m^2)
4 Refer to Table 2.1 for actual size.

Table 8.5
Allowable Spans For Cold-Formed Steel Ceiling Joists (33 ksi)
Two Equal Spans With Bearing Stiffeners
10 Lbs. per Sq. Ft. Live Load (No Attic Storage) [1,2,3,4,5]

Nominal Joist Size [6]	Lateral Support of Top (Compression Flange)					
	Unbraced		Mid-Span Bracing		Third-Point Bracing	
	Spacing (inches)		Spacing (inches)		Spacing (inches)	
	16	24	16	24	16	24
2 x 4 x 33	12'-4"	10'-11"	13'-5"	10'-11"	13'-5"	10'-11"
2 x 4 x 43	13'-6"	12'-1"	16'-4"	13'-4"	16'-4"	13'-4"
2 x 4 x 54	14'-9"	13'-1"	18'-4"	15'-0"	18'-4"	15'-0"
2 x 4 x 68	16'-4"	14'-5"	19'-8"	16'-9"	19'-8"	16'-9"
2 x 4 x 97	19'-6"	17'-2"	21'-8"	18'-11"	21'-8"	18'-11"
2 x 6 x 33	14'-0"	12'-7"	18'-2"	14'-10"	18'-2"	14'-10"
2 x 6 x 43	15'-2"	13'-7"	20'-11"	18'-1"	22'-1"	18'-1"
2 x 6 x 54	16'-5"	14'-8"	22'-5"	19'-5"	24'-11"	20'-4"
2 x 6 x 68	17'-11"	15'-11"	24'-1"	21'-5"	28'-0"	22'-10"
2 x 6 x 97	21'-2"	18'-8"	27'-7"	24'-5"	31'-1"	27'-2"
2 x 8 x 33	15'-7"	14'-1"	21'-3"	15'-10"	21'-3"	15'-10"
2 x 8 x 43	16'-10"	15'-1"	23'-6"	21'-2"	27'-6"	22'-5"
2 x 8 x 54	18'-1"	16'-2"	24'-11"	22'-5"	30'-2"	26'-6"
2 x 8 x 68	19'-7"	17'-6"	26'-8"	23-'11"	32'-2"	28'-7"
2 x 8 x 97	22'-10"	20'-2"	30'-2"	26'-10"	35'-10"	31'-11"
2 x 10 x 43	17'-11"	16'-2"	25'-1"	22'-7"	30'-6"	24'-9"
2 x 10 x 54	19'-3"	17'-3"	26'-7"	23'-11"	32-'4"	29'-1"
2 x 10 x 68	20'-9"	18'-6"	28'-5"	25'-6"	34'-4"	30'-10"
2 x 10 x 97	23'-11"	21'-2"	31'-10"	28'-4"	38'-0"	34'-0"
2 x 12 x 43	18'-11"	17'-0"	26'-6"	23'-10"	32'-4"	24'-5"
2 x 12 x 54	20'-2"	18'-1"	28'-1"	25'-3"	34'-2"	30'-9"
2 x 12 x 68	21'-9"	19'-5"	29'-10"	26'-10"	36'-2"	32'-7"
2 x 12 x 97	24'-10"	22'-1"	33'-4"	29'-9"	39'-10"	35'-8"

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m, 1 psf = 0.0479 kN/m^2.

1 Table provides the maximum ceiling joist span in feet and inches to either side of the interior support.
2 Bearing stiffeners shall be installed at all bearing and concentrated load locations.
3 Deflection criteria: L/240 for total loads.
4 Ceiling dead load = 5 psf (0.24 kN/m^2)
5 Interior supports for multiple span joists shall consist of structural walls or beams. Interior supports shall be located within 2 feet (610 mm) of mid span provided that each of the resulting spans do not exceed the maximum applicable span shown in the table above.
6 Refer to Table 2.1 for actual sizes.

Table 8.6
Allowable Spans For Cold-Formed Steel Ceiling Joists (33 ksi)
Single Spans With Bearing Stiffeners
20 Lbs. per Sq. Ft. Live Load (Limited Attic Storage) [1,2,3]

Nominal Joist Size [4]	Lateral Support of Top (Compression Flange)					
	Unbraced		Mid-Span Bracing		Third-Point Bracing	
	Spacing (inches)		Spacing (inches)		Spacing (inches)	
	16	24	16	24	16	24
2 x 4 x 33	8'-0"	7'-0"	9'-8"	8'-1"	9'-11"	8'-3"
2 x 4 x 43	8'-8"	7'-8"	10'-9"	9'-1"	10'-10"	9'-5"
2 x 4 x 54	9'-3"	8'-3"	11'-7"	9'-11"	11'-7"	10'-1"
2 x 4 x 68	10'-0"	8'-11"	12'-5"	10'-10"	12'-5"	10'-10"
2 x 4 x 97	11'-7"	10'-3"	13'-7"	11'-11"	13'-7"	11'-11"
2 x 6 x 33	9'-2"	8'-3"	12'-2"	10'-5"	13'-3"	11'-0"
2 x 6 x 43	9'-10"	8'-10"	13'-4"	11'-6"	14'-9"	12'-5"
2 x 6 x 54	10'-5"	9'-5"	14'-4"	12'-6"	16'-1"	13'-7"
2 x 6 x 68	11'-3"	10'-0"	15'-4"	13'-5"	17'-5"	14'-10"
2 x 6 x 97	12'-9"	11'-4"	17'-1"	15'-1"	19'-7"	16'-9
2 x 8 x 33	10'-3"	9'-3"	14'-4"	12'-5"	15'-11"	13'-4"
2 x 8 x 43	10'-11"	9'-10"	15'-5"	13'-8"	17'-11"	15'-5"
2 x 8 x 54	11'-8"	10'-6"	16'-3"	14'-7"	19'-3"	16'-8"
2 x 8 x 68	12'-5"	11'-2"	17'-3"	15'-6"	20'-7"	18'-0"
2 x 8 x 97	13'-11"	12'-5"	18'-7"	17'-0"	22'-9"	20'-1"
2 x 10 x 43	11'-9"	10'-7"	16'-6"	14'-10"	19'-10"	17'-1"
2 x 10 x 54	12'-5"	11'-2"	17'-5"	15'-8"	21'-1"	18'-7"
2 x 10 x 68	13'-3"	11'-10"	18'-5"	16'-7"	22'-4"	19'-11"
2 x 10 x 97	14'-9"	13'-2"	20'-2"	18'-1"	24'-4"	21'-10"
2 x 12 x 43	12'-5"	11'-2"	17'-5"	15'-8"	20'-9"	18'-0"
2 x 12 x 54	13'-1"	11'-9"	18'-5"	16'-7"	22'-5"	20'-1"
2 x 12 x 68	13'-11"	12'-6"	19'-5"	17'-6"	23'-8"	21'-3"
2 x 12 x 97	15'-5"	13'-10"	21'-2"	19'-0"	25'-8"	23'-1"

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m, 1 psf = 0.0479 kN/m^2.

1 Bearing stiffeners shall be installed at all bearing and concentrated load locations.
2 Deflection criteria: L/240 for total loads.
3 Ceiling dead load = 5 psf (0.24 kN/m^2)
4 Refer to Table 2.1 for actual size.

Table 8.7
Allowable Spans For Cold-Formed Steel Ceiling Joists (33 ksi)
Two Equal Spans With Bearing Stiffeners
20 Lbs. per Sq. Ft. Live Load (Limited Attic Storage) [1,2,3,4,5]

Nominal Joist Size [6]	Lateral Support of Top (Compression Flange)					
	Unbraced		Mid-Span Bracing		Third-Point	
	Spacing (inches)		Spacing (inches)		Spacing (inches)	
	16	24	16	24	16	24
2 x 4 x 33	10'-5"	8'-6"	10'-5"	8'-6"	10'-5"	8'-6"
2 x 4 x 43	11'-8"	10'-4"	12'-8"	10'-4"	12'-8"	10'-4"
2 x 4 x 54	12'-9"	11'-3"	14'-3"	11'-7"	14'-3"	11'-7"
2 x 4 x 68	14'-0"	12'-4"	15'-11"	13'-0"	15'-11"	13'-0"
2 x 4 x 97	16'-7"	14'-5"	18'-3"	15'-5"	18'-3"	15'-5"
2 x 6 x 33	12'-3"	11'-0"	14'-1"	11'-0"	14'-1"	11'-0"
2 x 6 x 43	13'-3"	11'-10"	17'-2"	14'-0"	17'-2"	14'-0"
2 x 6 x 54	14'-3"	12'-9"	19'-2"	15'-9"	19'-4"	15'-9"
2 x 6 x 68	15'-6"	13'-9"	20'-9"	17'-8"	21'-8"	17'-8"
2 x 6 x 97	18'-0"	15'-11"	23'-7"	20'-6"	25'-11"	21'-1"
2 x 8 x 33	13'-8"	10'-9"	14'-8"	10'-9"	14'-8"	10'-9"
2 x 8 x 43	14'-9"	13'-3"	20'-6"	17-5"	21'-3"	17'-5"
2 x 8 x 54	15'-9"	14'-1"	21'-10"	19'-6"	25'-2"	20'-6"
2 x 8 x 68	17'-0"	15'-2"	23'-3"	20'-10"	27'-8"	23'-2"
2 x 8 x 97	19'-6"	17'-3"	26'-0"	23'-2"	30'-11"	27'-0"
2 x 10 x 43	15'-9"	14'-2"	22'-0"	17'-3"	23'-0"	17'-3"
2 x 10 x 54	16'-9"	15'-0"	23'-4"	21'-0"	27'-11"	22'-10"
2 x 10 x 68	18'-0"	16'-1"	24'-9"	22'-3"	30'-0"	26'-7"
2 x 10 x 97	20'-6"	18'-2"	27'-6"	24'-7"	33'-0"	29'-6"
2 x 12 x 43	16'-7"	14'-11"	22'-7"	16'-7"	22'-7"	16'-7"
2 x 12 x 54	17'-7"	15'-10"	24'-7"	22'-2"	30'-0"	24'-9"
2 x 12 x 68	18'-10"	16'-11"	26'-1"	23'-5"	31'-8"	28'-5"
2 x 12 x 97	21'-5"	19'-0"	28'-10"	25'-10"	34'-8"	34'-1"

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m, 1 psf = 0.0479 kN/m^2.

1 Table provides the maximum ceiling joist span in feet and inches to either side of the interior support.

2 Bearing stiffeners shall be installed at all bearing and concentrated load locations.

3 Deflection criteria: L/240 for total loads.

4 Ceiling dead load = 5 psf (0.24 kN/m^2)

5 Interior supports for multiple span joists shall consist of structural walls or beams. Interior supports shall be unocated within 2 feet (610 mm) of mid span provided that each of the resulting spans do not exceed the maximum applicable span shown in the table above.

6 Refer to Table 2.1 for actual sizes.

Table 8.8
Allowable Spans For Cold-Formed Steel Ceiling Joists (33 ksi)
Single Spans Without Bearing Stiffeners
10 Lbs. per Sq. Ft. Live Load (No Attic Storage) [1,2]

Nominal Joist Size [3]	Lateral Support of Top (Compression) Flange					
	Unbraced		Mid-Span Bracing		Third-Point	
	Spacing (inches)		Spacing (inches)		Spacing (inches)	
	16	24	16	24	16	24
2 x 4 x 33	9'-2"	8'-3"	11'-9"	10'-0"	11'-9"	10'-0"
2 x 4 x 43	9'-11"	8'-10"	12'-10"	11'-2"	12'-0"	11'-2"
2 x 4 x 54	10'-8"	9'-6"	13'-9"	12'-0"	13'-9"	12'-0"
2 x 4 x 68	11'-7"	10'-4"	14'-8"	12'-10"	14'-8"	12'-10"
2 x 4 x 97	13'-7"	12'-0"	16'-2"	14'-1"	16'-2"	14'-1"
2 x 6 x 33	10'-5"	9'-5"	14'-5"	10'-0"	15'-1"	10'-0"
2 x 6 x 43	11'-2"	10'-1"	15'-7"	13'-10"	18'-0"	15'-5"
2 x 6 x 54	12'-0"	10'-9"	16'-7"	14'-9"	19'-5"	16'-8"
2 x 6 x 68	12'-11"	11'-7"	17'-8"	15'-10"	20'-11"	18'-1"
2 x 6 x 97	14'-11"	13'-2"	19'-10"	17'-8"	23'-2"	20'-3"
2 x 8 x 33	-	-	-	-	-	-
2 x 8 x 43	12'-6"	11'-3"	17'-6"	15'-10"	21'-2"	17'-9"
2 x 8 x 54	13'-4"	11'-11"	18'-7"	16'-9"	22'-7"	20'-0"
2 x 8 x 68	14'-3"	12'-9"	19'-8"	17'-8"	23'-11"	21'-4"
2 x 8 x 97	16'-2"	14'-5"	21'-10"	19'-6"	26'-3"	23'-6"
2 x 10 x 43	-	-	-	-	-	
2 x 10 x 54	14'-2"	12'-9"	19'-10"	17'-10"	24'-2"	21'-9"
2 x 10 x 68	15'-2"	13'-7"	21'-0"	18'-11"	25'-6"	23'-0"
2 x 10 x 97	17'-1"	15'-2"	23'-2"	20'-9"	27'-11"	25'-1"
2 x 12 x 43	-	-	-	-	-	-
2 x 12 x 54	-	-	-	-	-	-
2 x 12 x 68	15'-11"	14'-4"	22'-2"	19'-11"	27'-0"	24'-4"
2 x 12 x 97	17'-10"	15'-11"	24'-4"	21'-10"	29'-4"	26'-5"

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m, 1 psf = 0.0479 kN/m^2.

1 Deflection criteria: L/240 for total loads.
2 Ceiling dead load = 5 psf (0.24 kN/m^2)
3 Refer to Table 2.1 for actual size.

Table 8.9
Allowable Spans For Cold-Formed Steel Ceiling Joists (33 ksi)
Two Equal Spans Without Bearing Stiffeners
10 Lbs. per Sq. Ft. Live Load (No Attic Storage) [1,2,3,4]

Nominal Joist Size [5]	Lateral Support of Top (Compression Flange)					
	Unbraced		Mid-Span Bracing		Third-Point Bracing	
	Spacing (inches)		Spacing (inches)		Spacing (inches)	
	16	24	16	24	16	24
2 x 4 x 33	11'-6"	8'-9"	11'-6"	8'-9"	11'-6"	8'-9"
2 x 4 x 43	13'-6"	11'-8"	15'-2"	11'-8"	15'-2"	11'-8"
2 x 4 x 54	14'-9"	13'-1"	18'-2"	14'-2"	18'-2"	14'-2"
2 x 4 x 68	16'-4"	14'-5"	19'-8"	16'-7"	19'-8"	16'-7"
2 x 4 x 97	19'-6"	17'-2"	21'-8"	18'-11"	21'-8"	18'-11"
2 x 6 x 33	13'-8"	10'-1"	13'-8"	10'-1"	13'-8"	10'-1"
2 x 6 x 43	15'-2"	13'-7"	18'-8"	14'-0"	18'-8"	14'-0"
2 x 6 x 54	16'-5"	14'-8"	22'-5"	17'-6"	22'-11"	17'-6"
2 x 6 x 68	17'-11"	15'-11"	24'-1"	21'-5"	27'-9"	21'-7"
2 x 6 x 97	21'-2"	18'-8"	27'-7"	24'-5"	31'-1"	27'-2"
2 x 8 x 33	-	-	-	-	-	-
2 x 8 x 43	16'-10"	15'-1"	20'-7"	15'-3"	20'-7"	15'-3"
2 x 8 x 54	18'-1"	16'-2"	24'-11"	20'-3"	26'-11"	20'-3"
2 x 8 x 68	19'-7"	17'-6"	26'-8"	23'-11"	32'-2"	25'-11"
2 x 8 x 97	22'-10"	20'-2"	30'-2"	26'-10"	35'-10"	31'-11"
2 x 10 x 43	-	-	-	-	-	
2 x 10 x 54	19'-3"	17'-3"	26'-7"	20'-11"	28'-1"	20'-11"
2 x 10 x 68	20'-9"	18'-6"	28'-5"	25'-6"	34'-4"	28'-5"
2 x 10 x 97	23'-11"	21'-2"	31'-10"	28'-4"	38'-0"	34'-0"
2 x 12 x 43	-	-	-	-	-	-
2 x 12 x 54	-	-	-	-	-	-
2 x 12 x 68	21'-9"	19'-5"	29'-10"	26'-10"	36'-2"	29'-0"
2 x 12 x 97	24'-10"	22'-1"	33'-4"	29'-9"	39'-10"	35'-8"

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m, 1 psf = 0.0479 kN/m^2.

1 Table provides the maximum ceiling joist span in feet and inches to either side of the interior support.
2 Deflection criteria: L/240 for total loads.
3 Ceiling dead load = 5 psf (0.24 kN/m^2)
5 Interior supports for multiple span joists shall consist of structural walls or beams. Interior supports shall be located within 2 feet (610 mm) of mid span provided that each of the resulting spans do not exceed the maximum applicable span shown in the table above.
5 Refer to Table 2.1 for actual sizes.

Table 8.10
Allowable Spans For Cold-Formed Steel Ceiling Joists (33 ksi)
Single Spans Without Bearing Stiffeners
20 Lbs. per Sq. Ft. Live Load (Limited Attic Storage) [1,2]

Nominal Joist Size [3]	Lateral Support of Top (Compression Flange)					
	Unbraced		Mid-Span Bracing		Third-Point Bracing	
	Spacing (inches)		Spacing (inches)		Spacing (inches)	
	16	24	16	24	16	24
2 x 4 x 33	8'-0"	6'-0"	9'-0"	6'-0"	9'-0"	6'-0"
2 x 4 x 43	8'-8"	7'-8"	10'-9"	9'-1"	10'-10"	9'-5"
2 x 4 x 54	9'-3"	8'-3"	11'-7"	9'-11"	11'-7"	10'-1"
2 x 4 x 68	10'-0"	8'-11"	12'-5"	10'-10"	12'-5"	10'-10"
2 x 4 x 97	11'-7"	10'-3"	13'-7"	11'-11"	13'-7"	11'-11"
2 x 6 x 33	9'-0"	6'-0"	9'-0"	6'-0"	9'-0"	6'-0"
2 x 6 x 43	9'-10"	8'-10"	13'-4"	11'-6"	14'-9"	11'-8"
2 x 6 x 54	10'-5"	9'-5"	14'-4"	12'-6"	16'-1"	13'-7"
2 x 6 x 68	11'-3"	10'-0"	15'-4"	13'-5"	17'-5"	14'-10"
2 x 6 x 97	12'-9"	11'-4"	17'-1"	15'-1"	19'-7"	16'-9
2 x 8 x 33	-	-	-	-	-	-
2 x 8 x 43	10'-11"	9'-0"	14'-7"	10'-0"	16'-0"	10'-8"
2 x 8 x 54	11'-8"	10'-6"	16'-3"	14'-7"	19'-3"	16'-8"
2 x 8 x 68	12'-5"	11'-2"	17'-3"	15'-6"	20'-7"	18'-0"
2 x 8 x 97	13'-11"	12'-5"	18'-11"	17'-0"	22'-9"	20'-1"
2 x 10 x 43	-	-	-	-	-	-
2 x 10 x 54	12'-5"	11'-2"	17'-5"	15'-8"	21'-1"	16'-9"
2 x 10 x 68	13'-3"	11'-10"	18'-5"	16'-7"	22'-4"	19'-11"
2 x 10 x 97	14'-9"	13'-2"	20'-2"	18'-1"	24'-4"	21'-10"
2 x 12 x 43	-	-	-	-	-	-
2 x 12 x 54	-	-	-	-	-	-
2 x 12 x 68	13'-11"	12'-6"	19'-5"	17'-6"	23'-8"	21'-3"
2 x 12 x 97	15'-5"	13'-10"	21'-2"	19'-0"	25'-8"	23'-1"

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m, 1 psf = 0.0479 kN/m^2.

1 Deflection criteria: L/240 for total loads.
2 Ceiling dead load = 5 psf (0.24 kN/m^2)
3 Refer to Table 2.1 for actual size.

Table 8.11
Allowable Spans For Cold-Formed Steel Ceiling Joists (33 ksi)
Two Equal Spans Without Bearing Stiffeners
20 Lbs. per Sq. Ft. Live Load (Limited Attic Storage) [1,2,3,4]

Nominal Joist Size [5]	Lateral Support of Top (Compression Flange)					
	Unbraced		Mid-Span Bracing		Third-Point Bracing	
	Spacing (inches)		Spacing (inches)		Spacing (inches)	
	16	24	16	24	16	24
2 x 4 x 33	8'-1"	6'-0"	8'-1"	6'-0"	8'-1"	6'-0"
2 x 4 x 43	10'-10"	8'-3"	10'-10"	8'-3"	10'-10"	8'-3"
2 x 4 x 54	12'-9"	10'-2"	13'-3"	10'-2"	13'-3"	10'-2"
2 x 4 x 68	14'-0"	12'-4"	15'-9"	12'-5"	15'-9"	12'-5"
2 x 4 x 97	16'-7"	14'-5"	18'-3"	15'-2"	18'-3"	15'-2"
2 x 6 x 33	9'-3"	6'-9"	9'-3"	6'-9"	9'-3"	6'-9"
2 x 6 x 43	13'-0"	9'-8"	13'-0"	9'-8"	13'-0"	9'-8"
2 x 6 x 54	14'-3"	12'-4"	16'-4"	12'-4"	16'-4"	12'-4"
2 x 6 x 68	15'-6"	13'-9"	20'-3"	15'-7"	20'-3"	15'-7"
2 x 6 x 97	18'-0"	15'-11"	23'-7"	20'-6"	25'-10"	21'-0"
2 x 8 x 33	-	-	-	-	-	-
2 x 8 x 43	14'-0"	10'-2"	14'-0"	10'-2"	14'-0"	10'-2"
2 x 8 x 54	15'-9"	13'-10"	18'-9"	13'-10"	18'-9"	13'-10"
2 x 8 x 68	17'-0"	15'-2"	23'-3"	18'-3"	24'-2"	18'-3"
2 x 8 x 97	19'-6"	17'-3"	26'-0"	23'-2"	30'-11"	25'-11"
2 x 10 x 43	-	-	-	-	-	-
2 x 10 x 54	16'-9"	14'-1"	19'-4"	14'-1"	19'-4"	14'-1"
2 x 10 x 68	18'-0"	16'-1"	24'-9"	19'-8"	26'-4"	19'-8"
2 x 10 x 97	20'-6"	18'-2"	27'-6"	24'-7"	33'-0"	29'-0"
2 x 12 x 43	-	-	-	-	-	-
2 x 12 x 54	-	-	-	-	-	-
2 x 12 x 68	18'-10"	16'-11"	26'-1"	19'-10"	26'-1"	19'-10"
2 x 12 x 97	21'-5"	19'-0"	28'-10"	25'-10"	34'-8"	31'-1"

For SI: 1inch = 25.4 mm, 1 foot = 0.3 m, 1 psf = 0.0479 kN/m^2.

1 Table provides the maximum ceiling joist span in feet and inches to either side of the the interior support.
2 Deflection criteria: L/240 for total loads.
3 Ceiling dead load = 5 psf (0.24 kN/m^2)
5 Interior supports for multiple span joists shall consist of structural walls or beams. Interior supports shall be located within 2 feet (610 mm) of mid span provided that each of the resulting spans do not exceed the maximum applicable span shown in the table above.
5 Refer to Table 2.1 for actual sizes.

Table 8.12
Allowable Horizontal Rafter Spans[1,2,3]
33 ksi

Nominal Joist Size [4]	Ground Snow Loads							
	20 psf Ground		30 psf Ground		50 psf Ground		70 psf Ground	
	Spacing (inches)		Spacing (inches)		Spacing (inches)		Spacing (inches)	
	16	24	16	24	16	24	16	24
2 x 6 x 33	12'-8"	10'-4"	11'-9"	9'-7"	9'-11"	8'-1"	8'-10"	7'-2"
2 x 6 x 43	15'-5"	12' -7"	14'-3"	11'-8"	12'-1"	9'-10"	10'-8"	8'-9"
2 x 6 x 54	13'-0"	14'-2"	16'-1"	13'-1"	13'-8"	11'-2"	12'-1"	9'-10"
2 x 6 x 68	18'-1"	15'-10"	17'-3"	14'-9"	15'-4"	12'-6"	13'-6"	11'-1"
2 x 6 x 97	20'-1"	17'-6"	19'-1"	16'-8"	17'-1"	14'	15'-7"	13'-2"
2 x 8 x 33	15'-5"	11'-5"	14'-4"	9'-10"	10'-7"	7'-1"	8'-3"	5'-6"
2 x 8 x 43	19'-1"	15'-7'	17'-9"	14'-6"	15'-1"	12'-3"	13'-3"	10'-9"
2 x 8 x 54	22'-7"	18'-5"	21'-0"	17'-1"	17'-9"	14'-6"	15'-9"	12-10"
2 x 8 x 68	24'-7"	20'-9"	23'-4"	19'-3"	20'-0"	16'-4"	17'-8"	14'-5"
2 x 8 x 97	27'-3"	23'-9"	26'-0"	22'-8"	23'-3"	19'-7"	21'-3"	17'-4"
2 x 10 x 43	21'-2"	17'-3"	19'-8"	16'-0"	16'-8"	13'-1"	14'-9"	10'-3"
2 x 10 x 54	25'-1"	20'-6"	23'-3"	19'-0"	19'-9"	16'-1"	17'-5"	14'-3"
2 x 10 x 68	29'-6"	24'-6"	27'-9"	22'-9"	23'-8"	19'-3"	21'-0"	17'-1"
2 x 10 x 97	32'-0"	28'-8"	31'-3"	27'-3"	28'-0"	23'-2"	25'-1"	20'-6"
2 x 12 x 43	23'-0"	18'-2"	21'-4"	15'-7"	16'-9"	11'-3"	13'-2"	8'-9"
2 x 12 x 54	27'-3"	22'-3"	25'-3"	20'-7"	21'-5"	17'-6"	18'-11	15'-5"
2 x 12 x 68	32'-1"	26'-2"	29'-9"	24'-3"	25'-3"	20'-7"	22'-4"	18'-2"
2 x 12 x 97	38'-4"	33'-6"	36'-6"	31'-6"	32'-8"	26'-9"	29'-0"	23'-7"

For SI: 1 inch = 25.4 mm, 1 foot = 0.3 m, 1 psf = 0.0479 kN/m^2.

1 Table provides the maximum horizontal rafter span in feet and inches for slopes from 3:12 to 12:12.
2 Deflection criteria: L/240 for live loads and L/180 for total loads.
3 Roof dead load = 12 psf (0.575 kN/m^2)
4 Refer to Table 2.1 for actual member size.

Table 8.13
Wind Speed to Equivalent Snow Load Conversion [1]

Roof Slope	Equivalent Ground Snow Load (psf)				
	Wind Speed (mph) Exposure C				
	70	80	90	100	110
3 / 12	20	20	20	30	50
4 / 12	20	20	30	50	50
5 / 12	20	20	30	50	50
6 / 12	20	20	30	50	70
7 / 12	30	30	50	70	70
8 / 12	30	30	50	70	Design Required
9 / 12	30	50	50	70	
10 / 12	30	50	50	Design Required	
11 / 12	30	50	70		
12 / 12	50	50	70		
	Wind Speed (mph) Exposure B				
	70	80	90	100	110
3 / 12	20	20	20	30	50
4 / 12	20	20	20	30	50
5 / 12	20	20	20	30	50
6 / 12	20	20	20	50	50
7 / 12	20	30	30	5 0	70
8 / 12	20	30	50	50	70
9 / 12	30	30	50	70	70
10 / 12	30	30	50	70	Design Required
11 / 12	30	50	50	70	
12 / 12	30	50	50		

For SI: 1 mph = 1.61 km/hr, 1 psf = 0.0479 kN/m^2.

[1] Exposure C category shall be used if site wind exposure is unknown.

Table 8.14
Uplift Loads on Roof-to-Wall Connections
for Selection of Roof Tie-Downs (lbs/ft)[1,2,3]

Wind Speed (mph) and Exposure Category			
Up to 70 C or 90 A/B	**90 C or 110 A/B**	**100 C**	**110 C**
N/R	100 lbs/ft.	200 lbs/ft.	300 lbs/ft.

For SI: 1 inch = 25.4 mm, 1 lb. = 4.4 N.

1 N/R = uplift connector not required.
2 For 16-inch (406 mm) and 24-inch (610 mm) rafter spacing, the uplift load shall be multiplied by 1.3 and 2.0, respectively.
3 Uplift connectors shall be provided in addition to other fastening requirements.

9.0 MECHANICAL, UTILITIES, AND INSULATION

9.1 Plumbing

Plumbing shall comply with the applicable plumbing code. Copper and plastic pipes shall be separated from the steel framing by non-conductive grommets or other approved methods. A list of the appropriate types of plastic insulators and grommets for web holes which are pre-punched is generally available from the steel supplier.

9.2 Electrical Systems

Electrical system installation shall comply with the latest edition of the National Electric Code. Snap-in plastic insulators, grommets, conduit, or other approved wire protection methods shall be used to protect the plastic sheathing on electrical cables when passing through holes in steel framing members (i.e. punchouts in studs and joists).

9.3 HVAC Systems and Duct Work

HVAC installation shall comply with the applicable mechanical code and energy code.

9.4 Insulation

Insulation of steel frame exterior walls, floors, and roofs shall comply with the applicable energy code. All types of insulation are compatible with steel framing (e.g. batt insulation, spray-applied foam, foam plastic board, etc.). In many climates, a layer of exterior foam sheathing is required to meet energy code. Suggested insulation R-values for walls in various areas of the country can be found in AISI publication #RG-9405 *Thermal Design Guide for Exterior Walls* [18]. For additional information on thermal performance and fire resistance issues related to cold-formed steel framing in homes, the reader is referred to the NAHB Research Center reports *Energy Code And Related Thermal Performance Issues Associated With Steel Framing In Homes* and *Fire-Resistance Issues Related To Cold-Formed Steel Framing In Homes* [19] [20].

10.0 GENERAL CONSTRUCTION GUIDELINES

- Each stud, joist, and track member shall bear the Manufacturer's name, logo or initials, base metal thickness (uncoated), minimum specified yield strength, and minimum coating designation.

- All structural members shall be aligned vertically (in-line framing) to transfer all loads to the foundation.

- Track members shall not be used individually for any load carrying applications without an approved design

- Studs, tracks, and other steel members should be in good condition. Bent, warped, split, or otherwise damaged members shall be replaced.

- Bearing surfaces for joists, rafters, and trusses shall be uniform and level.

- All load bearing studs, including king and jack studs, shall be seated in the tracks with a maximum gap of 1/8 inch (0.32 mm) between the end of the stud and the web of the track.

- Adequate temporary construction bracing of wall, floor, and roof framing shall be provided until permanent bracing has been installed.

- Any corrections which involve cutting, drilling, or relocation of any truss member or component shall not be made without notifying the truss manufacturer of the need for and extent of the modifications. All major corrections, cutting, or drilling of truss members without the approval of a qualified design professional shall be prohibited.

11.0 REFERENCES

[1] *Specification For The Design Of Cold Formed Steel Structural Members* (August 19, 1986 Edition with December 11, 1989 Addendum). American Iron and Steel Institute (AISI). Washington, DC. 1989.

[2] *Minimum Design Load for Buildings and Other Structures* (ASCE 7-93). American Society of Civil Engineers, New York, NY. 1993.

[3] *Standard Building Code.* Southern Building Code Congress International, Inc. (SBCCI). Birmingham, Alabama. 1994.

[4] *Uniform Building Code.* International Conference of Building Officials (ICBO). Whittier, California. 1994.

[5] *The BOCA National Building Code.* Building Officials & Code Administrators International, Inc. (BOCA). Country Club Hills, Illinois. 1993.

[6] *Commentary on the Prescriptive Method for Residential Cold-Formed Steel Framing.* Second Edition. Prepared for the US Department of Housing and Urban Development, the American Iron and Steel Institute, and the National Association of Home Builders, by the NAHB Research Center, Inc., Upper Marlboro, MD. August 1997.

[7] ASTM A 370- 96 *Standard Test Methods and Definitions for Mechanical Testing of Steel Products,* American Society for Testing and Materials (ASTM), West Conshohocken, PA. 1996.

[8] ASTM A 653 / A 653M - 1996 *Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process*, American Society for Testing and Materials (ASTM), West Conshohocken, PA. 1996.

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[11] ASTM C 955-96a *Standard Specification for Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Board and Metal Plaster Bases*, American Society for Testing and Materials (ASTM), West Conshohocken, PA. 1996.

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[13] ASTM B633 -85 e1 *Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel*, American Society for Testing and Materials (ASTM), West Conshohocken, PA. 1994.

[14] SAE J-78-1979, *Steel Self Drilling Tapping Screws*, Society of Automotive Engineers, 1979.

[15] ASTM C 954-96ae1 *Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness*, American Society for Testing and Materials (ASTM), West Conshohocken, PA. 1996.

[16] ASTM Standard A 307 - 94 *Standard Specification for Carbon Steel Bolts and Studs, 60000 PSI Tensile Strength*, American Society for Testing and Materials (ASTM), ASTM, West Conshohocken, PA. 1994.

[17] AISI Publication RG-9518, *Design Guide For Cold-Formed Steel Trusses*, American Iron and Steel Institute (AISI), Washington DC. December 1995.

[18] AISI Publication RG-9405, *Thermal Design Guide For Exterior Walls*, American Iron and Steel Institute (AISI), Washington DC. December 1995.

[19] *Energy Code And Related Thermal Performance Issues Associated With Steel Framing In Homes*, Prepared for the US Department of Housing and Urban Development, The American Iron and Steel Institute, and the National Association of Home Builders, by the NAHB Research Center, Inc., Upper Marlboro, MD. April 2, 1997.

[20] *Fire-Resistance Issues Related To Cold-Formed Steel Framing In Homes*, Prepared for the US Department of Housing and Urban Development, The American Iron and Steel Institute, and the National Association of Home Builders, by the NAHB Research Center, Inc., Upper Marlboro, MD. April 29, 1997.

NAHB Research Center

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About Us

The NAHB Research Center was established in 1964 as a wholly-owned, not-for-profit, subsidiary of the NAHB (National Association of Home Builders). The Research Center studies all aspects of home building and tests and certifies building products and trade contractors.

The Research Center is located in its own facility equipped with laboratory and office space in a suburb of Washington, D.C. The Research Center's professional staff of over 80 includes scientists, engineers, economists, architects, planners, analysts, and professionals in related disciplines. Testing and certification programs are carried out in an advanced, fully-equipped laboratory. Located nearby is the Research Home Park, where innovative products and building systems can be tested and evaluated.

In addition to carrying out research for the NAHB, the Research Center conducts programs, projects, and activities for clients that include members of the home building industry, related industries and professions, and public sector agencies in the housing field. Major fields of activity include:

- Innovative products, systems, and technology that relate to home building, and designing programs to assist promising technologies in entering the mainstream;
- Writing, evaluating, changing, and updating model building codes and energy codes;
- Construction of research houses to test new and emerging technologies.
- Two-way communication between manufacturers and builders for direct exchange between those who make building products and those who buy and use them;
- Residential energy and resource conservation;
- Increasing the supply of accessible and affordable housing;
- Financial, regulatory, and land use issues;
- Coordinating practical and academic research through a consortium of colleges and universities;
- Business management, including administration of the National Housing Quality Awards, the National Remodeling Quality Awards, and the EnergyValue Housing Awards — all designed to be the highest recognition for quality in the home building field;
- Quantitative and qualitative market and technology research on building materials and building practices;
- International trade and association building in housing-related goods and services;
- Publications on technical, economic, and regulatory issues of interest to builders; and
- A laboratory testing and labeling program for building products — products are tested against nationally-recognized performance standards.

How to Use the Steel-Frame Download

If you install steel framing and have a computer running Windows 98 or higher (other than Win NT), you'll make good use of the steel-frame Web download. To collect this download, open your Web browser (such as Internet Explorer) and go to the site:

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You'll have to enter the license number from the download certificate on the perforated card inside the back cover of this book. If you prefer, use the same card to order the *Steel-Frame House Construction* download on CD. Either way, you'll receive:

1. An estimating program with over 1,000 labor and material costs for steel framing.
2. Dozens of steel-frame construction details in both Auto-CAD and WMF format.

To get started estimating costs for steel-frame construction, install the steel-frame download (or insert the CD in the CD-ROM drive of your computer). Then follow instructions on the screen.

The ShowMe Video

The *Steel-Frame House Construction* CD includes a 60-minute ShowMe interactive video explaining how to use the National Estimator program. This same video is available on the Web at http://Craftsman-Book.com/support/tne/showme/. Use the ShowMe tutorial to supplement instructions on the following pages. With ShowMe, you can sit back and relax and watch the video run — or click on buttons to jump from topic to topic. Exit any time you want. Then go back to ShowMe later to brush up on some advanced topic.

Opening the Construction Drawings

These drawings are in two formats, Auto-CAD and Windows Metafiles (WMF). If you're an Auto-CAD user, navigate to the AutoCAD folder under My Documents\Steel Frame House Contruction on your computer's local drive. Click to open the drawing of your choice. The files are saved using the same names and section numbers found in the *Prescriptive Method for Residential Steel Framing, Second Edition*. See page 312. You can change any drawing to meet your needs. Then save the drawing to your local drive under a different file name or in a different folder.

To insert a WMF file into a Microsoft Word file:

1. Open any Word document or start a new (blank) document.
2. Click on **Insert**.
3. Click on **Picture**.
4. Click on **From File**.
5. In the **Insert Picture** dialog box, click on the down triangle to the right of "Look in."
6. Navigate in your local disk to the folder My Documents\WMF.
7. Select the section that has the detail you want.
8. Double-click on the file name of that detail.
9. The drawing will appear in your document.

To move a WMF file:

1. Click anywhere in the drawing to "grab" it.
2. Holding your left mouse button down, drag the drawing to a new location. Then release the mouse button.

To resize a WMF file:

1. Click and hold on one of the four corner handles.
2. While holding the left mouse button down, pull the handle into or away from the picture. Your picture will resize as you move the corner handle.

Word processing programs seldom have the ability to change a WMF file. To make changes, you'll need a graphics program such as Paint Shop Pro. A free trial version of Paint Shop Pro is available on the Web at http://www.jasc.com.

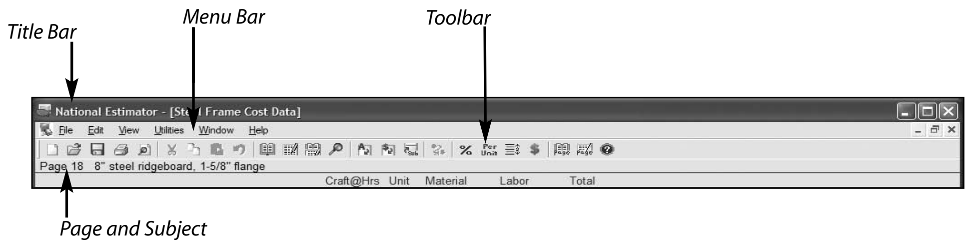
Using National Estimator

National Estimator begins when you click on **Start**, **Programs**, the **Construction Estimating** group and then **National Estimator**.

On the title bar at the top of the screen you see the program name, *National Estimator*, and [*Steel-Frame Cost Data*]. Let's take a closer look at the other information at the top of your screen.

The Menu Bar

Below the title bar you see the menu bar. Every option in *National Estimator* is available on the menu bar. Click with your left mouse button on any item on the menu to open a list of available commands.



Buttons on the Toolbar

Below the menu bar you see 24 buttons that make up the toolbar. The options you use most in *National Estimator* are only a mouse click away on the toolbar.

Column Headings

Below the toolbar you'll see column headings for the costbook:

Craft@Hrs for craft (the crew doing the work) and manhours (to complete the task)

Unit for unit of measure, such as per linear foot or per square foot

Material for material cost

Labor for labor cost

Total for the total of all cost columns

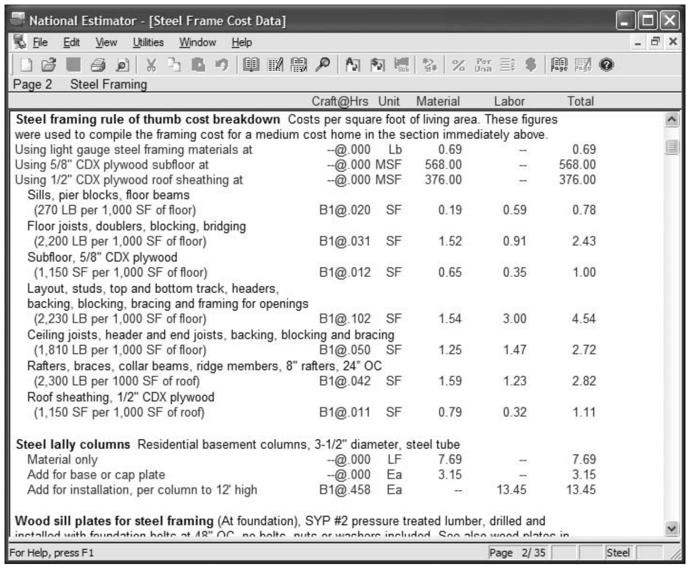
The Status Bar

The bottom line on your screen is the status bar. Here you'll find helpful information about the choices available. Notice Page 2/35 near the center of the status line. That's a clue that you're looking at page 2 of a 35-page file. Most of Craftsman's costbooks contain pictures, although Steel-Frame Cost Data does not. When you see PICT at the right of the status bar, a picture is available in the costbook. Click on PICT to show the picture. Click on PICT again to hide the picture.

Check the status bar occasionally for helpful tips and explanations of what you see on screen.

The Costbook

Thirty-five pages of steel-framing costs are available in the Costbook Window. Scroll down the page a ways and you'll notice the words *Steel Framing* at the left side of the screen just below the toolbar. That's your clue that the steel framing section of page 2 is on the screen.



The costbook window has the Steel-Frame Cost Data.

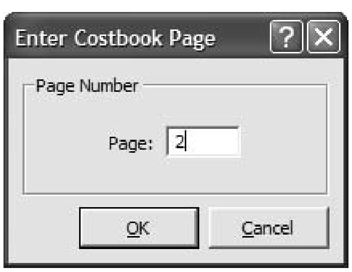
To turn to the next page, either:

- Press PgDn (with Num Lock off), -or-
- Click on the lower half of the scroll bar at the right edge of the screen.

To move down one line at a time, either:

- Press the ↓ arrow key (with Num Lock off), -or-
- Click on the arrow on the down scroll bar at the lower right corner

of the screen.



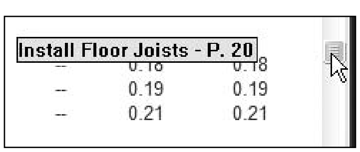
Type the page number you want to see.

To turn quickly to any page, either:

- Click on the Page (Turn to Costbook Page) button near the right end of the toolbar, -or-
- Click on **View** on the menu bar. Then click on **Turn to Costbook Page**.

Type the number of the page you want to see and press Enter↵. National Estimator will turn to the top of the page you requested.

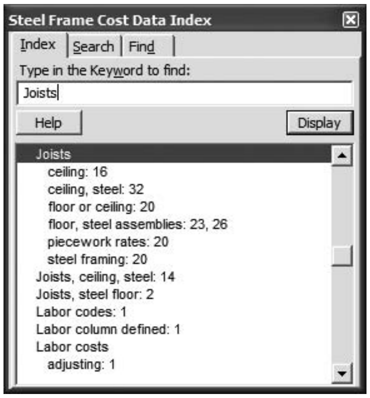
An Even Better Way



Drag the square to see any page.

Find the small square in the slide bar at the right side of the Costbook Window. Click and hold on that square while rolling the mouse up or down. Keep dragging the square until you see the page you want in the Page: box. Release the mouse button to turn to the top of that page.

A Still Better Way: Keyword Search



Use the electronic index to find cost estimates for any item.

To find any cost estimate in seconds, search by keyword in the index. To go to the index, either:

- Click on the (Index) button near the center of the toolbar, -or-
- Click on **View** on the menu bar. Then press **Index Window**.

Notice that the cursor is blinking in the Type in the Keyword to Find box at the right of the screen. Obviously, the index is ready to begin a search.

Your First Estimate

Suppose we're estimating the cost of 920 square feet of ceiling framed with 6" joists 24" on center. Let's put the index to work with a search for joists. In the box under Type in the Keyword to Find, type *joists*. The index jumps to the heading *Joists*.

The seventh item under joists is *Joists, ceiling, steel*: 14.

- Double-click on that line to select that page.

National Estimator turns to the Steel ceiling joists and soffits section of page 14. Press the [PgDn] page down key and the [↓] arrow key (or click on the down scroll arrow) until *6" steel ceiling joists, 24" OC* moves to the top of your screen.

Splitting the Screen

Most of the time you'll want to see what's in both the costbook and your estimate. To split the screen into two halves, either:

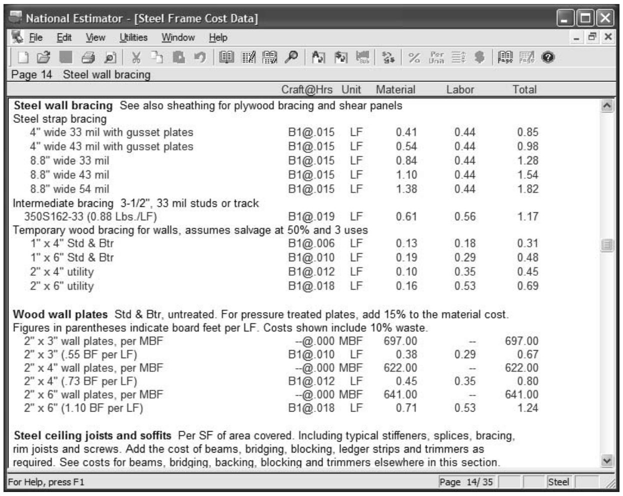
- Click on the (Split Window) button near the center of the toolbar, or
- Click on **View** on the menu bar. Then click on **Split Window** and your screen should look like the example on the next page.

Notice the costbook lines are at the top of the screen and your estimate form is at the bottom. Column headings are at the top of the costbook and across the middle of the screen (for your estimate).

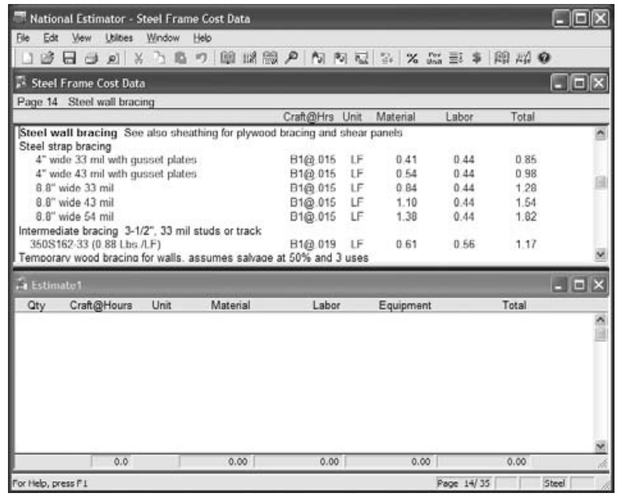
To Switch from Window to Window

- Click in the window of your choice, -or-
- Hold the [Ctrl] key down and press [Tab].

Notice that a window title bar turns dark when that window is selected. The selected window is where keystrokes appear as you type. Click in the bottom half of the screen so your estimate is selected.



Costs for steel wall bracing on page 14.



The split window: Costbook above and estimate below.

Beginning an Estimate

You can type anything in the Estimate Window. Let's start by putting a heading on this estimate:

The Blinking Cursor (insert point)

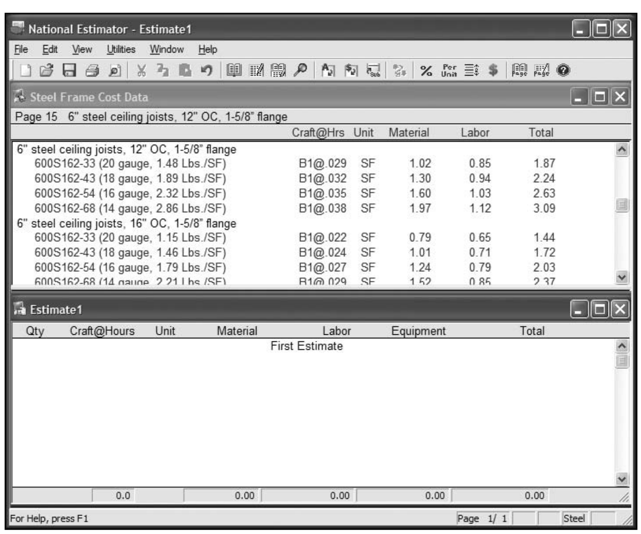
Mouse Pointer

Mouse Pointer

1. Press Enter once to space down one line.
2. Press Tab four times (or hold the space bar down) to move the Blinking Cursor (the insert point) near the middle of the line.
3. Type "First Estimate" and press Enter. That's the title of this estimate, "First Estimate."
4. Press Enter again to move the cursor down a line. That opens up a little space below the title.

Copying Costs to Your Estimate

Next, we'll estimate the cost of 920 square feet of 6" 18 gauge ceiling joists 24" on center. Click the (Split Window) button on the toolbar to be



Begin by putting a title on your estimate, such as "First Estimate."

sure you're in the split window. Click anywhere in the costbook (the top half of your screen). Then press the ↓ arrow key until the cursor is on the line:

600S162-43 (18 gauge, 1.04 Lbs./SF)	B1@.018	SF	0.72	0.53	1.25

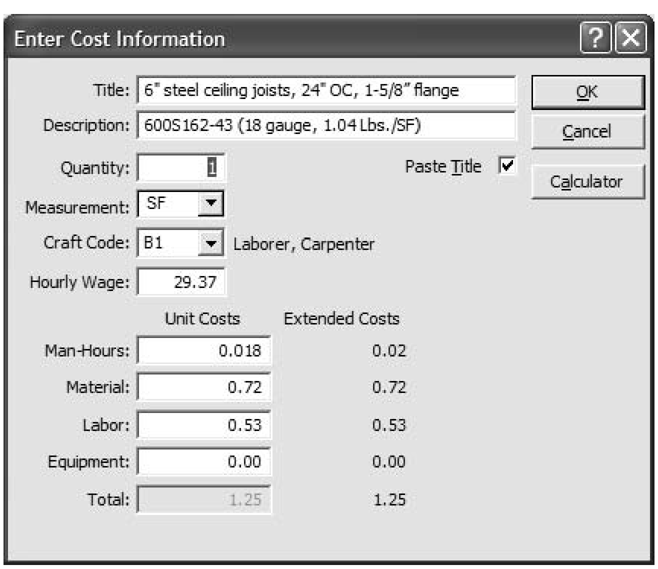
> **Hint:** Instead of clicking on the (Copy) and (Paste) buttons, you can both copy and paste by pressing the F8 key.

To copy this line to your estimate:

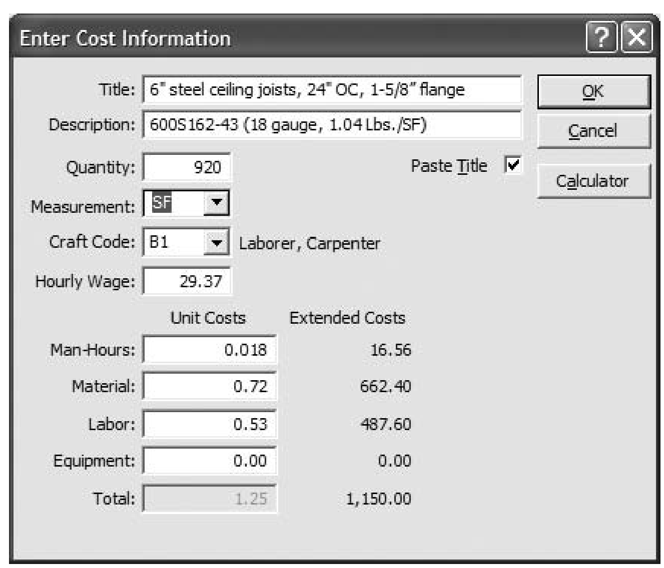
1. Click on the line.
2. Click the (Copy) button.
3. Click on the (Paste) button to open the Enter Cost Information dialog box.

Notice that the blinking cursor is in the Quantity box:

1. Type a quantity of 920 because the ceiling area is 920 square feet (23' x 40').
2. Press Tab and check the estimate for accuracy.
3. Notice that the column headed Unit Costs shows costs per unit, per "SF" (square foot) in this case.
4. The column headed Extended Costs shows costs for 920 square feet.
5. The lines opposite Title and Description show what's getting installed. You can change the words in either of these boxes. Just click on what you want to change and start typing or deleting.
6. You can also change any numbers in the Unit Cost column. Just click and start typing.
7. When the words and costs are exactly right, press Enter or click on **OK** to copy these figures to the end of your estimate.



Use the Enter Cost Information dialog box to copy or change costs.



Costs for the 920 SF job (extended costs) are on the right.

The new line at the bottom of your estimate shows:


6" steel ceiling joists, 24" OC, 1-5/8" flange
600S162-43 (18 gauge, 1.04 Lbs./SF)

920.00	B1@16.56	SF	662.40	487.60	0.00	1,150.00

Extended costs for ceiling joists as they appear on your estimate form.

920 is the ceiling area in square feet

B1 is the recommended crew, a building laborer and a carpenter

@16.56 shows the manhours required for the work

SF is the unit of measure, square feet in this case

662.40 is the material cost (the ceiling joists)

487.60 is labor cost for the job

0.00 shows there is no equipment cost

1,150.00 is the total of material, labor and equipment columns

Copy Anything to Anywhere in Your Estimate

Anything in the costbook can be copied to your estimate. Just click on the line (or select the words) you want to copy and press the F8 key. It's copied to the last line of your estimating form. If your selection includes costs, you'll have a chance to enter the quantity. To copy to the middle of your estimate:

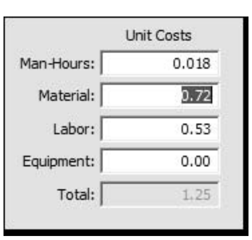
1. Select what you want to copy.
2. Click on the (Copy) button.
3. Click in the estimate where you want to paste.
4. Click on the (Paste) button.

Changing Wage Rates

Search for information on setting wage rates.

The labor cost in the example above is based on a laborer and a carpenter working at an average cost of \$29.37 per hour. (See page one for crew rates used in the costbook.) Suppose \$29.37 per hour isn't right for your estimate. What then? No problem! It's easy to use your own wage rate for any crew or even make up your own crew codes. To get more information on setting wage rates, press F1. At *National Estimator* Help Contents, click on the **Search** button. Type "wage" then click on **Setting Hourly Wage Rates** in the Choose topic to display window. To return to your estimate, click on **File** on the *National Estimator* Help menu bar. Then click on **Exit**.

Changing Cost Estimates



Change the material cost to .41.

With Num Lock off, use the ↑ or ↓ arrow key to move the cursor to the line you want to change (or click on that line). In this case, move to the line that begins with a quantity of 920. To open the Enter Cost Information Dialog box, either:

- Press Enter↵, -or-
- Click on the (Change Cost) button on the toolbar.

To make a change, either:

- Click on what you want to change, -or-
- Press Tab until the cursor advances to what you want to change.

Then type the correct figure. In this case, change the material cost to $.41 (forty-one cents).

Press Tab and check the Extended Costs column. If it looks OK, press Enter and the change is made on your estimating form.

Changing Text (Descriptions)

To select, click and hold the mouse button while dragging the mouse.

Click on the (Estimate Window) button on the toolbar to be sure you're in the estimate. With Num Lock off, use the ↑ or ↓ arrow key or click the mouse button to put the cursor where you want to make a change. In this case, we're going to make a change on the line that begins *6" steel ceiling joists*.

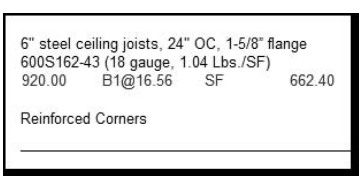
To make a change, click where the change is needed. Then either:

- Press the Del or ←Bksp key to erase what needs deleting, -or-
- Select what needs deleting and click on the (Cut) button on the toolbar.
- Type what needs to be added.

In this case, click just after C in OC. Then hold the left mouse button down and drag the mouse to the right until you've put a dark background behind the word *1-5/8" flange*. The dark background shows that this word is selected and ready for editing.

Press the Del key, or click on the (Cut) button on the toolbar, and the selection is cut from the estimate. If that's not what you wanted, click on the (Undo) button and *1-5/8" flange* is back again.

Adding Text (Descriptions)



Adding "Reinforced corners."

Some of your estimates will require descriptions (text) and costs that can't be found in *Steel-Frame Cost Data*. What then? With *National Estimator* it's easy to add descriptions and costs of your choice anywhere in the estimate. For practice, let's add an estimate for four reinforced corners to First Estimate.

Click on the (Estimate Window) button to be sure the estimate window is maximized. We can add lines anywhere on the estimate. But in this case, let's make the addition at the end. Press the ↓ arrow key to move the cursor down until it's just above the horizontal line that separates estimate detail lines from estimate totals. To open a blank line, either:

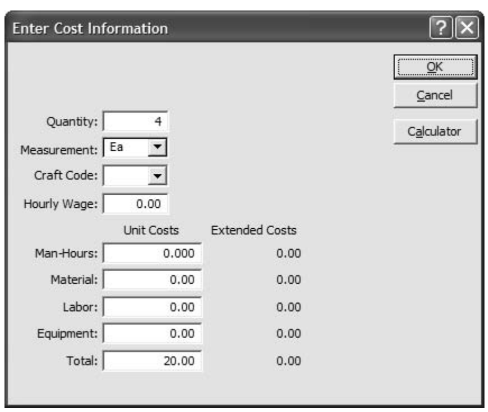
- Press Enter, -or-
- Click on the (Insert Text) button on the toolbar, -or-
- Click on **Edit** on the menu bar. Then click on **Insert a Text Line**.
- Type "Reinforced corners" and press Enter.

Adding a Cost Estimate Line

Now let's add a cost for Reinforced corners to your estimate. Begin by opening the Enter Cost Information dialog box. Either:

- Click on the (Insert Cost) button on the toolbar, -or-
- Click on **Edit** on the menu bar. Then click on **Insert a Cost Line**.

1. The cursor is in the Quantity box. Type the number of units (4 in this case) and press Tab.
2. The cursor moves to the next box, Unit of Measure.
3. In the Unit of Measure box, type "Each" and press Tab.
4. Press Tab twice to leave the Craft Code blank and Hourly Wage at zero.
5. Since these reinforced corners will be installed by the supplier, there's no material, labor or equipment cost. So press Tab four times to skip over the Hours, Material Cost, Labor Cost and Equipment Cost boxes.
6. In the Total Cost box, type "20.00." That's the cost per corner quoted by your supplier.
7. Press Tab once more to advance to OK.
8. Press Enter and the cost of four reinforced corners is written to your estimate.



Unit and extended costs for four reinforced corners.

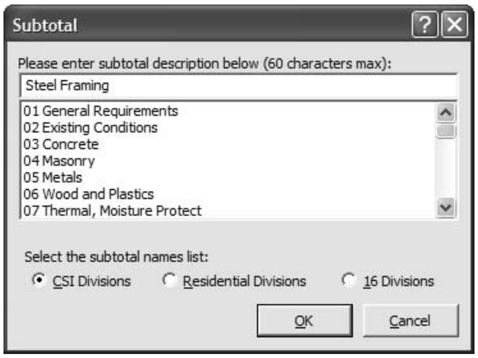
Note: The sum of material, labor and equipment costs appears automatically in the Total Cost box. If there's no cost entered in the Material Cost, Labor Cost or Equipment Cost boxes (such as for a subcontracted item), you can enter any figure in the Total Cost box.

Adding Lines to the Costbook

Add lines or make changes in the costbook the same way you add lines or make changes in an estimate. The additions and changes you make become part of the user costbook. For more information on user costbooks, press F1. Click on **Search**. Type "user" and press Enter

Subtotals Become QuickBooks Cost Categories

At the end of each section in your estimate, insert a subtotal. For a general contractor, estimate sections might be Demolition, Excavation, Foundation, Framing, etc. Estimate sections for a remodeling contractor might include Kitchen, Bathroom and Basement. Section subtotals help organize your estimates and make them easier to read and understand. Insert section subtotals wherever they make the most sense to you. These subtotals become cost categories when printing bids and invoices. Subtotal names become *QuickBooks* cost category names when exporting to *QuickBooks*.

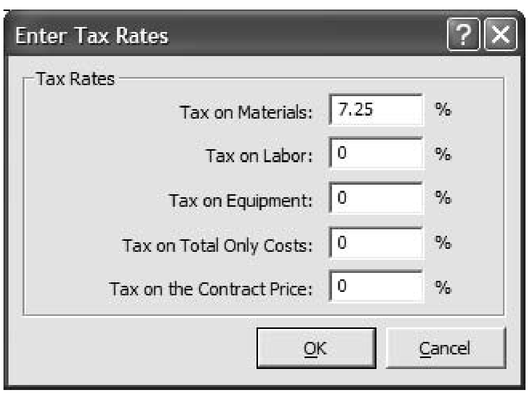


Insert a subtotal.

To insert a subtotal:

1. Click on the last cost line of the section (or on any blank line below the section).
2. Click on the (Subtotal) button on the toolbar (or click on **Edit** and **Insert Subtotal**).
3. Type a name or description for the section (such as "Steel Framing").
4. Press Enter.

Adding Tax



Type the tax rate that applies.

To include sales tax in your estimate:

1. Click on **Edit**.
2. Click on **Current Tax Rates**.
3. Type the tax rate in the appropriate box.
4. Press Tab to advance to the next box.
5. Press Enter or click on **OK** when done.

In this case, the tax rate is 7.25% on materials only. Tax will appear as the last line of the estimate.

Adding Overhead and Profit

Adding overhead & profit.

Set markup percentages in the Set Markup Amounts dialog box. To open the box, either:

- Click on the (Markup) button on the toolbar, -or-
- Click on **Edit** on the menu bar. Then click on **Markup**.

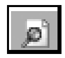
Type the percentages you want to add for overhead. For this estimate:

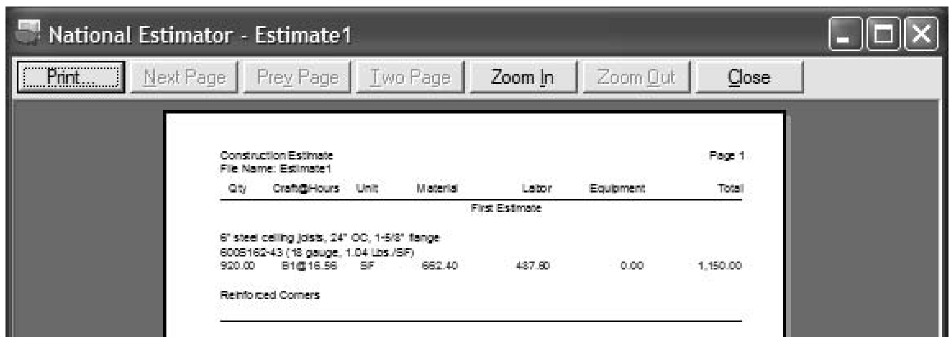
1. Type "15" on the Overhead line.
2. Press Tab to advance to Profit.
3. Type "10" on the Profit line.
4. Press Enter.

Markup percentages can be changed at any time. Just reopen the Set Markup Amounts dialog box and type the correct figure.

Preview Your Estimate

You can display an estimate on screen just the way it will look when printed on paper. To preview your estimate, either:

- Click on the  (Print Preview) button on the toolbar, -or-
- Click on **File** on the menu bar. Then click on **Print Preview**.



Use buttons on Print Preview to see your estimate as it will look when printed.

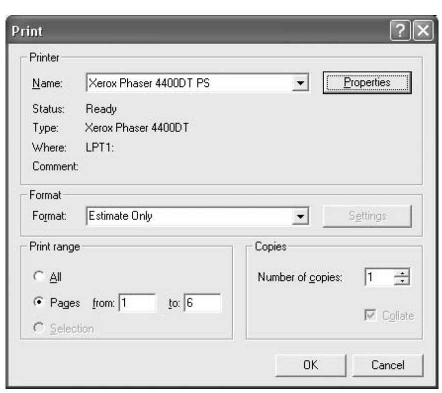
In Print Preview:

- Click on **Next Page** or **Prev Page** to turn pages.
- Click on **Two Page** to see two estimate pages side by side.
- Click on **Zoom In** to get a closer look.
- Click on **Close** when you've seen enough.

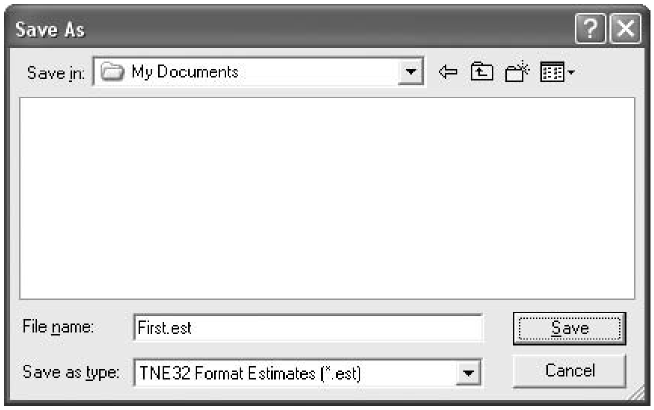
Printing Your Estimate

When you're ready to print the estimate, either:

- Click on the  (Print) button on the toolbar, -or-
- Click on **File** on the menu bar. Then click on **Print**, -or-
- Hold the Ctrl key down and type the letter **P**.
- Press Enter ↵ or click on **OK** to begin printing.



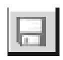
Options available depend on the printer you're using.



Type the estimate name in the File Name box to assign a file name.

Save Your Estimate to Disk

To store your estimate on the hard disk where it can be reopened and changed at any time, either:

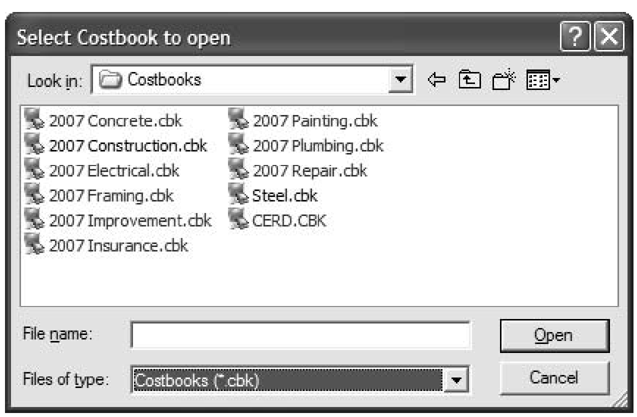
- Click on the  (Save) button on the toolbar, -or-
- Click on **File** on the menu bar. Then click on **Save**, -or-
- Hold the Ctrl key down and type the letter **S**.

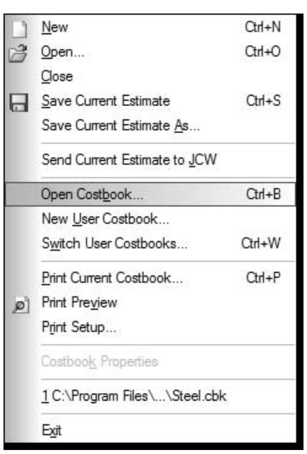
The cursor is in the File Name box. Type the name you want to give this estimate, such as *First*. Press Enter↵ or click on **OK** and the estimate is written to disk.

Opening Other Costbooks

Many construction cost estimating databases are available for the *National Estimator* program. The order form at the back of this manual has more information on these costbooks.

Open the costbook of your choice.





Click to switch costbooks.

If you own several of these manuals and have installed the database that comes with each, you can open several costbooks at the same time. To open another costbook:

- Click on **File**.
- Click on **Open Costbook**.

- Be sure the drive and directory are correct, usually *C:\Program Files\Craftsman\National Estimator\Costbooks.*
- Double-click on the costbook of your choice.

To see a list of the costbooks that are open, click on **Window**. The name of the current estimate or costbook will be checked. Click on any other costbook name to display that costbook. Click on **Window**, then click on **Tile** to display all open costbooks and estimates.

Select Your Default Costbook

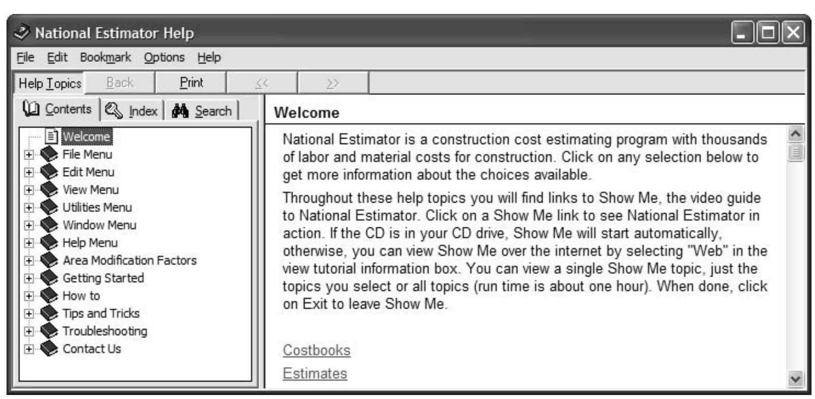
Your default costbook is the last costbook installed. It opens automatically every time you begin using *National Estimator*. Save time by making the default costbook the one you use most.

Select the default costbook.

To change your default costbook, click on **Utilities** on the menu bar. Then click on **Options**. Next, click on **Select** under Default Costbook. Click on the costbook of your choice. Click on **OK**. Then click on **OK** again.

Use National Estimator Help

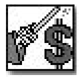
That completes the basics of *National Estimator*. You've learned enough to complete most estimates. When you need more information about the fine points, use *National Estimator* Help. Click on the (Help) button to see Help Contents. Then click on the menu selection of your choice. To print 40 pages of instructions for *National Estimator*, go to Help Contents. Click on



Click on File and then Print Topic.

Print All Topics (at the bottom of Help Contents). Click on **File** on the Help menu bar. Then click on **Print Topic**. Click on **OK**.

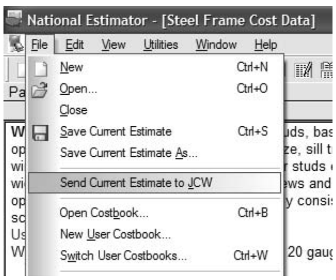
Converting Estimates with Job Cost Wizard



Job Cost Wizard icon.

Use *Job Cost Wizard* to:

- Convert estimates into bids and invoices you can send to a client.
- Export to *QuickBooks* where you can track job costs, receivables, payables, create payrolls and print financial reports.

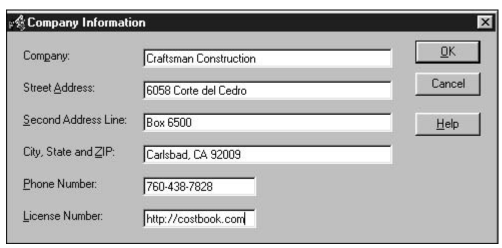


Send the estimate to Job Cost Wizard.

To view your completed estimate in *Job Cost Wizard*, either:

- Click on **File**, click on **Send Estimate to JCW**, or
- Hold the Ctrl key down and tap **J**

You can also start *Job Cost Wizard* by clicking on the *Job Cost Wizard* icon in the Construction Estimating program group. Then click on the name of the estimate you want to open.



Fill in information about your company.

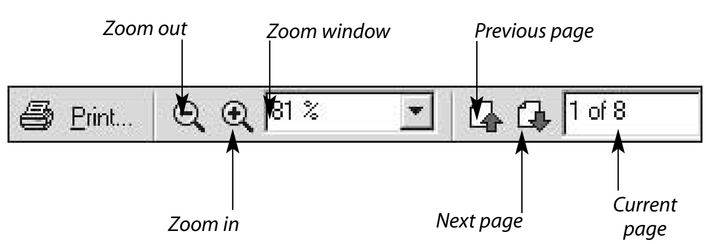
The Company Information dialog box will open the first time you use *Job Cost Wizard*. Type your company name and address. This will appear at the top of every estimate and invoice. When you've filled in infomation about your company, click on **OK** and your estimate will open in *Job Cost Wizard*.

To change any of the information about your company:

- Click on **Options.**
- Click on **Your Company Info.**
- Type the changes needed and click **OK.**

Zoom, Scroll and Turn Pages

If the estimate doesn't fit your screen, set the percentage of zoom. For 640 × 480 resolution, type 81% in the zoom window and press Enter.

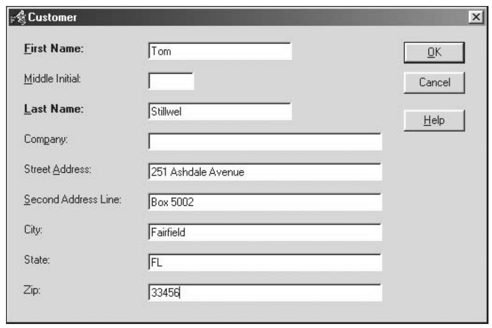


Click and drag the vertical slide bar at the right of your screen to scroll down the page. Turn pages by clicking on the Previous Page or Next Page buttons.

Enter Job Information

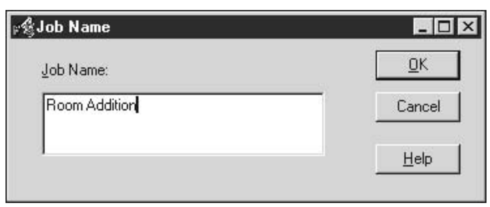
Job Cost Wizard needs some information about the job to create a nice-looking bid or invoice. For practice, enter job information for the Stillwel estimate:

1. **Customer name and address**. Click on the  (Customer Info) button on the toolbar to enter information about the customer. Only the customer first name and last name are required. All other information is optional. When done, click on **OK**.



Fill in Customer Information.

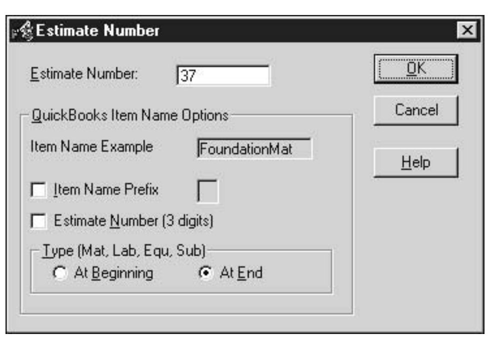
2. **Job Name**. Click on the  (Job Name) button on the toolbar. Then type the name of the job, such as "Room Addition." When done, click on **OK**.



Enter a Job Name.

 *For transfers to QuickBooks.* You can change the customer or job name after the file has been imported into *QuickBooks*. In *QuickBooks*, click on **Lists**. Click on **Customers:Job List**. Right-click on customer name or job name. Click on **Edit**. Then click on the tab of your choice.

3. **Estimate Number**. Click on the  (Estimate Number) button on the toolbar. Job Cost Wizard keeps track of the last number used and recommends using the next number in sequence. Click on **OK** when done.



Check the Estimate Number.

For transfers to QuickBooks. When *QuickBooks* imports an estimate or invoice, subtotals in your estimate become cost categories ("items") in *QuickBooks*. By default, cost category names in *QuickBooks* are the first 28 characters of estimate subtotal names plus the work type, either *Mat, Lab, Equ,* or *Sub*. You can change this default in the Estimate Number dialog box.

Job Cost Wizard Prints Invoices Your Way

Your estimates should cover every cost in a job. But your bids and invoices don't have to show all the details and reveal your markup. So *Job Cost Wizard* gives you choices about showing or hiding the details and markup.

Amount of Detail

To set the amount of detail, click on the (Details) button.

If *Show All* is selected, every item in your bid or invoice will show a cost and each will become a cost category on the *QuickBooks* Item List. *Subtotals Only* is the default and will usually be a better choice.

Fill in information about your company.

If *Subtotals Only* is selected, subtotals will be the only costs in your bid or invoice. Each subtotal in your estimate becomes a cost category on the *QuickBooks* Items list. That's usually the best choice. If *Subtotals Only* is selected for all four cost categories, click on **Omit Work Descriptions** to show subtotal categories but hide all work descriptions.

The names you give to subtotals in *National Estimator* become cost category names in *QuickBooks*. Cost lines in *National Estimator* not followed by a subtotal become the "Project" subtotal.

If *Omit Entirely* is selected, neither costs nor descriptions will appear for that type of cost — either material, labor, equipment or total only (subcontract). Use *Omit Entirely* for materials, for example, when materials are being furnished by the owner.

Total Only Costs are assumed to be subcontract items. Subcontract items have a cost in the total column but no cost for material, labor, or equipment.

Markup and Tax

Use the three buttons at the bottom of the Amount of Detail dialog box to show or hide markup (overhead, contingency and profit) and tax.

In Every Cost Item distributes markup and tax proportionately throughout the estimate. There's no mention of overhead, profit or markup anywhere in the estimate or invoice.

At End of Estimate puts markup and tax at the end of the estimate, as in *National Estimator*.

Omit Entirely omits markup and tax from the estimate or invoice. Use this option if you prefer to add markup and tax in *QuickBooks*.

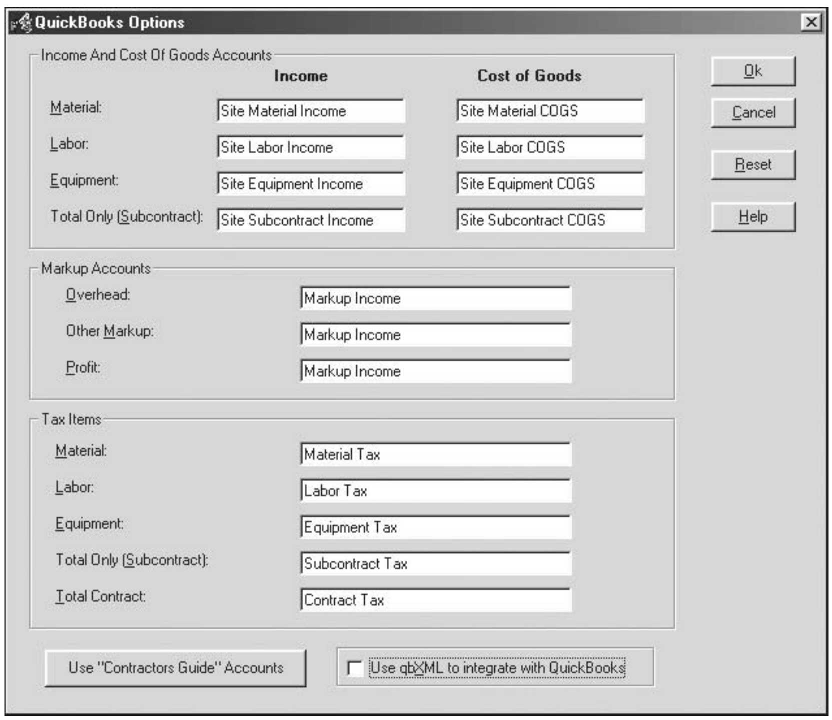
Click **Show Only Item Totals** if you don't want the invoice or estimate to show any breakdown of material, labor or equipment costs.

Click on **OK** when done with the Amount of Detail dialog box.

QuickBooks Account Names

Estimates and invoices imported into *QuickBooks* include expense and income account names. If the imported accounts do not exist already in your *QuickBooks* company, *QuickBooks* will create new accounts. You can control the names of these accounts by making changes in the *QuickBooks* Options dialog box.

- Click on the (*QuickBooks* Options) button on the toolbar, -or-
- Click on **Options** on the menu bar. Then click on ***QuickBooks* Options**.



Click on OK when done with QuickBooks Options.

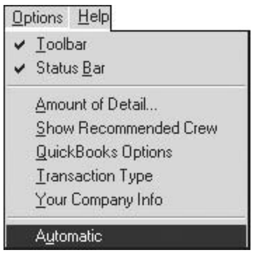
Enter the names you prefer for income, cost of goods, markup and tax accounts. Change "Material Tax" to "FL Sales Tax," for example, if the job is taxable under Florida law. *QuickBooks* will keep track of tax due in each state where you do business.

Click **Use "Contractors Guide" Accounts** if you prefer the account names recommended in *Contractor's Guide to QuickBooks Pro*. An order form for this title is at http://costbook.com. To restore the default account names, click **Reset**.

If *QuickBooks Pro* version 2002 or later is installed on the computer, you should see a check mark beside *Use qbXML to integrate with QuickBooks*. XML exports to *QuickBooks*, as will be explained on the next page. If *QuickBooks Pro* is installed but there is no check mark, click on **Use qbXML to integrate with QuickBooks**. You'll be asked to identify the *QuickBooks*

Company to receive imports from *Job Cost Wizard*. Select the company file you prefer and click **Open**. See Exporting an Estimate to *QuickBooks,* below, for more on opening the XML link to *QuickBooks*.

Automatic



Set up for automatic operation.

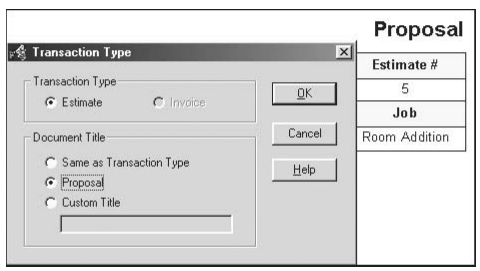
Job Cost Wizard always requires customer information, a job name and a job number before exporting an estimate. In automatic mode, *Job Cost Wizard* opens the Customer Info, Job Name and Estimate Number dialog boxes automatically after opening any estimate.

Job Cost Wizard runs in automatic mode when there is a check mark beside Automatic on the Options menu. To change to automatic mode, click on **Options** on the menu bar. Then click on **Automatic**.

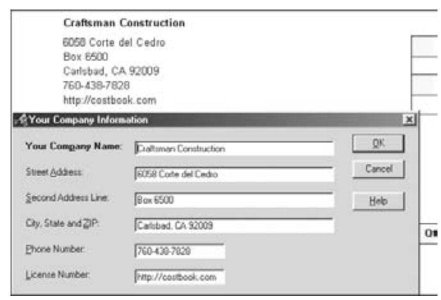
Transaction Type and Your Company Info

On the Options menu, click **Transaction Type** to change the form title from Estimate to Invoice to Proposal or anything you want (Custom). For *QuickBooks* exports, the transaction type has to be either Estimate or Invoice.

On the Options menu, click **Your Company Info** to change the company name or address.



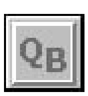
Changing the form title to "Proposal."



Enter your company name.

Click on the **Print** icon or **File** and **Print**. Then click **OK** to print the document.

Exporting an Estimate to QuickBooks



QB icon.

If you have *QuickBooks 2002* or later, *Job Cost Wizard* will select XML export by default. If you have an earlier version of *QuickBooks*, exports will create an Intuit Interface File (IIF). XML exports happen over a direct link between the two programs. For IIF exports, *Job Cost Wizard* writes a file in the *QuickBooks* folder.

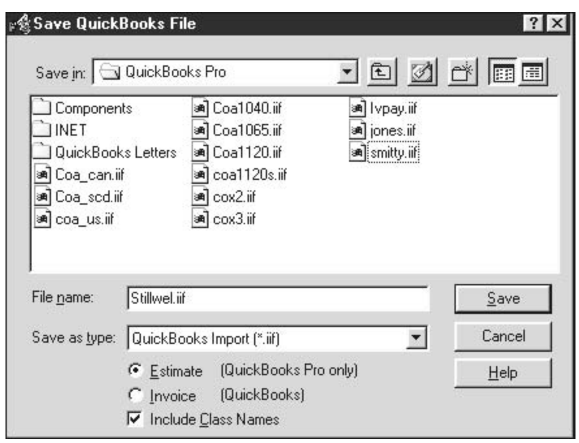
If you have 2002 QuickBooks or later*, use the XML export:*

1. Begin by clicking the **QB** icon.
2. *Job Cost Wizard* will advise that *QuickBooks* is asking permission to access the company file.

3. If you receive a warning about security level, follow instructions on the screen.
4. Click **Launch QuickBooks** and select the company file to receive the export.
5. *QuickBooks* will open.
6. Click **Yes, Always** to grant *Job Cost Wizard* access to the *QuickBooks* company file.
7. A bar will report that the transfer is in progress. Click **OK** when the export is successful.
8. In *QuickBooks*, click **Customers**. Click **Create Estimates**. Then click **Previous** to see the imported estimate. You can skip information on IIF exports and go right to turning estimates into invoices on page 310.

If you have an older version of QuickBooks*, use the IIF export:*

1. Begin by clicking the **QB** icon.
2. Change the drive or the folder if the *QuickBooks* folder is not listed at the right of *Save in*.
3. Check the file name to be sure it is what you want.
4. If you use *QuickBooks Pro*, click on **Estimate**.
5. If you use regular *QuickBooks*, click on **Invoice**.
6. When complete, click on **Save**.



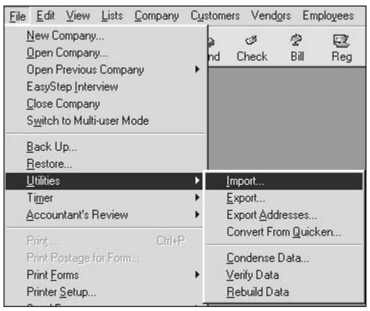
Exporting as an estimate to QuickBooks Pro.

Exporting an estimate to *QuickBooks Pro* does not affect the original estimate in any way. *Job Cost Wizard* can open and export an estimate as many times as you want. To create a second copy of the same estimate with different *Job Cost Wizard* options, save with a slightly different file name. But note that *QuickBooks Pro* can import an estimate for any customer and job only once. Details are on the next page.

Opening IIF Export Files in QuickBooks

Once an estimate or invoice has been written to file with *Job Cost Wizard*, start *QuickBooks*:

1. Click on **File**.
2. Click on **Utilities**.
3. Click on **Import**.



Importing into QuickBooks.

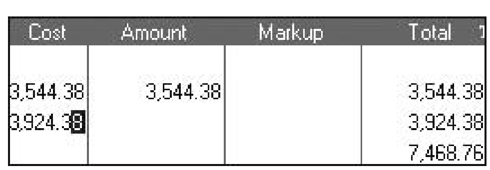
4. Double-click on the name of the estimate or invoice you want.
5. Click on **OK** when the import is complete.
6. Click on **Customers**.
7. Click on **Create Estimates** if you saved the file as an estimate.
8. Click on **Create Invoices** if you saved the file as an invoice.
9. Click on **Previous** to see the file just imported.

Important Note: With *QuickBooks Pro 2000* and higher, you can import an estimate only once from an IIF. On second import of the same estimate, you'll see an error message, "Can't record invalid transaction." If you make a mistake and want to import an estimate again, delete the previous imported estimate before importing again. Instructions for deleting an estimate are on page 310. If you want two versions of any one estimate in *QuickBooks Pro*, save the alternate estimate with a slightly different job name or customer name. That makes the estimate different enough so it will import perfectly into *QuickBooks*.

Filling in the "Amount" Column (IIF only)

An imported estimate is not complete until some figure appears in the Amount column of each cost line. So long as the Amount column is blank, *QuickBooks* will consider the estimated cost for that line to be zero (even when numbers appear in the Total column). If the Amount column for an entire estimate is left blank, *QuickBooks* reports will show the estimated cost for that job to be zero.

The fastest way to fill in the Amount column for a *QuickBooks* estimate is to click on a number in the Cost column and change the figure by a penny. Continue clicking and changing costs by a penny until every row of costs includes a figure in the Amount column.



Forcing a figure into the Amount column.

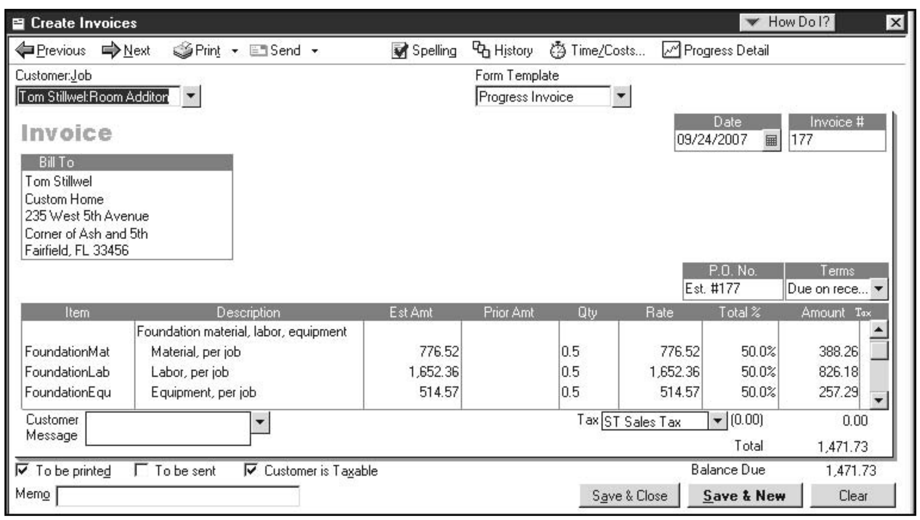
Turn an Estimate into an Invoice in QuickBooks

First, decide if you want an invoice for the whole job or for just part of the job (progress billing). If you prefer progress billing:

1. Click on **Edit**, click on **Preferences**, click on **Jobs & Estimates**, click on **Company Preferences**, click on **Yes** under *Do You Do Progress Invoicing*? Click on **OK**.

To create the invoice:

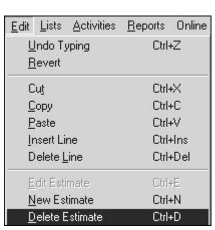
1. Click on the **Create Invoice** button at the top of the *QuickBooks* estimate screen.
2. Click on **Yes** to record changes to the estimate.
3. If you selected progress billing, enter a percentage or select items to be invoiced.
4. Click on **OK** and *QuickBooks* creates the invoice.
5. Make changes to the invoice if you want.
6. Click to print one copy for your file and another for your customer.
7. Click on **OK** when done. (Processing the file may take a little time.) *QuickBooks* reports will now include totals from the job just invoiced.



An invoice for the first half of the foundation work.

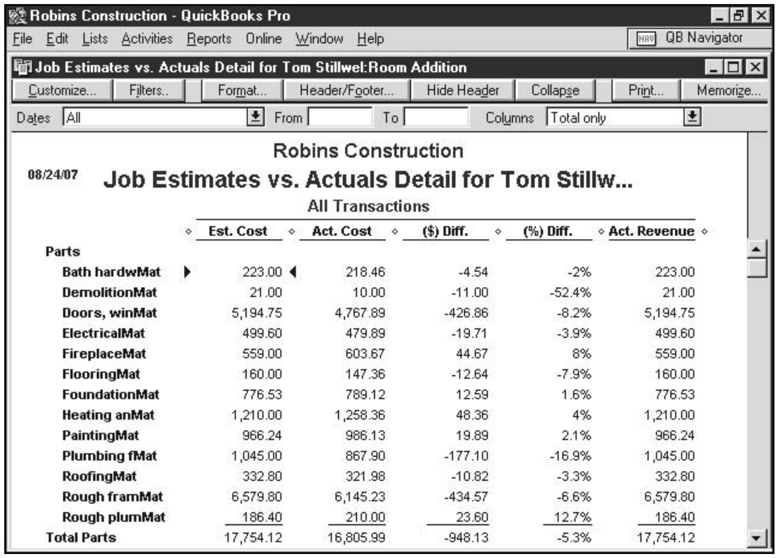
Don't Worry About Making a Mistake

QuickBooks is very forgiving. Practice all you want. Experiment any way you want. Then delete any estimate or invoice to remove every trace of it from *QuickBooks*. With the offending estimate or invoice displayed:



It's easy to delete an estimate.

1. Click on **Edit**.
2. Click on **Delete Estimate** (or Invoice).
3. Click on **OK**.
4. The estimate (or invoice) is deleted.



Robins Construction - QuickBooks Pro

File Edit Lists Activities Reports Online Window Help QB Navigator

Job Estimates vs. Actuals Detail for Tom Stillwel:Room Addition

Customize... Filters.. Format... Header/Footer... Hide Header Collapse Print... Memorize...

Dates All From To Columns Total only

Robins Construction

08/24/07 Job Estimates vs. Actuals Detail for Tom Stillw...

All Transactions

	Est. Cost	Act. Cost	($) Diff.	(%) Diff.	Act. Revenue
Parts					
Bath hardwMat	223.00	218.46	-4.54	-2%	223.00
DemolitionMat	21.00	10.00	-11.00	-52.4%	21.00
Doors, winMat	5,194.75	4,767.89	-426.86	-8.2%	5,194.75
ElectricalMat	499.60	479.89	-19.71	-3.9%	499.60
FireplaceMat	559.00	603.67	44.67	8%	559.00
FlooringMat	160.00	147.36	-12.64	-7.9%	160.00
FoundationMat	776.53	789.12	12.59	1.6%	776.53
Heating anMat	1,210.00	1,258.36	48.36	4%	1,210.00
PaintingMat	966.24	986.13	19.89	2.1%	966.24
Plumbing fMat	1,045.00	867.90	-177.10	-16.9%	1,045.00
RoofingMat	332.80	321.98	-10.82	-3.3%	332.80
Rough framMat	6,579.80	6,145.23	-434.57	-6.6%	6,579.80
Rough plumMat	186.40	210.00	23.60	12.7%	186.40
Total Parts	17,754.12	16,805.99	-948.13	-5.3%	17,754.12

Estimates vs. actuals detail.

Your Jobs in Quickbooks

- Click on **Reports**, **Company & Financial**, **Profit & Loss By Job** to see job income and expense.
- Click on **Reports**, **Company & Financial**, **Balance Sheet Standard** to see the new receivables total.
- Click on **Reports**, **Jobs & Time**, **Job Estimates vs. Actuals Detail**, select the customer and job to see a detailed cost comparison for the job. Until you start paying bills, the Actuals Cost column will be all zeros.

List of Steel-Framing Details on the Download

Instructions for using these drawings are on page 290.

Index

Note: The *Prescriptive Method for Residential Cold-Formed Steel Framing* booklet, which begins on page 181 of this book, is not included in this index. Use the *Contents* on page vii of the booklet to find what you need.

D

E

F

M

N

O

P

Q

R

S

T

U

V

W

X

Z

Practical References for Builders

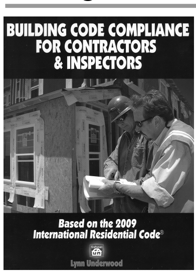
Basic Engineering for Builders

If you've ever been stumped by an engineering problem on the job, yet wanted to avoid the expense of hiring a qualified engineer, you should have this book. Here you'll find engineering principles explained in non-technical language and practical methods for applying them on the job. With the help of this book you'll be able to understand engineering functions in the plans and how to meet the requirements, how to get permits issued without the help of an engineer, and anticipate requirements for concrete, steel, wood and masonry. See why you sometimes have to hire an engineer and what you can undertake yourself: surveying, concrete, lumber loads and stresses, steel, masonry, plumbing, and HVAC systems. This book is designed to help the builder save money by understanding engineering principles that you can incorporate into the jobs you bid.
400 pages, 8½ x 11, $39.50

Construction Contract Writer

Relying on a "one-size-fits-all" boilerplate construction contract to fit your jobs can be dangerous —almost as dangerous as a handshake agreement. Construction Contract Writer lets you draft a contract in minutes that precisely fits your needs and the particular job, and meets both state and federal requirements. You just answer a series of questions — like an interview — to construct a legal contract for each project you take on. Anticipate where disputes could arise and settle them in the contract before they happen. Include the warranty protection you intend, the payment schedule, and create subcontracts from the prime contract by just clicking a box. Includes a feedback button to an attorney on the Craftsman staff to help should you get stumped — No extra charge. **$99.95**. Download the Construction Contract Writer at:
http://www.constructioncontractwriter.com

Building Code Compliance for Contractors & Inspectors



Have you ever failed a construction inspection? Have you ever dealt with an inspector who has his own interpretation of the Code and forces you to comply with it? This new book explains what it takes to pass inspections under the 2009 International Residential Code. It includes a Code checklist – with explanations and the Code section number – for every trade, covering some of the most common reasons why inspectors reject residential work. The author uses his 30 years' experience as a building code official to provide you with little-known information on what code officials look for during inspections. **232 pages, 8½ x 11, $32.50**

Markup & Profit: A Contractor's Guide, Revisited

In order to succeed in a construction business, you have to be able to price your jobs to cover all labor, material and overhead expenses, and make a decent profit. But calculating markup is only part of the picture. If you're going to beat the odds and stay in business – profitably, you also need to know how to write good contracts, manage your crews, work with subcontractors and collect on your work. This book covers the business basics of running a construction company, whether you're a general or specialty contractor working in remodeling, new construction or commercial work. The principles outlined here apply to all construction-related businesses. You'll find tried and tested formulas to guarantee profits, with step-by-step instructions and easy-to-follow examples to help you learn how to operate your business successfully. Includes a link to free downloads of blank forms and checklists used in this book. **312 pages, 8½ x 11, $47.50**

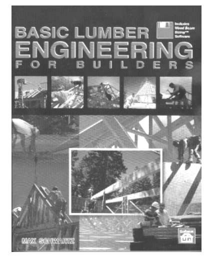
National Construction Estimator

Current building costs for residential, commercial, and industrial construction. Estimated prices for every common building material. Provides manhours, recommended crew, and gives the labor cost for installation. Includes a CD-ROM with an electronic version of the book with *National Estimator*, a stand-alone *Windows*™ estimating program, plus an interactive multimedia video that shows how to use the disk to compile construction cost estimates. **656 pages, 8½ x 11, $72.50. Revised annually**

Construction Estimating Reference Data

Provides the 300 most useful manhour tables for practically every item of construction. Labor requirements are listed for sitework, concrete work, masonry, steel, carpentry, thermal and moisture protection, doors and windows, finishes, mechanical and electrical. Each section details the work being estimated and gives appropriate crew size and equipment needed. Includes a CD-ROM with an electronic version of the book with *National Estimator*, a stand-alone *Windows*™ estimating program, plus an interactive multimedia video that shows how to use the disk to compile construction cost estimates. **432 pages, 11 x 8½, $39.50**

Basic Lumber Engineering for Builders



Beam and lumber requirements for many jobs aren't always clear, especially with changing building codes and lumber products. Most of the time you rely on your own "rules of thumb" when figuring spans or lumber engineering. This book can help you fill the gap between what you can find in the building code span tables and what you need to pay a certified engineer to do. With its large, clear illustrations and examples, this book shows you how to figure stresses for pre-engineered wood or wood structural members, how to calculate loads, and how to design your own girders, joists and beams. Included FREE with the book — an easy-to-use version of NorthBridge Software's *Wood Beam Sizing* program. **272 pages, 8½ x 11, $38.00**

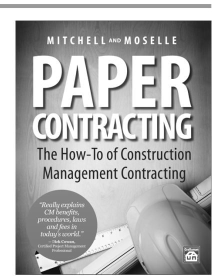
Roofing Construction & Estimating

Installation, repair and estimating for nearly every type of roof covering available today in residential and commercial structures: asphalt shingles, roll roofing, wood shingles and shakes, clay tile, slate, metal, built-up, and elastomeric. Covers sheathing and underlayment techniques, as well as secrets for installing leakproof valleys. Many estimating tips help you minimize waste, as well as insure a profit on every job. Troubleshooting techniques help you identify the true source of most leaks. Over 300 large, clear illustrations help you find the answer to just about all your roofing questions. **432 pages, 8½ x 11, $38.00**

Commercial Metal Stud Framing

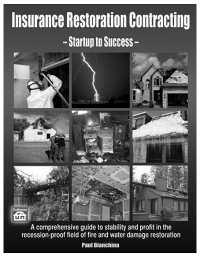
Framing commercial jobs can be more lucrative than residential work. But most commercial jobs require some form of metal stud framing. This book teaches step-by-step, with hundreds of job site photos, high-speed metal stud framing in commercial construction. It describes the special tools you'll need and how to use them effectively, and the material and equipment you'll be working with. You'll find the shortcuts, tips and tricks-of-the-trade that take most steel framers years on the job to discover. Shows how to set up a crew to maintain a rhythm that will speed progress faster than any wood framing job. If you've framed with wood, this book will teach you how to be one of the few top-notch metal stud framers.
208 pages, 8½ x 11, $45.00

Paper Contracting: The How-To of Construction Management Contracting



Risk, and the headaches that go with it, have always been a major part of any construction project – risk of loss, negative cash flow, construction claims, regulations, excessive changes, disputes, slow pay – sometimes you'll make money, and often you won't. But many contractors today are avoiding almost all of that risk by working under a construction management contract, where they are simply a paid consultant to the owner, running the job, but leaving him the risk. This manual is the how-to of construction management contracting. You'll learn how the process works, how to get started as a CM contractor, what the job entails, how to deal with the issues that come up, when to step back, and how to get the job completed on time and on budget. Includes a link to free downloads of CM contracts legal in each state. **256 pages, 8½ x 11, $55.50**

Insurance Restoration Contracting: Startup to Success



Insurance restoration –— the repair of buildings damaged by water, fire, smoke, storms, vandalism and other disasters –— is an exciting field of construction that provides lucrative work that's immune to economic downturns. And, with insurance companies funding the repairs, your payment is virtually guaranteed. But this type of work requires special knowledge and equipment, and that's what you'll learn about in this book. It covers fire repairs and smoke damage, water losses and specialized drying methods, mold remediation, content restoration, even damage to mobile and manufactured homes. You'll also find information on equipment needs, training classes, estimating books and software, and how restoration leads to lucrative remodeling jobs. It covers all you need to know to start and succeed as the restoration contractor that both homeowners and insurance companies call on first for the best jobs. **640 pages, 8½ x 11, $69.00**

Construction Forms for Contractors

This practical guide contains 78 practical forms, letters and checklists, guaranteed to help you streamline your office, organize your jobsites, gather and organize records and documents, keep a handle on your subs, reduce estimating errors, administer change orders and lien issues, monitor crew productivity, track your equipment use, and more. Includes accounting forms, change order forms, forms for customers, estimating forms, field work forms, HR forms, lien forms, office forms, bids and proposals, subcontracts, and more. All are also on the CD-ROM included, in Excel spreadsheets, as formatted Rich Text that you can fill out on your computer, and as PDFs. **360 pages, 8½ x 11, $48.50**

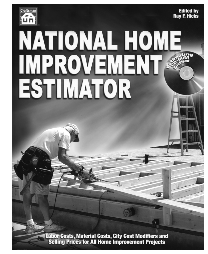
Blueprint Reading for the Building Trades

How to read and understand construction documents, blueprints, and schedules. Includes layouts of structural, mechanical, HVAC and electrical drawings. Shows how to interpret sectional views, follow diagrams and schematics, and covers common problems with construction specifications. **192 pages, 5½ x 8½, $16.75**

Contractor's Survival Manual Revised

This completely revised book explains how to survive hard times and succeed during the up cycles. Shows what to do when the bills can't be paid, finding money and buying time, transferring debt, and all the alternatives to bankruptcy. Explains how to build profits, avoid problems in zoning and permits, taxes, time-keeping, and payroll. Unconventional advice on how to invest in inflation, get high appraisals, trade and postpone income, and stay hip-deep in profitable work. **336 pages, 8½ x 11, $38.00**

National Home Improvement Estimator



Current labor and material prices for home improvement projects. Provides manhours for each job, recommended crew size, and the labor cost for the removal and installation work. Material prices are current, with location adjustment factors and free monthly updates on the Web. Gives step-by-step instructions for the work, with helpful diagrams, and home improvement shortcuts and tips from an expert. Includes a CD-ROM with an electronic version of the book, and National Estimator, a stand-alone WindowsTM estimating program, plus an interactive multimedia tutorial that shows how to use the disk to compile home improvement cost estimates.
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