Steel is perfectly straight, comes in accurately precut lengths, and thanks to recent code changes, is easier to use than ever

FRAMING WITH Light-Gauge Steel

by Matt Macarewich

My company builds high-end custom homes in Southern California. We used to frame everything with wood, but about eight years ago we started using light-gauge steel (LGS) because it gave us a higher-quality building. LGS won't rot, burn, or get eaten by termites, and every piece is perfectly straight. Now we rarely frame with anything but steel.

I recently started a business selling LGS materials and training builders to frame with steel. The same structural principles apply whether you frame with wood or steel; you still have studs, beams, headers, joists, and rafters. Some things are different, but once you understand what the differences are, you can frame with steel as confidently as you frame with wood.

Figure 1. As you can see from the size of the scrap pile, there's not a lot of waste on a steel framing job. This is what's left after framing half of a 3,000-square-foot house.

Figure 2. Most framers use chop saws with 14-inch abrasive blades to cut studs (right). It works, but the blades produce a lot of sparks and wear out quickly on heavier-gauge steel. It doesn't cost more to order precut studs, but if you need to cut on site, a dry-cut blade will do the job. The orange paint indicates that the joist is made from 14-gauge steel (below).

Engineering the Structure

Each stud manufacturer used to have its own method for assembling buildings. As a result, engineers had to provide stamped drawings for each job. But a few years back, building codes began to adopt the *Prescriptive Method for Residential Cold-Formed Steel Framing*, a collection of span charts and construction details for building with LGS. The latest version of the prescriptive method, the *Prescriptive Method for One and Two Family Dwellings,* has been incorporated into the *International Residential Code* (*IRC*) and is available as a separate document from the Steel Framing Alliance. In some jurisdictions it's now possible to use LGS without consulting an engineer, which is how it has always been with wood.

Even so, I highly recommend consulting an engineer who specializes in LGS. I have to use an engineer because stamped drawings are required in the seismic zones where I build. If the building is big enough, you'll need an engineer anyway because the prescriptive method does not apply to residential buildings with footprints greater than 36x60 feet. Engineers can also allow you to use details that haven't made their way into the code. The easiest way to find a qualified engineer is to contact the Light Gauge Steel Engineers Association.

Material

Most contractors are familiar with the light-gauge steel studs and track you can buy at lumberyards and drywall supply houses. These studs are usually 25-gauge steel with $1^1/_4$-inch flanges and are intended for non-load-bearing applications such as partition walls. The load-bearing studs used in LGS houses are much stronger, anywhere from 20-gauge to 12-gauge in thickness, with a minimum $1^5/_8$-inch flange. They also have a thicker galvanized coating and are made from higher-strength steel than non-bearing studs.

Structural studs are not stock items. You can buy them through a drywall

supply house, but they will be made to order by a roll-forming company. The roll former slits (cuts to width) the steel and runs it through a computer controlled machine that bends the profile, punches holes, and cuts each stud or track to the length you request. Incidentally, roll formers do not differentiate between joists, rafters, and studs. To them, almost everything is a stud or track. For example, a joist would be considered a 2x12 stud.

Around here, the lead time for a steel framing package is a couple of weeks. It takes the roll former only about a day and a half to produce all the framing for a 3,000-square-foot house. If you change something and need extra material, you can usually get it made in a few days. The roll formers I use don't charge a premium for small runs of added material, though I might have to pick it up myself or pay a delivery charge if I need it in a hurry.

The good thing about having framing stock made to order is that there's no upcharge for having it precut to the exact length you need. This saves labor and reduces waste (see Figure 1, previous page). If you need 14-foot 1-inch joists, you order that exact length. If you're not sure what length is needed, you can order the joists a couple of inches long and trim them on site. With wood, you'd be buying 16-foot pieces and ending up with longer pieces of scrap. You could use some of it for blocking, but there would still be more waste than with steel.

Tools and Fasteners for Light-Gauge Steel

The most popular tool for cutting studs on site is a 14-inch abrasive cutoff saw (Figure 2, previous page). The blades are cheap, but they throw a lot of sparks and wear out quickly. A better way to cut LGS is with a dry-cut carbide-tipped blade in a circular or cutoff saw. Be careful where you point the saw, because waste is ejected as a spray of metal chips. Heavy-duty electric shears and nibblers are good for cutting curves. A guy I know cuts metal framing with a 14-inch gas-powered hand-held saw. It's the LGS equivalent of cutting wood framing with a chainsaw.

Screwing and Nailing

I use an old 2,500-rpm B&D screw gun with the versa clutch. The clutching action makes this tool somewhat like using an impact wrench. With so many fasteners to drive, it's worth using a corded tool, but for small pick-up jobs I'll use a 12-volt Makita cordless impact driver. Drywallers and commercial steel stud guys like using 4,000-rpm guns, but you'll snap a lot of bits if you release the trigger a split second late.

Areas that will be drywalled or sheathed should be put together with low-profile Phillips head screws. Other connections should be made with hex-head screws, because it's easier to steer and control them with the gun. A variety of screws are available for different steel framing applications, and new ones are being developed every year.

Specialized nails and guns are available for assembling certain parts of LGS buildings. We use nail guns primarily to fasten wall and roof sheathing. Guns and fasteners are also available for

Steel Framing Terminology

To build with LGS, the first thing you need to learn is how to order material. The Steel Stud Manufacturers Association (SSMA) recently standardized the way it describes studs and track. The convention is to specify the web, member type, flange, and thickness.

For example, a set of plans might call for a 1200S162-68. The first set of numbers describes the depth of the web. In this case, it's 1200, which is 12.00 inches. The letter "S" stands for stud ("T" for track, "F" for furring channel). The next set of numbers refers to the width of the flange. In this case, it's 162, which is 1.62 inches ($1^5/_8$ inches). The last number refers to the thickness in mils (thousandths of an inch) of the steel used to make the stud. Here, it's 68 mils (.068 inch) thick, 14-gauge steel. By convention, track is sized by inside dimension (ID), and studs are sized by outside dimension (OD). This means that studs will fit perfectly if you order them the same size as the track.

Wood framers build walls with 2x4 and 2x6 studs. The equivalent material for steel framers would be 362S162-33 ($3^5/_8$x$1^5/_8$-inch 20-gauge) and 550S162-33 ($5^1/_2$x$1^5/_8$-inch 20-gauge). You can tell by looking that they're wall studs, but different-gauge metals are sometimes specified for different parts of the frame. To avoid confusion, each stud and track gets labeled every foot by the roll-forming machine. Additionally, some manufacturers color-code the ends of material. The most common colors by gauge are: 20-gauge (33 mils), red; 18-gauge (43 mils), yellow; 16-gauge (54 mils), green; 14-gauge (68 mils), orange; 12-gauge (97 mils), blue or black.

There are also designations for the strength of the steel, the thickness of the galvanized coating, and whether the studs have holes punched in them. Strength is rated in "ksi." For 20- and 18-gauge material, the minimum rating is 33ksi. For 16-gauge and thicker, it's 55ksi. G-60 is the minimum galvanized coating allowed for load-bearing studs. You can order G-90 and thicker coatings for buildings in harsh, exposed environments.

attaching drywall, siding, rigid foam, and for certain steel-to-steel connections (such as stud to track). The nails have limited shear values and vary in design depending on the gauge of the stud and the sheathing material.

Hand Tools

The contents of your toolbelt will change when you start framing with steel. Keep your hammer for prying and bending, but replace your pencil with a Sharpie felt-tip marker. You'll need heavy-duty aviation snips for notching and Vise Grip clamps to hold parts together for fastening. Metal studs are perfectly straight, so you can plumb and level anything in the building with a magnetic torpedo and a 4-foot level. Finally, you'll want a 5/16-inch magnetic nut driver, 2-inch and 8-inch magnetic bit extensions, and a handful of #2 short Phillips bit tips.

Figure 3. Wood frame carpenters are accustomed to framing walls flat and then standing them up. It's a little more work to do this with LGS because you have to flip the wall to fasten the other side (top). Traditionally, steel stud walls are assembled in the vertical position. The bottom track is fastened to the deck, the top track is propped up in the air, and the studs go in last (above and right). In this case, the supplier provided curved track for the curved walls.

Building Walls

LGS walls use track members for top and bottom plates. Studs fit inside the track and are held in place with two #10x3/4-inch self-drilling screws or pneumatically driven metal-to-metal nails. All fasteners should have a locally accepted code approval. In most cases, an ASTM or ICBO approval will be printed on the box and a manufacturer's logo will be imprinted on the head of the fastener. Metal framing can also be joined by clinching or welding, but those methods require special inspection and/or certification. Welding also burns off the galvanizing, so welds need to be recoated with cold-forming galvanizing paint.

Bottom track is cut and butted the same as wood bottom plates. Top tracks are different than top plates because they aren't doubled. Instead, they run the full length of the wall, and the flanges are notched to lap at the corners. We cut plates in the field, so I buy track in 20-foot lengths. LGS is rolled to order, so I could get 60-foot pieces, but it's hard to handle anything that long. For long walls, you can splice the top plate by putting a short section of stud inside the track and screwing in through the sides. Be sure to land the splice over a bay, so it won't interfere with the studs.

When you figure stud lengths, you need to account for the thickness of the track. I usually deduct 1/4 inch for the plates, so a 9-foot wall would be framed with 8-foot 11 3/4-inch studs.

Wood framers assemble walls on the deck and tilt them up. You can do this with LGS, but it's easier to build walls in the upright position (Figure 3). That's because you have to fasten studs through both sides of the track. If you assemble the wall flat, you have to flip it halfway through to fasten the other side. LGS is so straight that it's easier to brace up the corner studs and run the top track between them. The rest of the studs can be installed afterward.

Studs (including joists and rafters) are punched 2 feet on-center to provide openings for pipes and wire. Rule

number one is that the punch holes should line up when you look down the wall. This will happen if you follow rule number two, which is to install studs with the cut end up. That way the lowest hole will always be 2 feet off the floor (Figure 4).

Slab Foundations

Track is much more flexible than wood, so a wall that lands on a wavy slab-on-grade foundation will telegraph the lumps and dips to the ceiling and floor above. This means the foundation needs to be very flat — plus or minus 1/8 inch. There are a couple of fixes for a wavy foundation. You can set the top plate level and custom cut each stud, or you can use metal shims. I find that it's faster to cut. Slight variations in a foundation wall cause fewer problems with floors, because the track that functions as a rim joist does have some ability to span minor gaps, and you can shim the floor system as needed.

Anchor bolts. Because track is only 1/8 inch thick, anchor bolts should be set about an inch up from the slab surface. If you set the bolts too high, there won't be enough thread and you'll have to put a stack of washers under the nut. Pay attention to the wall thickness when you set the bolts, or else they'll be off center. A 2x6 is only 5 1/2 inches wide, but a 6-inch metal stud is exactly 6 inches wide.

Joists and Rafters

LGS joists and rafters are basically studs with wider webs; they're anywhere from 6 inches to 14 inches wide. Rim joists are typically wide pieces of track and are of lighter gauge than the joists. Steel rafters don't get seat cuts; instead, they're attached to the top track with L clips. Clips are also used to fasten rafters to hips and ridges. An alternate method is to cut 2 inches off the flanges, bend the web sideways, and screw through the tab that remains (Figure 5).

Web stiffeners required. Horizontal bearing members (joists, rafters, beams, and headers) require web stiffeners similar to those used in wood I-joist construction (Figure 6, next page). Without web stiffeners, concentrated loads will cause the web section of the member to bow. A stiffener is simply a short piece of stud or L metal screwed vertically to the side or fit between the flanges of the member that's being stiffened. Web stiffeners are required where rafters bear on walls, walls bear on joists, and joists bear on foundations or walls below. They're also required at the ends of beams and headers, and anywhere else you put a concentrated load on a horizontal member.

Beams, Posts, and Headers

One of the most labor-intensive tasks on a steel framing job is fabricating beams and headers. The most common assemblies are box beams and back-to-back headers.

Figure 4. Studs, joists, and rafters are punched 2 inches on-center to accommodate pipes and wire. You should install them so the holes line up.

Figure 5. Metal L clips can be used for a variety of connections. Here they're being used to fasten rafters to a bearing ridge, but they can also be used to attach joists to beams, beams to beams, and rafters to plates.

Box beams are made by ganging two or more joists between a pair of tracks (Figure 7). The pieces are fastened through the top and bottom track at 12 inches on-center with #10 self-drilling screws. The track is there only to hold the joists together, so it doesn't have to run the full length. I've installed beams built up from as many as five joists.

Back-to-back headers are made by putting a pair of joists back to back and screwing through the webs. Headers can also be boxed, but the top piece of track is replaced by the top plate of the wall. The lower header track is installed open side down so there's something to attach the cripples to. We don't use jacks or trimmers. Instead, we cut the header studs 6 inches long and create web extensions by cutting back the flanges. The extensions lap the king studs and are attached with a specified number of screws (Figure 8, next page). It's important to remove the rolled corner when you cut back the flanges; otherwise, there will be a bump in the drywall. You should also notch 1 3/4 inches off the top of the web extension so the upper track will fit over the king studs.

The span charts in the prescriptive code apply to beams and headers made from unpunched material. It's possible to construct them from punched material, but you'll need an engineer's approval. In addition, stiffeners need to be installed wherever there is a concentrated load on the beam. The L clips that hold the beam or header to the structure often function as stiffeners, but in some cases you'll have to stiffen members with short sections of stud.

Figure 6. Web stiffeners are required at the bearing points of joists, rafters, beams, and headers. In this photo, the carpenter is using a short section of stud to stiffen the end of a rafter.

Figure 7. Box beams are made by putting two or more unpunched studs between a top and a bottom track. Here, joists have been flush-framed to a box beam in the floor system.

Layout

The biggest difference between framing with wood and framing with LGS is how you do the layout. With steel, you need to be much more careful about load paths. The top track can't support loads between studs, so in most cases, each rafter, truss, and floor joist needs to land directly on a stud (Figure 9, next page).

Steel studs have a hard side and a soft side: The web side is hard, the open side soft. We like to build walls with the open sides all facing the same direction. A few might face the other way, but only at openings, intersections, and the ends of walls. Ideally, the hard side of the stud will be in line with the hard side of the joist below and the rafter above. However, it's permissible to offset these planes as much as 3/4 inch by facing the joist one way and the stud the other. But they still need to stack.

When needed, however, there are ways to get around this. You can turn the rim joist into a beam or build the wall with an oversized top track (6 inches or taller) that's designed to function as a continuous header. If you size these members correctly, the wall won't need headers and the studs and joists won't have to align.

Fastening Trim

It's more difficult to attach trim to a building that's framed with steel, but there are ways to do it. Senco makes hardened 15-gauge finish nails that will penetrate 14-gauge steel. I personally like to put wood bucks in door openings to make it easier to hang and case the doors. For large crown, I will

screw a wood nailer onto the drywall. I attach baseboard with construction adhesive and cross nail into the drywall to hold it till the glue sets.

Thermal Conductivity

One of the toughest issues facing the LGS industry is how to build an energy-efficient structure. Steel is a great conductor of heat — not a good thing when you're trying to conserve energy. LGS is extremely popular in Hawaii because the outside temperature doesn't vary much at all. I build in a coastal climate zone, where it's relatively easy to meet energy code requirements.

In this area, tract builders create a thermal break by putting foam insulation on the outside of 3 1/2-inch exterior walls. I build custom homes and meet the requirements by building 5 1/2-inch exterior walls, sheathing the entire surface, and completely filling the cavity with insulation. This is more insulation than we need, but it's a way to compensate for the added conductivity of steel. In colder parts of the country, you need to be a lot more serious about installing thermal breaks. One possible way to deal with this issue is to use less conductive proprietary studs, such as the ones made by Tri-Chord Steel Systems, Inc.

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Figure 8. Jack studs aren't necessary in an LGS frame. In this case, the studs that make up the sides of the header are notched and the assembly is attached by screwing through the web.

Figure 9. Wall track (plates) will not support vertical loads between studs, which is why studs have to be in line with joists and rafters unless there's a beam between them.

Sources

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