



Bundles of wood studs and steel joists await use in a hybrid frame.

Hybrid Framing with Wood & Steel

Most builders and remodelers were affected by the swings in lumber prices during the past year — remember lumber quotes that were only good for 24 hours? The increases were all the more shocking because lumber prices have been mostly flat through the last decade (adjusted for inflation) and only recently began to reflect the pricing fluctuations common with other commodities. As subsidized timber sales end and additional environmental pressures emerge, lumber prices will continue to fluctuate and increase. The \$64,000 question is, What can we do about it? Start using something else?

My company has almost 20 years of design/build general contracting experience in a variety of commercial and

residential work. We've always used steel framing in commercial applications and wood framing in residential projects. Why? In large part because "that's the way we always did it." However, given the recent uncertainty in lumber prices and the comparatively low price of steel framing, we decided to try a hybrid framing system in our multifamily residential work.

Match the compressive strength of wood studs with the bending strength of steel joists for a strong, economical shell

Steel Framing
Lightweight steel framing is cold-formed — the studs, joists, track, and accessories are manufactured by brake-forming and punching galvanized coil and sheet stock. There are a variety of manufacturers, with plants located throughout the U.S. (see box at end of article). You can typically find steel framing through your local commercial drywall

and finish supplier. Find out what brands are available in your area — structural capacities and available sizes and gauges vary among the manufacturers — and make sure that you design according to the product literature of the manufacturer you buy from.

Sizes. Steel framing members are available in a wide variety of sizes and gauges (see Table 1, next page). Most manufacturers use color-coding to prevent the different gauges from being mixed at the job site. Pricing of steel framing is always quoted per thousand lineal feet, though you can buy less.

Advantages of Steel Framing

The advantages of steel are obvious. Currently, 25-gauge steel studs are half the cost of 2x4s. In a recent project, we saved over 35¢ per lineal foot on steel joists as compared with wood 2x12s.

In strength, steel framing holds no comparison — its allowable bending stress values typically range from 21,000 to 33,000 psi (Table 2, next page). By comparison, the bending fiber stress (Fb) for select structural

by Tim Duff

Table 1:
Sizes of Steel Framing

Studs

Widths: 1⁵/₈"*, 2¹/₂", 3⁵/₈", 4", 6"
Gauges†: 25*, 20, 18, 16, 14, 12

Joists

Widths: 4", 6", 8", 9¹/₄", 10",
12", 14"
Gauges†: 18, 16, 14, 12

* Non-loadbearing uses only

† Gauge equivalents: 25=.019",
20=.0346", 18=.0451", 16=.0566",

Table 2: Strength of Steel vs. Wood Joists

Required joist size to frame 16-foot span, 16 inches on-center,
for 40-lb live load + 10-lb dead load @ L/360 deflection:

Joist Type	Size	Cost	E*(psi)	Fb†(psi)
Steel (Marino brand)	8" 16 ga.	\$1.03/lf	29,000,000	33,000
No. 2 SPF	2x12	\$1.32/lf	1,300,000	875
Select Struct. Doug Fir-larch	2x10	\$1.35/lf	1,800,000	1,800
Wood I-Joist (TJI 15SP)	9 ¹ / ₂ "	\$1.43/lf	N/A	N/A

Note: The prices in this chart are contractor's prices for northern New England as of November 1993. * Modulus of elasticity. † Max. fiber stress in bending.

Douglas fir is 1,800 psi (ordinary No. 2 SPF is a lowly 875 psi).

Steel is a processed, not an organic material. As such, it arrives at the job site straight and consistent — no checks or knots to work around. While it expands and contracts like anything else, steel won't swell or move from changes in moisture content.

Design flexibility. With steel framing, the variety of sizes and gauges gives the builder great flexibility in determining cost-effective framing solutions. Take, for example, a situation where you want to maximize ceiling headroom. With wood framing you can use a narrower joist but you'll probably have to decrease the on-center spacing, increasing both labor and material costs. With steel, you can use a narrower joist but in a heavier gauge, and keep the joist spacing the same. And since the cost of steel framing material is primarily based on weight,

this solution will cost you no more, either in labor or material.

There is little limitation in the length of steel framing. If desired, joists and studs can be fabricated up to 40 feet in length. Given sufficient quantities, wholesale distributors can also cut joists and studs to exactly the length you need.

Disadvantages. Steel does have its disadvantages. The standard 25-gauge non-loadbearing studs are flimsy to work with. And for those not accustomed to working with the material, steel is sharp and will slice your skin if you don't handle it properly. We always ask for "hemmed" track — it's much safer than unhemmed (Figure 1).

Steel is also hard to cut, and many of the tools in your toolbox just won't work on the stuff. Eye protection — a good idea when cutting lumber — is imperative when cutting steel (Figure 2).

Probably the biggest drawback with

steel is its lack of insulating qualities. Steel studs are about 400 times more heat-conducting than wood studs. Used in exterior applications, steel studs can reduce overall R-values by up to 50%. A wholesale changeover to steel framing would result in a drastically inferior thermal envelope. Also, with exterior steel studs, fastening the typical residential exterior finishes and blocking for trim would take longer.

Hybrid Solution

Our solution has been to integrate wood and steel: We use wood framing for exterior walls and the roof and steel framing for floor systems and interior partitions.

Wood studs provide better insulating values, as well as a nail base for exterior finishes. Studs are primarily compression members and don't need particularly high fiber-stress values. Quicker-growth

Track Options

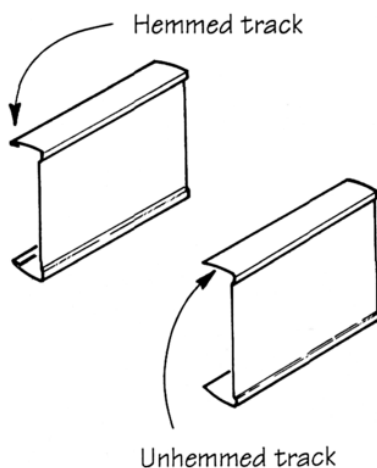


Figure 1. Hemmed track (top) is much safer to work with than unhemmed (bottom).

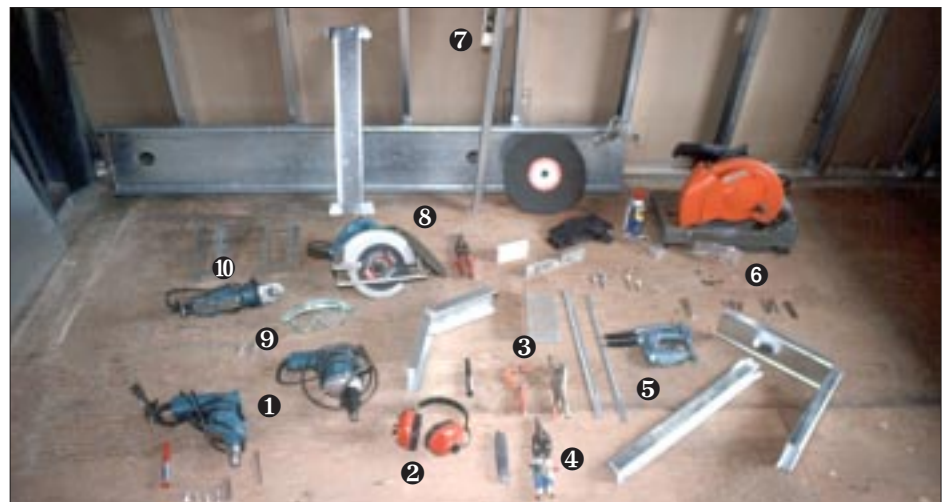


Figure 2. Framing with steel requires a special set of tools: (1) variable speed drill and screw gun (2) hearing protectors (3) vise clamps (4) metal snips (5) light-gauge metal punch (6) metal cut-off saw (7) magnetic level (8) circular saw with abrasive metal blade (9) safety glasses (10) right-angle drill.

and structurally inferior softwoods work just fine here.

For floor systems, however, you need a framing material with a high strength-to-weight ratio, one that's rigid, and is available in long lengths. Steel joists fit the bill perfectly. For girders, beams built up of multiple members are again much lighter and stronger in steel than in wood, and they won't cup or warp.

In the interior, we use steel studs for both bearing and nonbearing walls. Once you're used to it, you can frame faster with steel than with wood because the material is lighter and easier to handle. For non-loadbearing partitions, we use standard 8-foot steel studs and hold them up slightly from the bottom track to match the 8-foot 1-inch exterior walls that we get using precut wood studs. For interior bearing walls, we either buy studs precut to exact length or cut them on site.

We've also found that you can attach baseboard to steel studs by nailing with galvanized finished nails instead of installing a lot of blocking. We block only at those points where we need nailing for a short length of baseboard.

Steel floor joists. In framing floor systems, there are several points to keep in mind. If you plan carefully, you can order precise lengths of the various members your specific project requires. There is no need to pay for excessive waste. You can minimize thermal bridging by holding the track (band joist) away from the outside edge of the foundation wall, then filling the gap with fiberglass insulation or rigid foam board (Figure 3). Just make sure you maintain the typical minimum end bearing of 1½ inches for the joists.

Also, at end bearing points you have to install web stiffeners (Figure 4, next page). Because steel has such high tensile strength, individual members do not normally approach a bending failure. Instead, steel joists will fail by folding at bearing points, where shear forces are greatest. Web stiffeners help resist shear and must be used at ends and anywhere along the joist span where there are point loads or loadbearing walls above. Since we use wood studs in the exterior walls, we cut our web stiffeners from stud scraps. They must be cut to fit tight, then slid into the joist end before it is put in place. Otherwise, once the track is on, there's no way to get the web stiff-

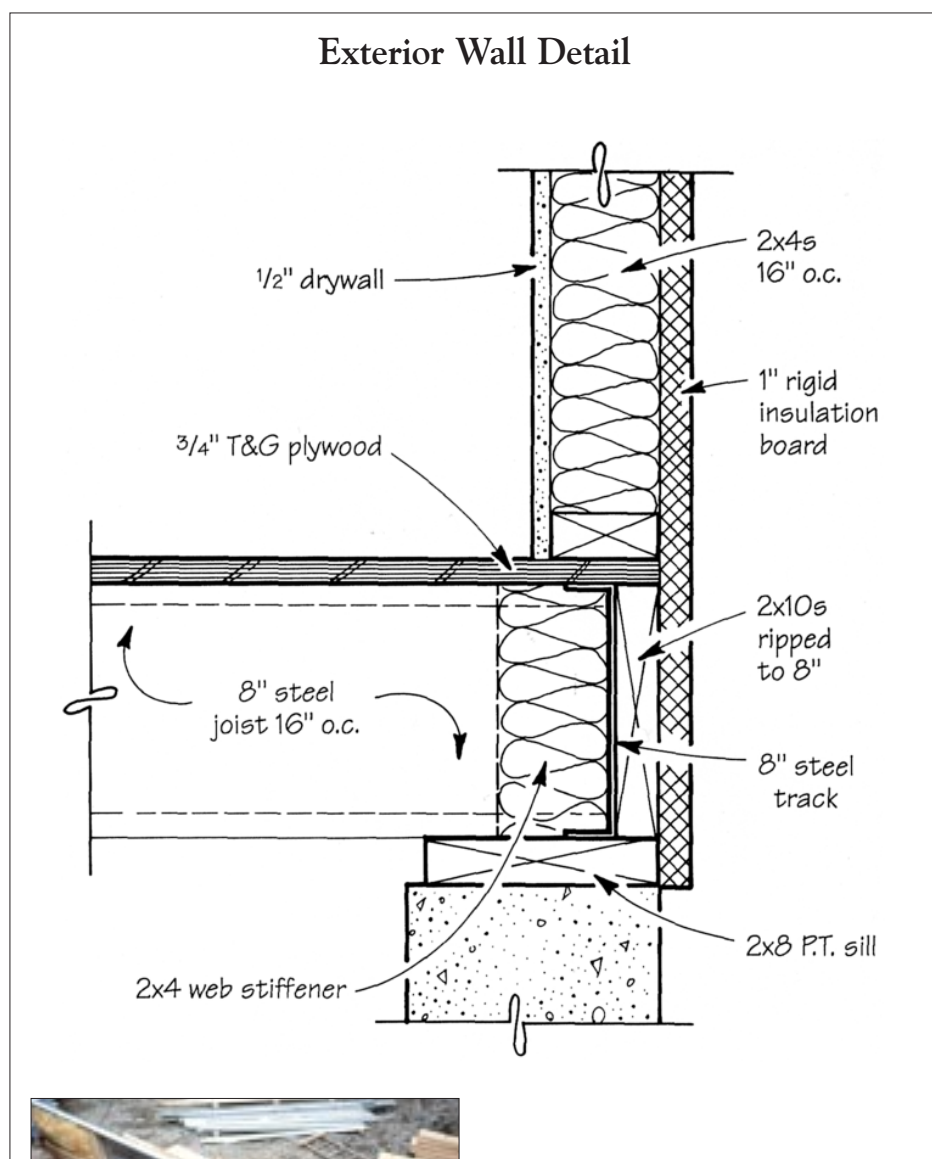


Figure 3. Because steel is much more heat-conducting than wood, the author uses wood studs for exterior walls. The steel band joist is backed with a ripped 2x10, and stuffed with batt insulation for an extra measure of thermal protection (inset).

eners in. Also, avoid holes 12 inches from the end bearing point.

Subflooring. You attach plywood subflooring to steel joists as you do to wood joists. Use a heavy-duty construction adhesive, like Hilti's CA3400, that's approved for use with steel. Be sure to wipe down the joist flange with paint thinner to remove the oils used in the manufacturing process or the adhesive may not stick. For attaching subflooring, we use Marino's Teks screws with wings (Figure 5, next page). The wings on the screw tip clear out the plywood shavings so the threads don't clog. When the screw hits the steel, the wings shear off. These

screws cost more but they save time.

Bridging is more straightforward with steel joists than with wood. The plywood subflooring braces the top flange, and metal strapping braces the bottom flange. There is no need for full-depth blocking at midspan. We use standard 20-gauge drywall furring channel — "hat" channel — for strapping. The channel goes up quickly and provides a good backing for the ceiling drywall. If you try to screw the drywall directly to the thicker steel of the joist, the self-tapping drywall screws will be pulled right through the paper face.

Joist-to-joist connections are easy



Figure 4. Steel joists require web stiffeners at bearing points to prevent the webs from folding under load. The 2x4 stiffener is slid into the end of the joist before it is fastened, then moved into place after the track is installed (left). These cantilevered double joists (below left) have stiffeners at the support wall and at their ends, where the exterior wall above will bear.



Figure 5. The author's crews use special self-tapping screws for attaching plywood subflooring to steel joists. The wings on the screw tip clear the plywood shavings so the threads don't clog, then shear off when they hit the joist.

with standard available hangers, or you can have simple 12-gauge plates fabricated.

What'll the Subs Think?

Subcontractors have various reactions when first confronted with steel framing. The prepunched cutouts in steel joists make wiring go quicker but they don't usually line up perfectly for straight pipe runs. Plumbers and electricians with commercial experience use hand punches to quickly make holes. Electricians have to exercise caution when running conventional Romex wire. Snap-in plastic grommets, available for standard-size prepunched holes, must be used to protect the wire sheathing.

But ultimately, the cost-effectiveness of hybrid framing with steel depends on acceptance of the material by the people who will install it. There is no point in trying this technique unless you embrace it wholeheartedly. Even with good planning and the inherent advantages of steel, our initial labor costs increased by a factor of 25%, because screws simply take longer to install than nails. With experience, we've been able to trim the increased labor costs to 10% to 20% above all-wood construction. But since steel framing materials are less expensive than wood framing, for now we are still able to match or beat our costs for all-wood frames. Hopefully, the steel framing industry will in time develop pneumatic fasteners and other products to help us bring our labor costs down as well. ■

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For More Information

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