BUILDING A Timber Barn

by John Miller

These buildings capture the visual appeal of traditional timber framing without elaborate joinery

I built my first timber-frame barn in 1986 at the request of a homeowner who wanted to replicate the style of an existing barn in town, which dated from the early 1800s. With permission, I photographed and examined the details of that building, noting both its structural details and the aesthetic considerations that went into its construction. The barn was smaller and simpler than barns intended to house livestock and tons of feed, which were often built with massive timbers and pegged mortise-and-tenon joinery. But with its exposed framing, solid plank sheathing, and balanced proportions, it still had tremendous visual appeal.

Once I built that one, a steady stream of barn clients seemed to spring out of the woodwork. I've specialized ever since, building barns at a rate of eight to ten each year (along with some barn rehab work and an addition here and there when the weather turns bad). The form varies, but the method is pretty constant. In this article, I'll cover the essential elements.

Figure 1. An all-pine interior reflects the author's homage to this traditional construction method, although it's a sure bet that if the practical-minded original builders had had plywood, they would have used it.

What's Wrong with Nails?

The availability of mass-produced nails and bolts in the 19th century freed up old constraints in framing and house carpentry, turning joined and pegged timber-frame structures into quaint relics practically overnight. Liberated from labor-intensive overlapping and interlocking timber joints, builders began producing buildings with unheard-of speed. But the timeless look of a timber-frame building remains popular. And none of my customers care how their barn is held together as long as it's strong and looks good. So, in the tradition of our times, I happily spike butted and mitered framing members together with common nails and use nail guns to apply planking and trim. Wherever possible, we conceal the fasteners. I appreciate and respect traditional post-and-beam framing methods,

Figure 2. The author usually builds on a poured-concrete stem wall (above left). The slab area is filled and compacted, then poured later. Although a building inspector may occasionally require post anchors to tie the vertical structural members to the foundation, toe-nailed posts are generally accepted, provided the mudsill is properly bolted (above). Another option is concrete piers and pressure-treated carriage beams, which greatly reduce excavation and foundation costs (left).

but if customers want a barn built purely that way, I tell them I'm not their guy. My main goal is that the only wood seen in the final product is solid full-dimension lumber (see Figure 1, previous page).

Foundations

The underpinnings of the barn vary, depending on the desired application of the building. Eighty percent of our buildings serve at least partly for garaging a vehicle or two and, more often than not, we build on a poured-concrete stem wall and pour the slab last. In other cases, we build on a monolithic slab or a wood deck supported on poured-concrete piers (Figure 2, previous page). We recently built a barn over a full basement foundation with a wood I-joist deck that ultimately received a poured-concrete cap and supported two cars. My clients always have a specific purpose in mind for their barn beyond protecting their cars, whether it's a place to build boats, exercise, or run a home business, so our methods have to be adaptable.

Design

A barn's layout and design are based more on the builder's seat-of-the-pants sense of proportion than any prescriptive formula. They're also driven by practical considerations. With a particular post spacing in mind, I may ask for 28-foot-long 6x6 lintels, but sometimes the mill cuts and ships what's available. So we may end up with a stack of 14- and 18-footers instead. For this reason I don't try to fine-tune the lumber list down to the last board, but buy extra footage instead. My lead carpenter, Alan Dunham, develops the specific layout on the first day of construction, and it's different for every job. While the other crew members sort the lumber drop into specific lengths, square-cut every piece on one end, and cut rafters to a pattern, Alan decides how best to use the beam pile delivered.

Framing layout. While the economy of building on modules based on plywood dimensions doesn't pertain to traditional barn construction using lumber sheathing, there are a couple of reasons for sticking with the typical light-framing layout. First, a 24-inch-on-center joist layout gives the inspector something familiar to evaluate. Second, we often use plywood and OSB in my buildings but only where it doesn't ultimately show. For example, when the building department decides to designate the upstairs over a barn garage as habitable space (usually triggered by a bathroom in the plans), we're forced to hang gypsum firewall downstairs in the car bays. In that case, I'll use a plywood subfloor overhead because it will be covered (Figure 3). I'll also use plywood for a first-floor subfloor when we build on piers or a full foundation.

Figure 3. Engineered lumber and plywood find use in concealed locations, such as in a pine-veneered barn door header, or, in this case, in a subfloor that eventually will be concealed by a gypsum ceiling when the habitable space upstairs is finished.

Figure 4. The second-floor joist ledger is notched into the outside face of the posts, which extend above the floor to create a knee-wall, adding headroom and storage space to the "loft." The posts are united with a continuous 6x6 lintel that carries the rafters.

Figure 5. Posts are notched for a 2x10 ledger and 4x4 purlins before standing. This barn is being raised over a full foundation on an engineered-lumber deck frame. Pine floor boards will cover the plywood subfloor.

Figure 6. As a touch of authenticity, the author often uses recycled wood window sash and installs them in site-made pine frames.

The Frame

To achieve the right "look," there's no beating the tried-and-traditional materials. My frames are built from locally harvested and milled eastern white pine, which arrives at the site still green. Except for rare cases when the lumber comes from an unfamiliar sawmill, all of our framing stock is rough-sawn to full dimension. A 6x6 is literally 6 inches square, and my joists measure a full 2 1/2x10 inches. Occasionally, but not often, I'll have a client who wants the interior surfaces planed smooth, which requires a simple request to the sawmill and a material upcharge to the customer.

Walls are framed with 6x6 posts on 6- to 8-foot centers. We can spread or squeeze the layout to suit the overall wall length. The posts are tied at the top with a continuous 6x6 lintel.

Typically, we work with 12- to 14-foot-long posts and build a story-and-a-half balloon-framed wall with a level lintel around the full perimeter (Figure 4, previous page). We lay all the posts on sawhorses for gang-cutting. Because the lengths are nominal and rough from the mill, the first task is to square-cut one end. At the ceiling level, typically 8 feet, we notch the exterior face of the posts to let in a 2x10 ledger board (Figure 5). The floor joists rest on that ledger and run to the center of the building span.

Between the mudsill and the lintel, we notch the posts to fit a 4x4 wall purlin. The purlin is typically located around 4 feet high on the wall and establishes the common windowsill height. This height provides uninterrupted wall area for installing a perimeter workbench.

No headers needed. With both the lintel and the joist ledger carrying overhead loads, individual window headers are unnecessary. Instead, we reinforce the opening cutouts with 4x4 jambs and a butt-fitted 4x4 header, both for appearance and to provide solid nailing for the exterior trim. We often use recycled divided-light wood sash in new pine frames (Figure 6). Not only does this provide the barn with the right look of Yankee make-do frugality, but I can get the sash free from a replacement

Balloon-Framed Barn

The barn frame is assembled from rough-sawn, full-dimension lumber and sheathed with nominal 1x10 pine boards, either square edge or shiplap, depending on whether a secondary siding is applied. Rigid insulation, applied over the sheathing and covered with siding and roofing, adapts the barn for comfortable winter use.

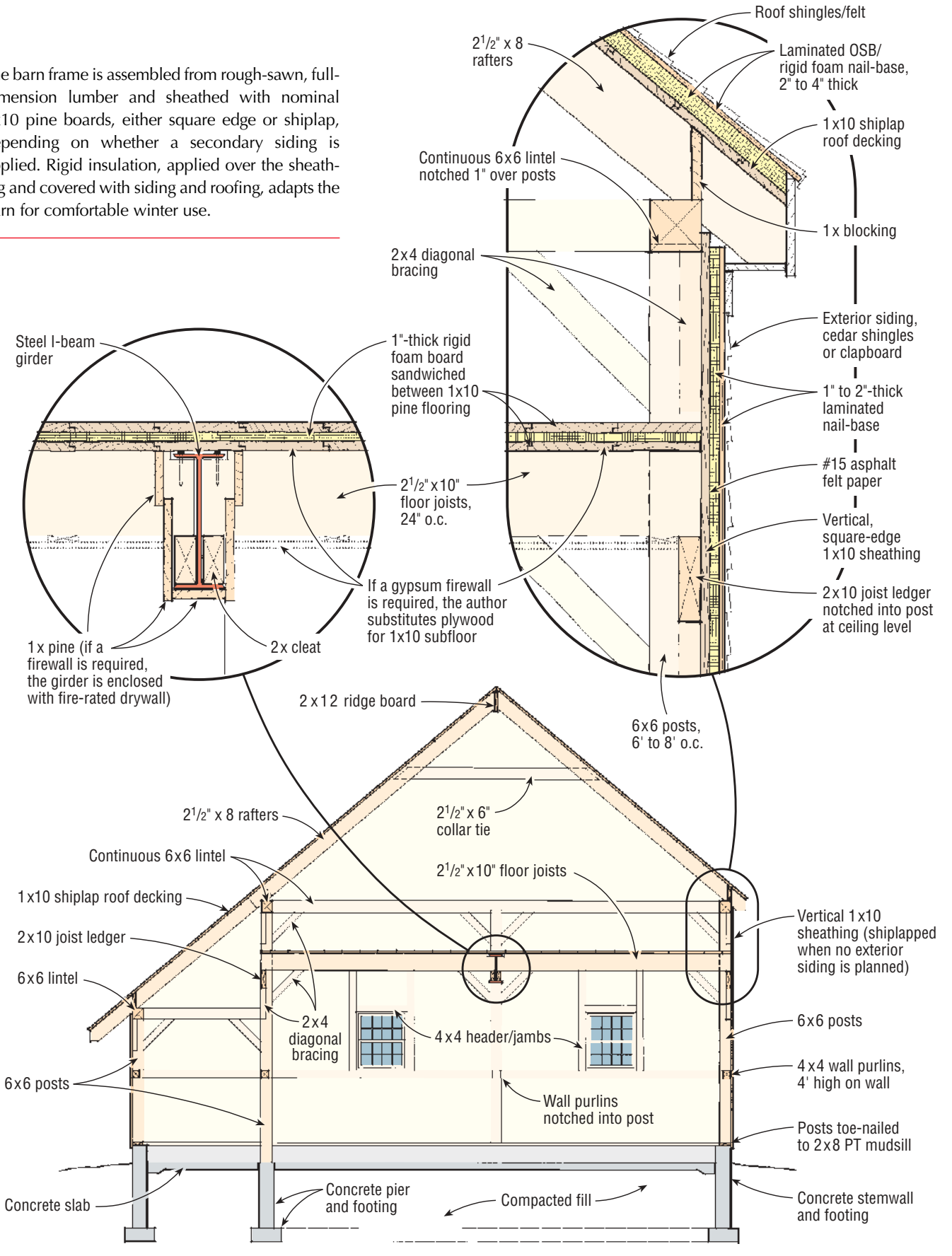

Figure 7. At center span, joists are carried by a steel I-beam and rest on a 2-by pine cleat that's nailed to the bottom flange (right). The top edge of the joist is notched to clear the top flange and allow for shrinkage settling, so that a lump doesn't develop over the beam in the floor upstairs. A nail driven through a predrilled hole in the flange captures the joist to prevent roll-over.

Figure 8. Flooring layout begins at the center of the span to ensure that a single floor board covers the top flange of the steel beam and can be nailed down at its edges. The center of the board eventually comes into full contact with the beam as the joists dry and shrink.

window contractor.

Sometimes we let the posts run long and cut them in place. The clients may still be undecided about the second-story windows, preventing us from predetermining the required opening height, or the top of the foundation may be so uneven that it's easier to stand the posts and trim the tops to a level line.

Girders. At the center of the second floor, we typically use a steel I-beam strongback to break the span. While steel isn't a traditional barn-building material, it allows me to eliminate some of the posts required by a sawn wood girder. It's also easier for us to work with than an engineered wood beam, because we don't need multiple layers or metal joist connectors. Instead, the floor joists are nailed to a 2-by cleat set on the bottom beam flange and are secured by a 16d common nail driven down through the top flange (Figure 7). Predrilling the steel flange doesn't take much effort; I have a helper do it. The end of the joist is notched around the top flange and is slightly higher than the beam, to allow for eventual drying shrinkage. Otherwise, the flooring will develop a hump over the girder. To minimize the appearance of the I-beam, we can easily veneer the sides and bottom with 1-by pine.

We set the 2^1/$_2$x10-inch floor joists on 2-foot centers. To create a stairwell, we leave one joist out, usually at the end of the run. After installing short, diagonal braces between every post and the 2x10 ledger to help stiffen the frame, we're ready to install the 1x10 shiplap subflooring. Alan maps the layout from the center of the deck to ensure that a single board will bridge the steel I-beam (Figure 8). Beginning at one side of the deck, the first board is notched around the posts, and the rest of the floor is laid with butt joints staggered over joist centers. Flooring goes quickly, face-nailed with 3-inch common gun nails, two in the field and three at the butts.

Next, we set the 6x6 lintels, which

are scribed in place over the posts, then notched to let in the posts (Figure 9). The notches help ensure that the green posts won't twist excessively as they dry, and they give the framing more of a "crafted" look. Butt joints in the lintel always break on post centers. We nail through the lintel into the posts with 10- and 12-inch-long galvanized spikes, predrilling every hole (Figure 10). The lintel gets mitered at corners. A 12-inch spike, driven in from the gable end, pins the joint tight.

It usually takes about two days to erect a typical basic barn frame to the level of the second-floor lintel. That includes all the posts, ledgers, wall purlins, diagonal braces, and second-floor planking. At this point, we'll also have all the rafters cut and ready to raise. But before we raise the roof, we vertically plank the walls. The planking helps to brace the structure, which otherwise has a small but noticeable amount of sway to it. Planking goes quickly; window openings are cut later.

Rafters. The main roof is either a 10- or 12-pitch. We use full $2^1/_2$x8-inch rafters, spaced without regard to the post or floor joist centers. The

Figure 9. The posts are all cut to an equal height and are captured by notches in the lintel beam (above). The lintel is first scribed in place (left), then flipped over and kerfed with a circular saw set to cut 1 inch deep.

Figure 10. Mid-span posts are spiked with 12-inch-long galvanized nails, while end cuts and butt joints are nailed with lighter-gauge 10-inch nails (above). All holes get predrilled (left). Outside lintel corners are mitered with a 12-inch spike driven from the gable side (above right) to keep the joint tight (right).

hefty 6x6 lintel allows us to spread the rafter centers out to 3 feet, more or less (Figure 11). At skylight openings, we double the rafters on either side and may shift adjacent rafter spacing for a balanced appearance. A big part of the appeal of these buildings is just this casual, nonaligned approach to framing. We're careful with plumb, level, and square but take full advantage of the method's flexibility.

The ridge board is nonstructural, usually a 2x12. Alan stands the ridge first, then sets the end rafter pairs and another pair near the middle, using a temporary prop to prevent sagging. Then he spaces the remaining rafters, nailing them all first at the ridge only. That makes it easier to sight down the ridge board and straighten it as needed, by moving the rafter tails in or out on the lintel before nailing them. We secure the rafters with metal ties on the outer face of the lintel, where they barely show.

Sheathing As Siding

The entire frame is enclosed with air-dried 1x10 pine, smooth on one side. Pine is all you see in the interior of the finished building. Barns vary in size and complexity, but the median price runs about $35,000. If I'm working with a client to cut costs, exterior siding is first up on the chopping block. In the most basic and economical form, the walls of my barns are finished simultaneously, inside and out, with the application of the vertical shiplap planking that encloses the frame, rough side out. Window and door trim is urethane-caulked along the back edge prior to installation over the siding. The head casings are capped with a pitched board in traditional style (Figure 12, next page). I also try to make the roof overhangs as deep as possible to provide some shelter for the windows. Leaks and water stains can occur around the openings, but with a wide-open interior, things don't stay wet for long. The method is slightly crude but fairly effective.

Figure 11. The rafters are carried by the hefty lintel and therefore don't have to align with the vertical framing below. Three-foot spacing is a nominal standard that can be adjusted to accommodate skylight openings and provide a balanced appearance.

At the next level of quality, we apply exterior siding, typically eastern white cedar shingles or western red cedar clapboard. Shiplap sheathing becomes redundant, so I use air-dried, square-edge 1x10 instead. Green lumber is less expensive, but not without its perils. Drying shrinkage came back to bite me once or twice early on, with gaps between boards becoming unacceptably wide. Now I'm careful to buy lumber with a stated moisture content of around 15% to 20%, and I've had no complaints about joint movement. Some of those seams will open seasonally when humidity drops, so I'm a stickler for using #15 asphalt felt paper on the walls to keep the joints nice and black. Housewrap doesn't look good showing through the gaps.

The roof is planked with 1x10 shiplap pine, laid perpendicular to the rafters (Figure 13, next page). There's little, if any, difference in the time it takes to sheath a roof with solid lumber versus plywood, and single roofing boards are safer and easier to handle and place in a breeze than full sheets of plywood. The shiplap pine is milled smooth on one face and is $^{13}/_{16}$ inch thick, so it's important to use only 1-inch roofing nails to make sure no penetrations mar the interior ceiling.

Insulation

A barn is only as warm as the weather outside, but life goes on year-round. When my New England clients plan to use their barn on a regular basis, as a home office or for a business, a heating system and insulation become important.

Since there are no enclosed framing cavities, I usually let the homeowners deal directly with their own contractor and heating system of choice. The same goes for wiring and plumbing. The only subcontractors I work with are in excavation, foundations, siding, and roofing. But because the insulation installs over the outside of the sheathing, we always handle that aspect of the job ourselves. We use rigid polyisocyanurate foam board on the walls and the roof. The basic board has a black glass-fiber-reinforced, asphalt-impregnated facing and is typically used under membrane roofing. The thickness varies, depending on the level of insulation we're trying to achieve, between 1 and 2 inches on the walls and up to 4 inches on the roof.

I'm not an energy nerd, and the customer and I are in agreement that we're building a barn and nothing but a barn. In most cases, that clarity helps keep us from having to meet standard compliance levels of insulation for habitable space.

We typically hold the insulation in place with roofing nails and roofing tins; I recently bought Hitachi's Plasti-Tacker (Hitachi Power Tools, 800/598-6657, www.hitachi-koki.com), which fires a staple through a plastic disk and really takes the drudgery out of this particular task.

OSB. Although we can and have applied cedar shingles or bevel siding right over the foam on the walls using 2-inch-long staples or nails, I prefer to cover the foam with a solid nail base of 1/2-inch OSB. To simplify this process, we've begun to use rigid foam panels with the OSB already laminated to one face, made for roofing applications but equally suitable for

Figure 12. When shiplap pine sheathing does double duty as siding, the author uses urethane sealant behind door and window frames, and adds a sloped cap board to help drain water away. Deep roof overhangs also provide some protection on the eave sides.

Figure 13. One-by-ten board sheathing installs quickly and provides a sturdy base for roofing. On an uninsulated roof, it's important to use 1-inch roofing nails in asphalt shingles to prevent unsightly penetrations on the interior ceiling.

Figure 14. Exterior-mounted isocyanurate foam insulation panels with a laminated OSB nail-base facing provide moderate levels of insulation without altering the appearance of the interior walls and ceiling. Wall insulation is typically 1 inch thick, while roof cladding varies from 2 to 4 inches thick.

Figure 15. To insulate a wood-framed floor, the author sandwiches 1-inch-thick foam board with a fiber-reinforced facing between layers of 1x10 pine and nails the finish layer through to the framing.

wall application (Figure 14). The opposite side has a glass-fiber-reinforced asphalt-impregnated facing. I buy the panels from Beacon Sales (Somerville, Mass., 617/666-2800, www.beaconsales.com), a regional roofing industry supplier. The panels are made by Atlas Roofing (www.atlasroofing.com) and are available in two types: Crossvent panels have regular air channels under the OSB facing and preserve the manufacturer's warranty for asphalt roofing applications but cost about 15% more than nonvented panels. The ACFoam Nailbase panels are nonvented and can be used on walls or under a cedar shingle roof in conjunction with a ventilating underlayment. We lay the panels down tight over the pine planking and nail them to the framing every 12 inches, using annular-ring pole-barn spikes. From there on in, it's trim, siding, and roofing as usual.

To insulate a wood floor, we lay felt-faced 1-inch rigid foam board over the subfloor and cover it with a second, finish layer of pine, nailing it through to the framing (Figure 15). The resulting floor is fairly airtight and has a nice resilience underfoot. This method makes it simple to insulate only the upper level of the barn if desired, in which case we leave the end- and knee-walls uninsulated. A good wood stove is the typical heating plant and is generally adequate to keep the space comfortable.

John Miller *builds traditional New England structures and lives in E. Harwich, Mass.*