Save Time With Factory-Framed

Crane-hoisted panels get a floor in fast, flat, and cut for ducts and utilities

BY FERNANDO PAGÉS RUIZ

I pride myself on being the most efficient builder possible. For nearly 15 years, I've built homes using factory-framed components to improve production efficiency in my company. With factory-framed walls and roof trusses, I thought the industry had reached its peak in framing technology. So when my wall-panel manufacturer suggested testing a new factory-framed floor system, I expected only an incremental improvement in production time. I didn't know that I would come to regard factory-framed floors as perhaps the most-important framing enhancement since factory-made roof trusses.

My first experience with factory-framed floors was on the PATH Concept Home in Omaha, Neb., a demonstration house that my company built. This house boasts the latest technology and building methods in residential construction. Weyerhaeuser's iLevel NextPhase program (www.ilevel.com), which includes this floor system, was an important element in that project. It showed how off-site, component-built floor panels could improve quality and safety on the job site while greatly reducing construction time.

During the building process, I expected that a solid portion of a day would be devoted to laying the first floor. However, the carpenters arrived on site at 8 a.m., and by 9:15, the first floor was complete. The first floor would have been done sooner, but the media covering the PATH project delayed the process. I was told that without any interruptions, the floor would have been done in about 30 minutes. In any event, I was impressed.

Panelized framing components are not new, but floor panels are

Because they're so new, these floor panels can be hard to locate. In fact, iLevel is the only company I could find that produces them. iLevel suggests going to their Web site to find the nearest mill or lumberyard that has been set up to build floor panels with the system.

Floor panels come in 8-ft. widths and in up to 60-ft. lengths. Each floor panel typically is constructed with engineered I-joists

Photo this page, top right facing page: Jeff Beebe. Inset photo, facing page: Fernando Pagés Ruiz. Drawings facing page: Courtesy of Millard Lumber.

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Floors

Safety note
Hard hats are a must when working around a crane. Don't assume otherwise just because this builder forgot his.

FACTORY PLANS ARE MORE REFINED

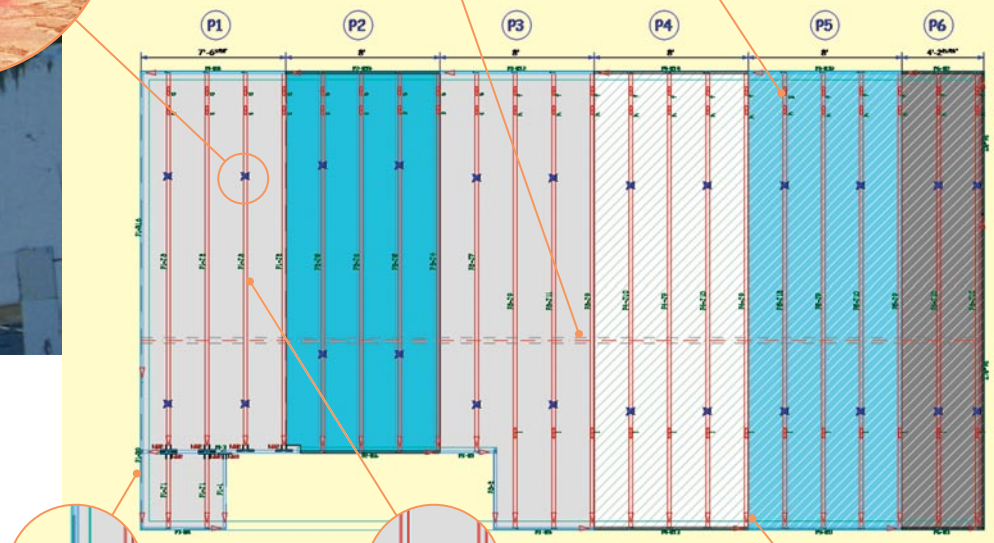
The plans, created by iLevel software, are used by factory crews to build floor panels that include HVAC, plumbing, and framing details. The factory set of plans also includes the proper stacking order for delivery and installation information for the on-site carpentry crew.

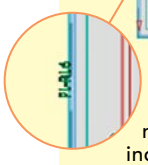
Floor panels are built in a factory setting. *Trained crews assemble each panel on flat, square framing tables to maximize production speed and quality control.*

Crane-lift holes are marked at precise points on each panel to ensure that the panels fly level.

Beam locations are marked prominently on the layout plan.

HVAC and plumbing openings are labeled on the plan, but arrive on site already cut in the floor joists.





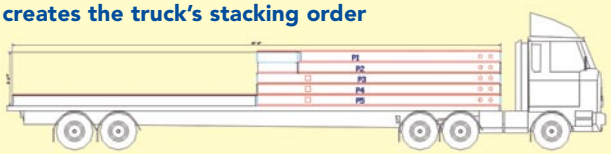
Rim boards are labeled with two numbers. The first indicates the panel the board belongs to (P1), and the second indicates its positioning in the layout (R16).

Floor joists have the same labeling convention as rim boards. The first number indicates the panel that the joist belongs to (P1), and the second lets the assembly crew know where to position the joist (J3).

Red triangles indicate the direction each joist is to be fed into the saw and in what direction it should be assembled in the panel.

Computer software creates the truck's stacking order

The stack of panels should arrive on site with the first panel on top and the last panel on the bottom.



or open-web trusses, LSL rim boards, and oriented-strand-board (OSB) sheathing. In addition to being more stable, these engineered-lumber components are more uniform and are more consistent than traditional dimensional lumber.

The floor systems I use are designed with proprietary iLevel software. The programs control machinery that measures and marks each component with cut locations, sheathing layouts, and nailing patterns. Floor joists also are marked for HVAC and plumbing chases. To minimize waste, the software keeps track of cutoff material and configures usable pieces back into other panel plans.

When the components are marked, computer-operated saws and trained crews cut

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A FOUR-STEP INSTALLATION PROCESS

1. Lay a bead of construction adhesive along the panel's end joist.
2. Fly the next panel into place, shiplapping the sheathing over the rim joist and the end floor joist.
3. Make sure the panel is square to the sill or top plates, and pull it tight to the previous panel.
4. Nail the panel to the floor joist and into the sill or top plates.

and assemble each panel on perfectly flat, square framing tables. The assembly takes place in a factory, which has a major benefit. The floor is protected from the weather, so building schedules can stay on track despite days of driving rain or lingering snow.

Coordinate with subcontractors early in the construction cycle

To take full advantage of the floor-panel system, start by refining building plans on paper with your subcontractors. Make sure the blueprints accurately represent the house you want to build. Ask the plumber and the HVAC contractors to draw their piping and ducting scheme on the plans, with pipe and duct sizes noted.

A team of factory engineers further refines the plans and will alert you of any structural discrepancies. Sometimes the duct-layout plan has a plenum too large for the floor system you have chosen. Have the subcontractor find another scheme within the limitations of the floor system, such as running two ducts instead of one, or deal with ducts the conventional way by using a dropped ceiling.

Once the factory engineers have gone over the plans, they provide you with the dimensions needed to pour the foundation.

Foundations have to be absolutely square and level

To use any factory framing system effectively, including panelized walls and roof trusses, foundations have to be near perfect. A foundation 1 in. or more out of square over 60 ft. is a problem. Of course, you should expect a high level of accuracy even if you frame conventionally. But trying to place a perfectly square floor panel on a crooked foundation is like trying to pound a square peg into a round hole. For this reason, a factory rep usually measures the foundation before the floor is built.

If the foundation discrepancies exceed factory tolerances, the rep might call you with the bad news: "You'll have to stick-frame this one." Josh Weekly, a framing supervisor for Millard Lumber in Omaha, has made this call more than once.

A visit from the factory rep isn't a requirement, though. "With experience, you can knock a few days off the construction calendar by ordering the floors based directly off your plans—at your own risk," says Weekly. However, when my company is working with a new floor plan, I always have a factory rep take foundation measurements. Once the rep has the dimensions, the rep goes back to the factory, and panel assembly begins. This process takes a bit longer, but I don't worry about the floor not fitting the foundation. The panels usually are ready about a week after the rep's visit.

While the panels are being built, prep the foundation

"Laying the sill plate is the most-important step in the process," says Weekly, who often trains new framers on using floor panels. It's not much different than plating a conventional framing job. However, a seamless panel installation hinges on the accuracy of the sill-plate layout (sidebar facing page).

Weekly rarely looks at blueprints during this process. "Only for reference," he says, adding that "if you follow the factory version of the layout plan exactly, the floors will fit perfectly, with bearing points centered on walls and beams, plumbing and duct openings lined up like gun barrels, and stairway openings, cantilevers, and insets balanced perfectly in relation to the foundation and the wall framing to come."

Drawing facing page: Dan Thornton

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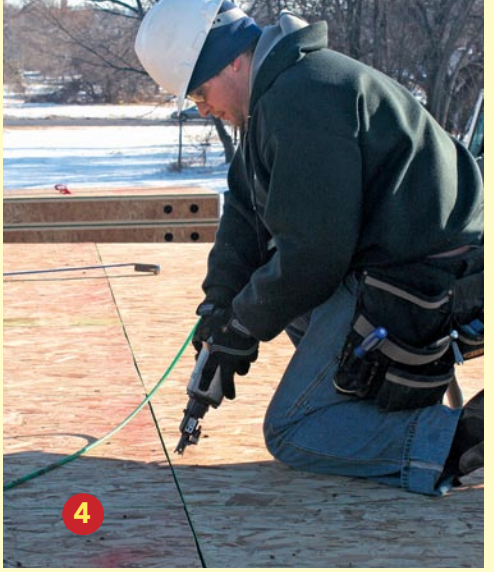


In addition to the sill-plate installation, basement bearing walls need to be built. "We stick-build most basement bearing walls on site to take up any slack in the slab level," says Weekly. Carpenters can cut the wall ¼ in. to ½ in. low to make up for waviness in the basement floor. Later, they shim between the floor panels and the top plates for a level installation.

To check for level, carpenters pull a stringline from sill plate to sill plate over the bearing-wall and beam locations to make sure they do not stand proud. Panels are square and level. If you have a wavy foundation or uneven interior bearing points, the floors will not bear fully.

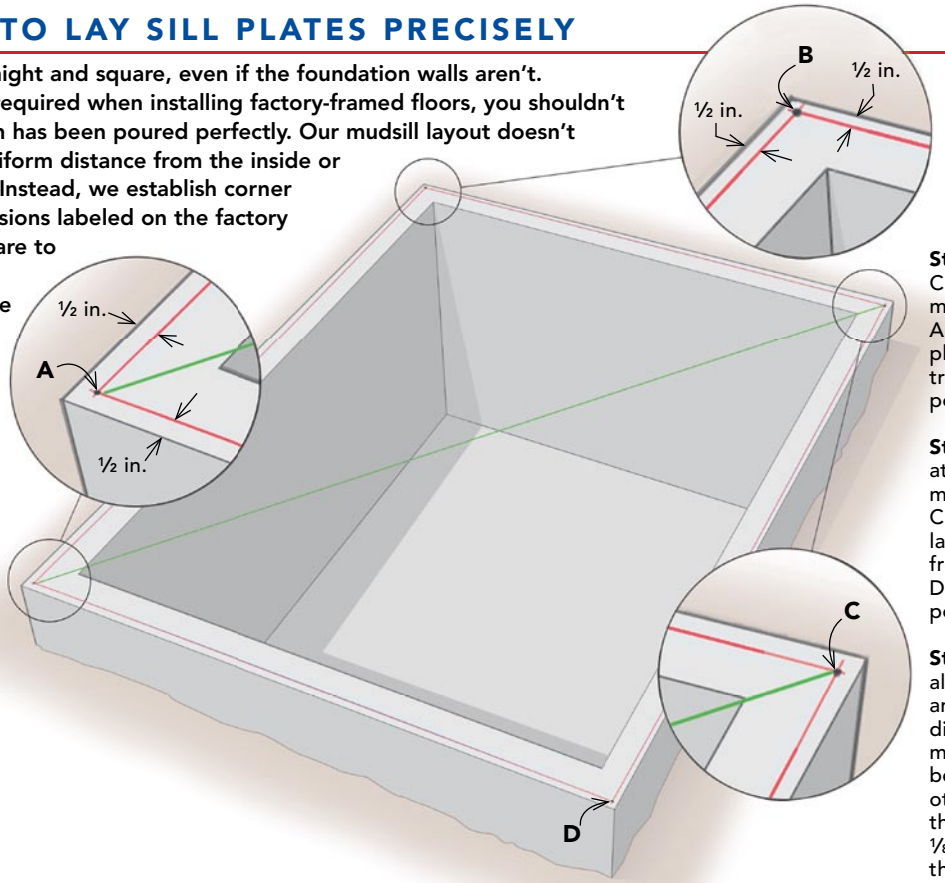
A crane moves the panels

The morning the floor panels arrive, the mood on the job site resembles the mood on a concrete pour. Anticipation builds by the minute, with all hands ready to hit the deck for a burst of furious activity. A crane arrives, parks in the street a few minutes early, and drops its outriggers. The boom is extended, ready to unload panels and hoist them into place. My lumberyard, Millard Lumber, supplies a crane with every delivery, given that there's no other way to unload and move floor panels. They're too big for an all-terrain forklift and too heavy for even the burliest of crews to maneuver. At a minimum, you need a 20-ton crane with a 60-ft. boom, long enough to pick up panels and place them on a structure two or three stories high. Crane fees can vary, but they cost about $150 an hour here in Omaha, where I build.

A semi with a flatbed trailer pulls up with a load of panels stacked in the proper order of construction: first panel on top, last panel on the bottom. However, stacking and loading requirements occasionally force a change in the arrangement, so the first order of business involves checking the panel numbering. Every panel is keyed to the plans with a number, so it's easy to see if No. 1 rests on top or three panels down. If panels are out of order, the crane operator can sort them. The stack of panels, organized by the same soft-

A SIMPLE WAY TO LAY SILL PLATES PRECISELY

The mudsills should be straight and square, even if the foundation walls aren't. Considering the precision required when installing factory-framed floors, you shouldn't assume that the foundation has been poured perfectly. Our mudsill layout doesn't involve setting the sill a uniform distance from the inside or outside of the foundation. Instead, we establish corner points based on the dimensions labeled on the factory plans. Factory dimensions are to the exterior face of the sill plates, about ½ in. from the edge of the foundation to provide space for the wall sheathing. Here's how we lay out a standard 2x6 mudsill when working with factory-framed floors.



Step 1: Check the plan measurements. Wall and diagonal dimensions should be prominently labeled on the plans. They'll be referenced to establish all the corner points.

Step 2: Start with a long wall. Establish points A and B by measuring ½ in. in from the outside of the foundation corners. Snap a line between points A and B.

Step 3: Mark point C by intersecting measurements BC and AC found on the layout plan to form a right triangle. Snap a line from point B to point C.

Step 4: Mark point D at the intersection of measurements AD and CD, also found on the layout plan. Snap a line from point A to point D and from point C to point D.

Step 5: Double-check all the measurements and both diagonal distances. The diagonal measurements should be within ⅛ in. of each other. If for some reason the difference exceeds ⅛ in., adjust line CD until the diagonals match, and resnap the short-wall lines.

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ware that engineers the floors, usually works seamlessly with the construction sequence.

To move the panels, the crane operator uses bands of reinforced fabric strapped to balance points on the joists. Again, software locates the "lift holes" for each panel, and a 4-in. hole saw drills through the sheathing directly over the proper point. On site, a crew member threads a strap through each hole, loops it around the floor joist, then slips the strap over the crane's hook. The panel stays level as it's maneuvered into place.

Placement of first panel is critical

Like setting the bottom course of a masonry wall, the first panel determines square and true for all the rest. "It's mainly a question of lining up the three sides of the panel's rim joists precisely with the sill plate," says Weekly. After lowering the panel as carefully as possible, adjustments are made by tapping the panel with a sledgehammer until each corner lines up within 1⁄16 in. of the factory specification. After measurements confirm accurate placement, a few toenails through the rim board and into the sill hold the panel in place. As subsequent panels are lifted, carpenters lay a thick bead of construction adhesive along the edge of the previous panel's end joist. Sheathing on every panel except the first is set back 1 9⁄16 in. from the edge of the end joist to shiplap the panels together. A few gentle taps with a sledgehammer butt the panel tight to the previous one, while a sharp eye makes sure the panel is parallel with the sill plates.

Some panels can take a bit of persuasion to come together. Carpenters draw these panels together with a wall puller, a tool that has two pick ends that dig into the floor sheathing with a lever that, when pulled, ratchets the panels tight. Originally designed to pull a framed wall into alignment, this cool but nonessential tool in the conventional framer's kit becomes an indispensable piece of equipment for panelized-floor installation.

As the next panel flies off the truck, the carpenters double-check measurements from the edge of the rim joist to the end sill plate. They do this after every panel placement before toenailing the rim joist to the sill.

The last panel is usually the smallest. It has a "flying edge" with no end rim joist attached. This allows carpenters to trim the panel to fit the foundation, fixing any small discrepancies that might show up in the final fit between the floor and the foundation walls. To set up the last panel, carpenters measure from each corner of the previous panel to the edge of the foundation's sill plate. They transfer these measurements to the last panel. As the crane holds the panel at waist height, carpenters cut the sheathing and the rim joist to the exact measurement. "It's easier to trim the panel suspended at table height," says Weekly. However, the panel can be adjusted in place if needed.

After the last panel is in place, it's time to plug the lift holes left in the sheathing. First, dried-glue residue from manufacturing is removed. Then, with 4-in. round cutouts supplied by the lumberyard, the plugs are glued and screwed in place. Once the floor is laid, one worker can toenail the joists to the sill plates while the rest of the crew starts snapping lines for wall layout.

Laying second-story floors mirrors the installation of the first

The safety advantage of using factory-framed floor panels really comes to light as you move higher up the structure. You don't have to hump joists and sheathing up ladders, and you can do your work from a solid platform rather than taking the risk of having a floor joist roll underfoot.

Laying the panels on walls rather than on a concrete foundation gives you greater flexibility to adjust for variances between stories. Just as with the beams and bearing walls in the basement, it's critical that the top plates stay in plane from wall to wall so that the floors lie perfectly flat. Because the second-floor dimensions are typically the same as the first, simply plumb the exterior walls, and nail the panels through the rim joist to the top plates.

Panels are more valuable than cost savings

For an exact price comparison between factory- and site-framed floors, you would have to frame the same floor twice, once

AVOIDING PROBLEMS

The majority of problems encountered when working with factory-framed floor panels are due to human error. Mismeasuring, entering the wrong data, and installing the panels the wrong way all can create havoc on the job site. If you check the foundation for square but not level, don't be surprised when the panels don't lie flat on the mudsill. If the carpenters install a seemingly identical panel in the wrong order, they could discover later that a key bearing point was missed entirely. Here are a few tips to avoid the most-common problems:

- **Compare blueprint details with panel CADs. Pay particular attention to beam pockets, stairway locations, and other critical measurements. Report inconsistencies to the factory before ordering the panels.**
- **Follow the engineered drawing dimensions to 1⁄16 in. when installing sill plates and laying the first panel.**
- **Install panels in the sequence indicated by the factory. Panels look alike, but do not install like roof trusses, where order doesn't matter.**
- **Check the labels on every panel to make sure you orient them properly during installation (right and left sides). One panel out of sync can compromise the rest of the layout (especially with duct and plumbing runs). This problem is hard to fix once the crane has left the job site.**

- **Keep top plates and sills level. Whether load-bearing or not, interior walls should have their top plates level with the mudsill (on the first floor) or the top plates of exterior walls (second floor). Otherwise, the floors will teeter-totter over the high spots.**

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Second-floor safety. *Installing factory-framed floors on second and third stories is easier and much safer than stick-framing. Carpenters work off a solid floor rather than having to walk the tops of narrow walls. This prevents on-site injuries and increases building speed.*

in the field and then again in the factory. Even if you could afford to take on this comparison project, you would have to decide when to do it: during a perfect summer day, in the rain, in bitter cold, with or without wind? Each climatic condition would influence the result—out in the field. One of the difficult-to-quantify but obvious advantages of the factory floor comes with climate and quality control. Have you ever tried building one cabinet in a well-organized shop and another in a driveway full of ruts and loose gravel?

Although computer-operated machines mark and cut all the joists and beams to exact dimensions, the assembly work for factory floor panels is done a lot as it is on the job site, with carpenters rolling joists and nailing sheathing. The difference is that these carpenters are working at a comfortable height, on level, square framing tables instead of balancing on top of second-story walls. Also, the factory floor is always dry and warm. On average, it takes factory hands about 30% less time to build a floor in these conditions than it would take the same carpenters to roll joists on the job site.

Once the floor panels arrive at the job site, the savings in time is dramatic. A true cost comparison depends on what you pay framers and how you quantify material waste and handling. At the factory, scrap lumber is used regularly; on the job site, a lot of it goes into the trash. Your time at the job site includes costs such as interest, insurance, taxes, and worker's-compensation fees. The less time you spend on the job (in man-hours as well as calendar days), the lower these overhead costs are. When you factor all costs into the equation, factory-framed floors begin to save you money. But if you're looking for a simple cost comparison, the slightly higher price of the lumberyard's services, offset from the direct cost of job-site labor, makes the factory-framing package a dollar wash. It just depends on where you want your dollars to go: the carpenters or the supplier? I have enough work to keep them both busy. But I would rather have my carpenters moving on to another project than camped out rolling joists. □

Fernando Pagés Ruiz, a frequent contributor to *Fine Homebuilding*, operates Brighton Construction Company in Lincoln, Neb. Photos by Rob Yagid, except where noted.

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