FRAMING WITH Pre-Cut Components

All of the material in the conventionally framed wall system for this ski company housing project was pre-cut and shipped from about 450 miles away.

by Michael Davis

Pre-cut, prefabricated, and modular systems all have inherent benefits and drawbacks. My first attempt at prefabrication using an "automated" assembly line setup was a full wall panel on a multifamily project, calculated and drawn by hand. Although this approach was crude, it was surprisingly effective. I created a layout book and began building prefab walls. I took the book home at night and used white-out for minor adjustments, redrawing and pasting in larger corrections. It changed day to day, but by the time the project was in full swing, we had a product that worked very, very well.

Prior to that, for about 10 or 15 years, we did everything we could think of in conventional prefab, including arches, drop ceilings, and framed roof details. Everything we did seemed to pay off. Most notable was the amount of waste, which was next to nothing. And as our construction company's market expanded from New Mexico into places like Aspen and Vail, Colo., where labor is both scarce and expensive, I

With this innovative system, you can get fast, top-quality framing with no waste and no mistakes

Figure 1. Everything is fitted carefully to keep freight costs down and create a tight, solid, stackable package that will help reduce warping (left). "Hybrid-prefab" packages contain everything you need to build walls, including pre-cut plates, headers, trimmers, channels, corners, nails, hardware, and drawings (right).

thought prefabrication would still be the answer to all our clients' needs.

Shipping air. But I eventually discovered the Achilles' heel of panelized walls — freight costs. You can turn one tractor-trailer load of lumber into six truckloads of walls. Any savings you realize from the efficiency of panelization is eaten up by the cost of shipping. The term in the business is "shipping air." Somehow I had to use what I had learned about assembly line techniques to achieve a competitive edge.

A System Evolves

My answer to the problem was to do a partial, or hybrid, prefab. I would precut all the walls, lay out the plates, build the components, and ship packages of wall plates and bundles of components to the site for assembly. The advantage of this process is efficiency; speed, accuracy, quality control, no mistakes, no storage problems, and optimal use of labor.

Halfway there. We realized some of the benefits of factory-style fabrication, but there were drawbacks. The projects that we shipped were fairly complex, with up to fifty different units of components, including headers, trimmers, channels, and corners, all of various sizes. When a crew would break into a unit of pre-cut, pre-laid-out lumber, they would spend half the day roaming a field of stacked components, gathering one of this, four of that, and so on.

This was not an efficient way to build. Many of the projects that we contracted for were on small sites, and we simply did not have the room to spread out. A different approach was required.

Freeze-dried walls. The idea started to gel as I watched a documentary on climbers attempting to scale Mount Everest. I saw them huddled in their tents preparing freeze-dried meals thousands of feet above the nearest stove top. "Why not freeze-dried walls?" I thought. The idea is to bundle a plate, component, hardware, and nail package. Just add a little labor, and you have a panelized building package, miles away from the nearest prefab plant.

Of course, the thing about great ideas is that unless you have the right people to execute them, they remain just ideas. Luckily for me, I did have the right people. We are now turning out neat, easy-to-ship "freeze-dried" units — about four or five projects a year —

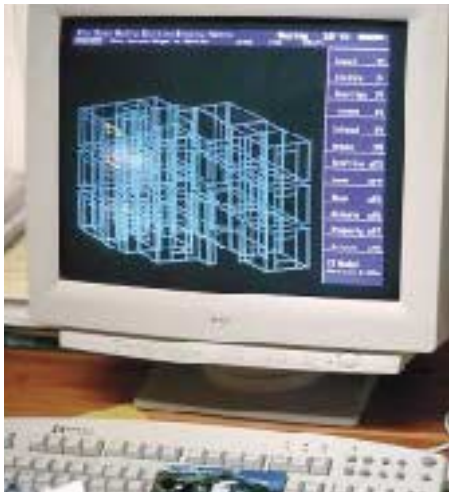

Figure 2. It all starts with a careful review of the drawings and a Keymark design system. Mistakes are a lot cheaper and easier to correct on paper than during cutting or assembly.

60,000 to 180,000 square feet each, and assembling them within about a 500-mile radius of our headquarters in Albuquerque, N.M.

Hybrid Prefabrication

My process is not a true prefab operation because we don't actually assemble the plates and components into finished wall panels. It is actually a pre-cut framing package (see Figure 1), composed of everything required to frame a hotel or apartment unit completely. You may have seen similar packages on piecework frames in California. We have taken that concept a few steps farther. While we developed the system with multifamily projects in mind, it could work equally well for tracts or large custom projects.

On one semi-truck we can typically ship enough pre-cut, labeled, and packaged material to cover a 20,000-square-foot area in walls. Each banded, wrapped, and numbered package measures 4 feet wide and 16 feet long. The height depends on the size and complexity of the unit. Units are designed to fit two abreast, three units end to end, and stacked 8 feet high — about 23,000 pounds.

Along with every prenailed subcomponent required (such as sills, cripples, headers, trimmer assemblies, corners, channels, nails, and hardware) our packages include every plate — cut to length and detailed per the plan. Every member is labeled, nailed, drilled, and fitted as required. Every package includes a dimensioned layout and placement plan and a plastic-wrapped shipping list with a printout of exactly what pieces are included. This includes a list of the wall plates, indicating the width and length of each wall, as well as elevations for walls where additional clarity would be helpful.

Quality and efficiency. Every step of our process has multiple quality controls built in. Quality is our foremost concern, because the product that we are shipping will be delivered to carpenters who are paid twice as much as our prefab team. Plus, the men in the field are working in far rougher conditions: limited space, snow, cold weather, and so on. Our goal is to take half the work and all the thinking out of framing.

Figure 3. As wall plates are cut to length, they are labeled and nailed into sets (left). Pre-cut plates are then moved to the layout station, where stud and component placement, top plate length and positioning, anchor bolts, and "courtesy cuts" at doorways are laid out (right).

Where To Start

The process starts with a careful review of the plans, which enables us to catch discrepancies early on that might lead to problems in the field. My associate, Christopher Head, who has training in both architecture and framing, inputs data into a commercially available computerized wall-panel design system (Figure 2). He is very methodical, and when he prints out a set of walls, you know they are going to work like a charm.

Once the input and design have been completed and any problems resolved, a complete set of shop drawings is printed and forwarded to the project architect for review. These documents, along with any adjustments required by the architect, become our Bible for the project.

Accurate cut lists. Chris then works through the drawings to define logical areas or "units" that can be grouped into a package — such as apartments with identical floor plans. Wall plate and component cut lists are compiled, and three copies of every list are printed. The lists are precise. The item counts are cross-referenced. Quantities are confirmed and totals balanced in much the same way an accountant might tie in figures on a financial statement. When the field operation begins, everyone is provided with specific instructions on what is required to complete the work.

Splitting Up the Tasks

The operation is broken into two production "lines" — wall plates and components. On the plate side, lumber is dropped at the cutting station, and I receive the first of the three wall plate lists. I check the quality of each piece of lumber, and I use the premium lumber first for the longest lengths on our various cut lists. Material with defects, such as bows or excessively large knots, is trimmed and the defects removed. Shorter walls are then cut from the salvaged material. The smallest and least desirable materials are cut into blocks

Figure 4. Perfectly uniform two-way channels make backwards installation impossible. Note the efficient use of lumber that might otherwise be scrap.

Figure 5. These timber cutoffs have been salvaged from the scrap pile and ripped down to 2 3/4 inches for use as cripples. This eliminates splitting problems, reduces waste, expedites assembly, and improves quality.

for channels and corners. Nothing goes to waste. By working from the longest to the shortest, we are able to use every section of lumber, even down to pieces as small as 6 inches.

Dimensional consistency. Often a CCA-treated 2x6 will measure 5 3/4 inches wide, while the nontreated plate is 5 1/2 inches. If walls are framed with the bottom plates wider than the top plates, problems occur during plumb and line. If the bottom plate of an intersecting wall is 1/4 inch too wide, then the top of the wall will be 1/4 inch out of plumb. This is a progressive error that gets worse the more walls you tie together. By running every piece of treated plate through a table saw, we ensure that the top and bottom plates are the same size. This ensures that plumb and line goes faster and smoother and that the finished product is better.

Organizing the plates. Once the plates have been cut to length, they are numbered. The wall designation is written on the top, bottom, and end of each plate as well. Experience has taught us that it is not always possible to view the bottom of the wall to read the number. By taking a few extra seconds per wall to write the designation on the end of each plate, we can save valuable time for those in the field.

The plates are then joined together — one nail within 12 inches of the end of the plate and one nail every 6 feet along the length of the wall. The fastening of the plates plays an important role in getting a straight wall to the site. The guys on the tables complain a bit about how hard it is to split the plates, but at least when they are separated, they are straight.

We are careful to nail through the top plate only. This way, once the wall is split and assembled, an 8d nail left sticking out will be hanging harmlessly from the top, as opposed to sticking up out of the bottom plate, waiting to impale an unsuspecting foot.

Wall plates are sorted, and each set of plates is checked off of the computer printout. The wall plates, along with the verified list, are bundled into a package. This package then moves from the cutting/nailing station to the layout station.

Layout

When Chris receives a package, he checks the list again to verify that it was completed. He then discards the list from the cut station and begins checking the length, plate dimension, and quality of each set of plates using a second copy of the wall-plate list as he lays them out (Figure 3, previous page). Anything that doesn't meet Chris's high standards is recut. Chris lays out the wall plates and stacks them. He double-checks the second copy of the panel list to ensure that the package is accurate and complete. Then he sends the package to the top plate-prep station.

At this station, top plates are cut, labeled, and tacked to the wall plates. Also, in order to speed completion in the field, two 1/4-inch kerfs (or courtesy cuts) are made on the bottom plate to allow easy removal of door plates after erection. As plates and components are moved from one station to another in the yard, they are bundled, reusing the banding from the original lumber bunks.

The project that we are fabricating now requires expansion anchors at 24 inches on-center at certain interior bearing walls. The bolt layout is included in our computer wall elevation. The bolt layout is done by Chris, and the holes are predrilled in the bottom plate. This eliminates the need for the field supervisor to determine which walls require bolting or to do a layout. He simply hands a carpenter's helper the box of expansion anchors that was included in the wall pack and instructs him to install an anchor in every pre-drilled hole.

Components

While the plates are traveling through the various stations, the component crews are hard at work assembling headers, trimmers, channels, and corners from lists that are cross-referenced to the wall panel elevations. The header

team gets one copy of the list to check off timber and engineered-lumber headers and posts. Another copy of the list is provided to the crew that nails up all the stud-based components, such as king stud/trimmers, corners, and channels. Each piece of cut lumber is clearly marked and then checked off the list.

Structural elements include dimensional lumber, Parallam and LVL headers, and king stud/trimmer assemblies ranging from single, double, triple, and quad trimmers, to Parallam trimmers and support columns. A wide range of rough openings and load-path considerations makes buildup a challenge. However, it is precisely this type of project that is best suited for our system. By placing all these various headers, trimmers, sills, and blocks together in one package, each piece clearly marked to match the layout, we make what would otherwise be a very difficult and confusing task a fairly simple "frame by number" assembly.

We normally use solid timbers in lieu of built-up header assemblies. The cut-offs from the timbers are recycled into solid blocks for channels. We use 4x4, 4x6, and 6x6 blocks to form two-way corners and channels. This is one more way that we take the thinking out of wall assembly and save time in the field. These components are universal, so you can't put a tee or corner in backwards (Figure 4).

Cripples. We use these timber cut-offs to solve another common framing problem. If the header does not completely fill the space from the top of the opening to the bottom of the double top plate, cripples must be cut to fit in this space. Once dimensional lumber is cut to a length shorter than its width (for example, a 2x6 cripple cut shorter than $5\frac{1}{2}$ inches), it is likely to split when nailed. For example, to fill a $3\frac{3}{4}$-inch void between the top of a header and the bottom of the double plate in a 2x6 wall, we cut solid cripples from beam stock $5\frac{1}{2}$ inches wide (to match the 2x6 wall), 4 inches long, and $3\frac{3}{4}$ inches deep (Figure 5). These cripples can be toe-nailed to the top of the header with no danger of splitting.

Figure 6. Carpenters assemble pre-cut wall panels on site (left). Wall plates are stacked at the far end of the table, headers, sills, cripples, and tees are stacked to the left, with finished walls to the right. Everything required is in the package. The compact lumber packages will result in an enormous pile of wall panels. Two short walls at the bottom of the pallet are used to create clearance for the forklift (below). Carpenters can spread and erect wall panels very quickly. Notice how clean the area is (bottom).

The buildup crew is also responsible for holddown assemblies. Posts for holddowns are cut to length and marked with the bolt pattern for the scheduled hardware. The posts are then run through a two-step process on our drill press. First, we drill an oversized hole on the back side of the post to allow the nut and washer to be countersunk into the column, so as to not interfere with wall sheathing. Then the hole for the bolt is drilled through the post at 1/16 inch larger than the required fastener. Using a drill press ensures that the holes are straight and true. In many cases we will go ahead and bolt the holddown onto the column. This assembly can be installed in the wall once concrete-embedded bolt locations are verified.

Any stud material that is not straight and true is moved to the cut station, where it is used for cripples, blocking, or plates for small walls. Lumber will always move. Crowns become more pronounced. Twists and cups develop. We make sure that all the studs that go into our packages at least start out straight.

Final Assembly

As the wall plates and components are completed, they move to the final assembly station. Yard foreman Dave Gonzales oversees this critical step as the triple check in our quality-control process. He begins assembling each package with the third copy of the wall and component lists. He verifies that the plate crew has provided every wall required and that the buildup crew has delivered the correct type and quantity of component assemblies. Dave is a real perfectionist. It's not uncommon to see him breaking out his power planer to smooth blocks in a channel that don't flush up just right. Anything that doesn't look good to Dave is rejected. He knows that we count on him to catch any errors that might have slipped by the rest of us. We do not hurry him. If he is not 100% sure that a package is correct he knows that he won't catch any grief from us if he tears the whole thing down and starts over. When it leaves our yard it has to be right.

Holding platforms. We developed a set of small platforms to hold the stickers or support boards under the package. Each platform is designed to hold a double 2x4 sticker that is 48 inches long. The platforms provide a space so that banding material can slide through beneath the double 2x4. The 4-foot-long double 2x4 stickers come from materials that I deem to be "terminally crooked" at the cut station. Even the most unruly board will find a home and a useful life in our shop. Once the banding is in place, the sticker is secured to the package. This gives us a full 3-inch clearance for the forks on the lift. Providing ample clearance below the package enables the forklift operator to unload and stack unit packages unassisted. He never has to get off the lift because each package has adequate blocking below it to allow his forks to clear. Furthermore, the stickers are laid out on a standardized grid, six to a package. This enables us to stack each package atop another without any additional blocking.

Wrapping the package. All of our packages are wrapped to protect them from moisture and ultraviolet light. We order all our materials wrapped to help keep them in the best possible condition. We recycle all of our lumber wraps as covers for the completed product. When we run short of recyclable wrapping, we use a 6-mil black plastic cover.

Figure 7. This is all of the framing waste from a 60,000-square-foot project, plus somebody else's trash — barely a small pickup load.

On Site

The walls are assembled in a prefab area on site (Figure 6, previous page), stacked, and the plastic cover reused to protect the finished walls until they can be installed (often this is the third useful life for these covers). In this way, fabrication can start well before the concrete slab is completed. By the time the slab is ready, all the walls for that building are framed and ready to be stood up.

Getting a head start on the walls can greatly reduce the time required for framing, thereby accelerating the overall project schedule. However, we feel that the greatest benefit from the system is realized by placing a framing table directly on the slab and assembling the walls near where they are to be used. Another small crew can then erect the walls once the unit is completed. This eliminates the need for stacking, banding, and moving the packages of finished walls, which is in itself a time-consuming process.

No waste. When we started on our current project, we had a large dumpster delivered to the yard for all the scrap that we expected to generate. After three weeks of operation we don't have enough waste to fill the back of a pickup truck (Figure 7).

I look at it this way: You pay for lumber, you pay to have it delivered, you pay to have it cut up, and if you throw it away, you pay to have it hauled off. So to me, careful use of materials and recycling is just good business. Whether you want to save the world or save a buck, you end up doing many of the same things.

Most importantly, the guys in the field love our packages because they are right. Not sort of, not really close, but right on the money!

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