Built-up Center Beams

These simple site-built beams are the backbone of the house, so make sure you build them straight and set them level

BY RICK ARNOLD AND MIKE GUERTIN

We looked at a basement remodel recently. But before we got to the basement, the owner was showing us large cracks in the tile floor in the kitchen and entry. She hadn't noticed the drywall cracks forming in some doorways. We'd seen these symptoms before, and in the basement, we found that the center beam had been built of green lumber and had shrunk almost $^{3}/_{4}$ in. So before the remodel could begin, we had to jack up that center beam so that it could do its job: Hold up the house.

Built-up beam basics

In the simplest terms, a built-up center beam provides a straight, level surface that sup-

Center beam goes here. After the crew measures from the corner of the foundation, the exact location of the center beam and all its individual layers are marked on the mudsills.

Keep beam flat during preassembly. For a straight beam, sections of the beam are preassembled on the ground and must be kept flat, with the tops of the boards kept flush. Just a few nails join the layers at this point.

ports the floor joists between the walls of the foundation. Like most, the beam we installed for the project in this article was even with the mudsills and was carried by columns set on footings at regular intervals.

A built-up beam is made of several layers of lumber nailed together and set on edge. The beam for this project was made of dimensional lumber, but laminated veneer lumber (LVL) can also be used (sidebar right). The number of layers and the size of the lumber are determined by the load that the beam has to carry, the species of lumber and the span between support columns.

Most center beams fit into recesses in the foundation called beam pockets. The simplest center beam spans from one side of the foundation to the other. With larger or more complex designs, there may be several beams, and some beams may span only a portion of the basement width.

Sketch the beam before you start

Before we order materials for a new house, we sketch a beam plan that shows the numbers and lengths of the boards in the beam. On the sketch we mark the centerpoint of each support column and the measurement between those points as well as to the inside edges of the foundation.

Most center beams are longer than the longest available stock lumber, so we plan for butt joints in each layer. With an engineer's approval, butt joints can fall between columns, but rather than take chances, we locate all butt joints over the columns. These joints should be staggered between layers. On the sketch, we label each beam layer by number and the boards in each layer by letter to keep things organized on the job site.

Before we assemble the beam, we measure from the corners of the foundation and mark the exact center of the beam on the mudsills above the beam pockets (photo right, facing page). Working from the center, we draw the edges of each beam layer on the mudsill.

We also set up A-frame scaffolding to support the beam temporarily as we set it in place (photo below). The tops of the A-frames put the beam close to its final height, and staging planks on the lower cross bars put us in a good position for assembling and positioning the beam.

Keep the beam flat during assembly

At this point, we cut the pieces of the beam to length. Each board is given its piece-and-layer label, and the direction of the crown is marked. The boards are then spread out in their approximate location on the ground inside the foundation.

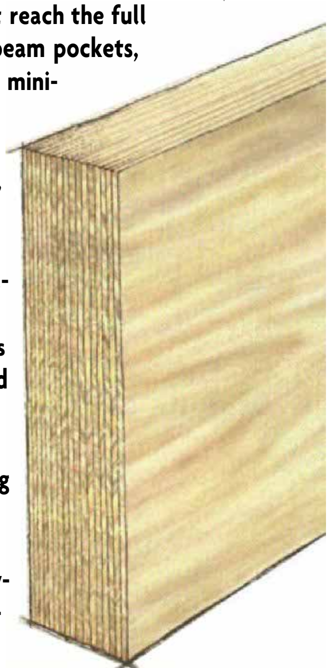
It's much easier to assemble part of the beam and lift it into position on the A-frames rather than build it from scratch in position. And although we've seen it done, we never preassemble the entire beam and try to lift it into place, which is a dangerous proposition regardless of the size of your crew. So starting at one end of the beam, we line up the second layer on top of the first. We keep the

Up, over and into the pocket. Preassembled beam sections are easy for two crew members to lift. Here, crew members slide one end of the beam into the foundation pocket and rest the other end on the A-frame scaffolding.

The LVL alternative

Although we install a lot of dimensional-lumber center beams, laminated veneer lumber (LVL) may be a better choice when you want to reduce the number of support columns and simplify the installation. LVL boards span greater distances than similar-size dimensional lumber and are much less prone to shrinking. They also come in longer lengths.

LVL boards are 1¾ in. thick and from 7 in. to more than 18 in. deep. Layers of an LVL beam are joined together with nails or bolts just as with a dimensional-lumber beam. And you can usually purchase and handle lengths that reach the full distance between beam pockets, or at least halfway, minimizing butt joints.



LVL beams are dimensionally stable, so they can be set level with the mudsills without allowing for shrinkage. Also, LVL tends to be straighter and have no crown, so LVL beams don't take much tweaking to get them true.

On the downside, LVL beams are heavier than dimensional lumber, so plan your crew accordingly. A 36-ft. LVL beam that's 9½ in. high is more than two people can handle safely. LVL is also much more dense than regular lumber, which makes nailing the layers together more difficult. Pneumatic nailers don't always drive nails in completely. We find that clamping the members together before shooting the nails helps, and any nails that aren't sunk completely can be sent home with a hammer.

Long, straight and strong comes at a price. Expect an LVL beam to cost twice as much as a dimensional-lumber beam.

—R. A. and M. G.

Drawing: Dan Thornton

Wedges keep the beam standing up. Temporary 2x wedges that are placed in the pocket keep the beam from moving while assembly continues.

Almost a beam. The last board in the first layer completes the bridge between the foundation pockets. At this point, the first two layers are still only tacked together.

tops of the boards flush as they're nailed together (photo left, p. 70).

Nails staggered every few feet are enough to hold the two layers together at this point. We try to keep the beam as flat as possible during this process. Any waves built into the beam as it's tacked together can be hard to take out later. For long center beams (more than 40 ft.), we assemble two or three of these two-layer sections, orienting the crowns in the same direction. The first of the assembled sections is then lifted onto the A-frames and slid into the beam pocket (photo p. 71). Blocks of 2x wedge the beam section upright temporarily (photo left). Next we add preassembled sections or additional pieces until the first two layers are complete from pocket to pocket (photo above).

Brace the beam to keep it straight

Before adding the rest of the layers, we brace the beam straight so that no curves are built in (photo top right, facing page). We stretch a string the length of the partial beam, spacing the string from the beam with two short 1x3 blocks. A third block is used as a gauge.

Before nailing on the braces, we make sure the beam hasn't sagged. If it has, we adjust the A-frames until the beam is approximately level again. Then we extend an adjustable 2x4 brace from the mudsills across the top of the beam at each support-column location. These handy braces, available through concrete-form supply houses, consist of a turnbuckle that is then attached to a 2x4. The adjustable ends of the braces are nailed 2 in. in from the edge of the mudsill so that they don't interfere with the rim joist and floor joists.

Keeping the beam roughly straight, we nail the other end of each brace to the beam. Then one crew member fine-tunes the brace on the turnbuckle end while another gauges the beam with a block. Besides keeping the beam straight, the braces keep it from rolling over while we add the final layers. When the two layers have been braced straight, we fasten them together permanently with rows of 12d or 16d nails every 12 in. to 16 in. apart. The nails are driven at an angle, so they don't poke through the other side.

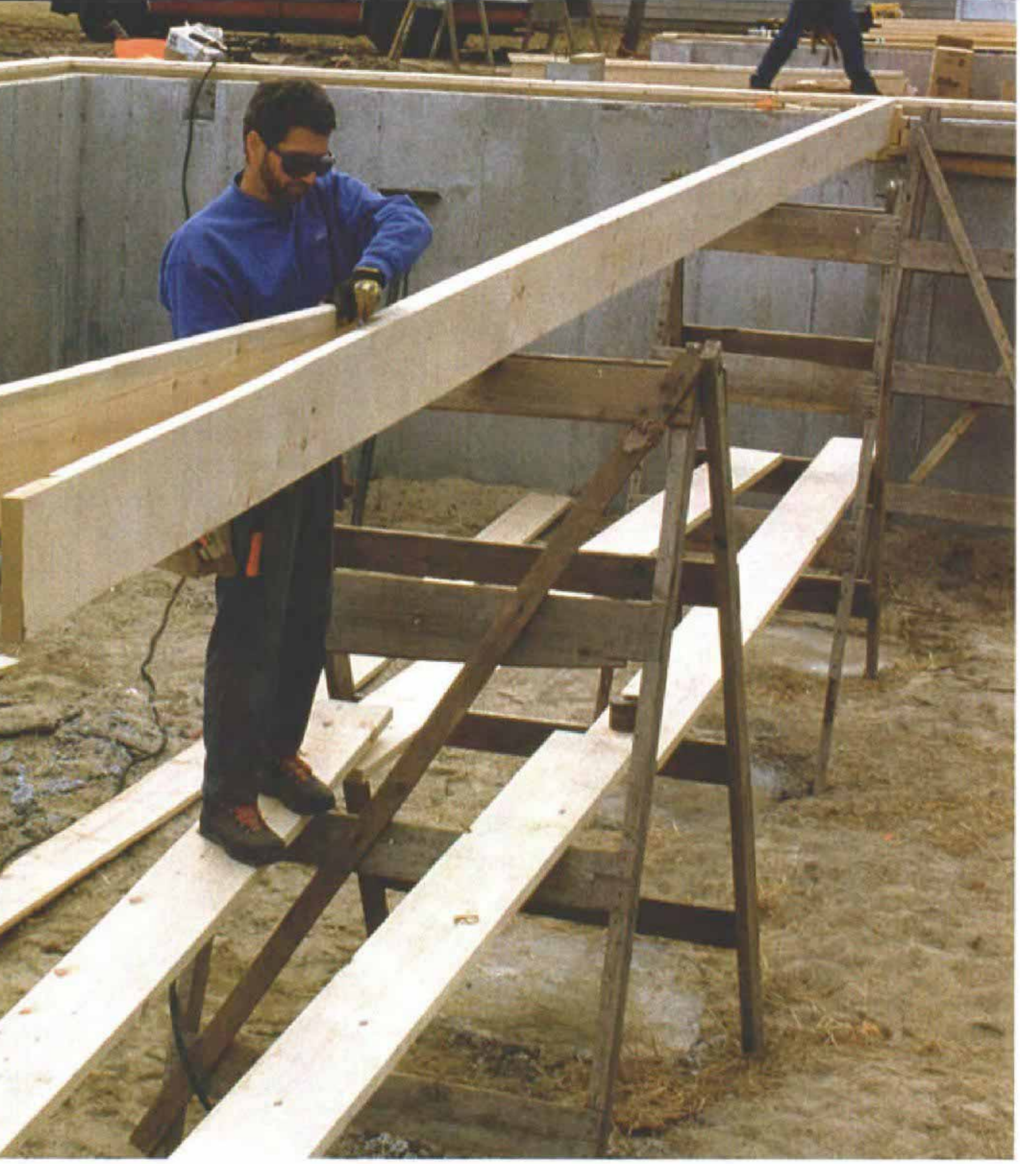
Add final layers one at a time

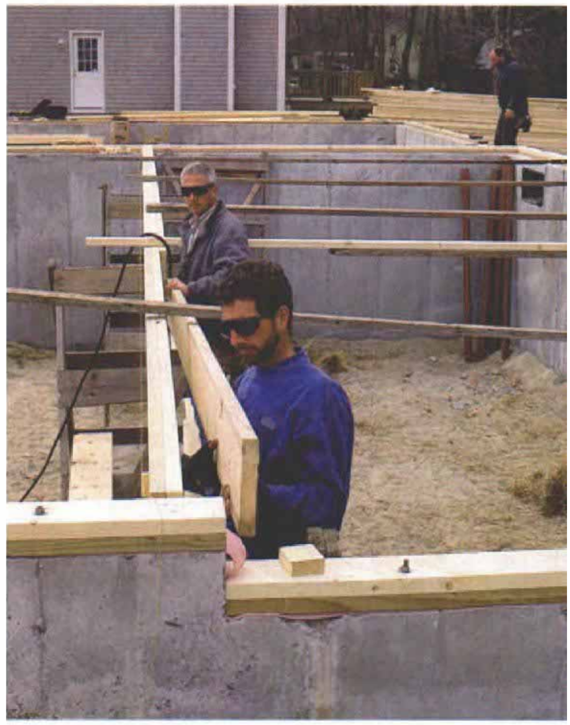
The next layer can now be added to the beam with the crown up and the top flush with the rest of the beam (photo top right, facing page). When that layer is tacked in place, we make sure the beam is still straight before nailing it off.

If the beam has a fourth layer, it is added the same way. As we add successive layers, we're careful to keep the joints staggered and to install each board according to our sketch.

Set the beam a little high

Dimensional lumber always shrinks. A two-plate mudsill that's 3 in. thick can be expected to shrink ⅛ in. to ¼ in. over the first year or two as the house dries out. Even though we try to build our center beams of kiln-dried lumber, a beam can shrink up to ⅝ in. depending on its moisture content when it's installed. To compensate for this shrinkage,





One piece at a time. After the first two layers are braced straight and nailed off, each of the final layers is added one board at a time. After the entire layer is in place, the crew goes back and nails it off.

Need a lift? Strings stretched across each support column keep the beam in plane with the sills. Screw jacks replace the scaffolding support, and using a gauge block, the crew sets the beam $1/4$ in. to $3/8$ in. above the mudsills to compensate for future shrinkage.

Lifting a beam without jacks

Here is a site-built alternative for raising a center beam without screw jacks. First, lay down an 8-ft. 2x6 in the basement on a flattened area of ground that runs perpendicular to the beam just to the side of the column location. Cut two 2x6s about 5 in. longer than the distance from the 2x6 on the ground to the bottom of the beam, and nail the two 2x6s together at the tip of one end with the other ends spread apart. Slide the nailed ends under the beam, and place the loose ends on the flat 2x6 to form an A-frame (photo left).

Tack the top of the A to the underside of the beam, and tap the legs inward equally to make the beam rise. If more than one lift is being used, adjust each a little at a time and equally along the length of the beam until the beam is at the correct height. To keep the legs from kicking out, nail on 2x blocks to back up each leg.

—R. A. and M. G.

Photo bottom left this page: Tom O'Brien

Beam ends rest on permanent shims. Shims that support the ends of the beam can't rot or be crushed. Steel plates and plywood can be used for small spaces (photo left), and lumber shims with the grain in a vertical position are used to fill larger spaces (photo right).

Recycled steel strapping keeps the beam in place. An X made of steel strapping from the lumber delivery anchors the beam to mudsills while the floor is being assembled.

we install the beam $\frac{1}{4}$ in. to $\frac{3}{8}$ in. above the top of the mudsills.

To level the beam, we first stretch a series of strings between the mudsills perpendicular to the beam, one string over each column location. We always use strong twine that can be pulled tight without sagging. Just as with straightening the beam, spacer blocks are placed under the strings at each end.

Screw jacks that raise the beam are then placed about 1 ft. from each column location, snugged up to the bottom of the beam. If screw jacks aren't available, there is a site-built alternative (sidebar p. 73).

With the screw jacks in place, the A-frames can be removed. We adjust the jacks until the beam is $\frac{1}{4}$ in. to $\frac{3}{8}$ in. higher than the mudsills, nudging each jack a little at a time to bring the beam slowly up to position (photo bottom right, p. 73).

Permanent shims in beam pockets

Once the beam is at the correct height at each of the column locations, we move to the beam pockets and install permanent shims to lift the ends of the beam to the same height. Shims should be made of dimensionally stable material that won't crush or rot.

The thickness of the space below the beam affects the choice of shim material. Spaces $\frac{1}{2}$ in. or less are best filled with steel plates, Several plates can be stacked to fill the void, or steel plates can be used in combination with plywood (photo top left). Softwood shims, such as cedar shingles, should never be used to shim a center beam.

Pressure-treated lumber shims should never be used with the grain flat. In this position, they can shrink and allow the beam to settle. Instead, we install these shims with the grain in a vertical position (photo top right). These shims work best to fill spaces 3 in. or more.

We also replace the temporary blocks on the sides of the beam pockets with pressure-treated blocks. To make sure that the beam stays on its layout marks while the floor is being framed, we nail steel straps in an X between the beam and the mudsill (photo bottom left). We usually make the X out of the steel strapping from the lumber delivery.

Columns: now or later?

Most of the houses we build call for $3\frac{1}{2}$-in. diameter concrete-filled steel columns (also known as Lally columns) as permanent supports. The columns can be installed at this point (sidebar right), but because there is no weight on the beam yet, we sometimes wait until the floor system has been installed. When they're supporting the weight of the floor, they're less likely to be knocked out of place accidentally.

But don't wait too long. Once load-bearing walls and the weight of a second floor have been added, it may not be possible to lift the beam without more powerful jacks. □

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Installing the support columns

Before the columns can go in, we first make sure the beam is still level. If our strings have been stretched for more than a day, we retighten them to take out any sag. Then each post location is marked on the bottom of the beam, and the distance from the concrete footing to the bottom of the beam is measured at each post location.

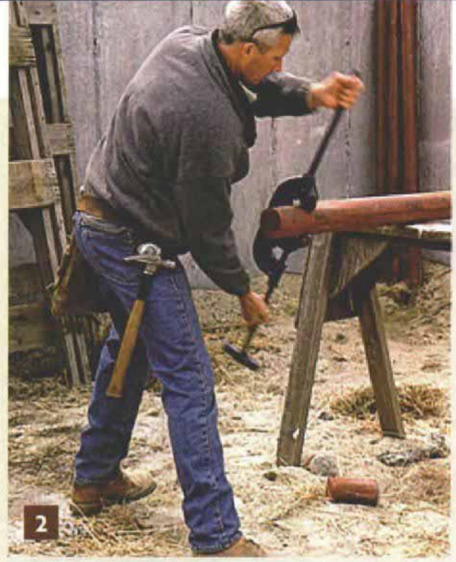
If the layers on the bottom of the beam aren't flush, we chisel off a flat spot for the top column plate. We also take off any high spots on the footings for a smooth surface. The measurements are written on the beam. To obtain the actual cutting length, we subtract the thickness of the top and bottom plates if one or the other isn't already welded to the column, and mark that length on the column.

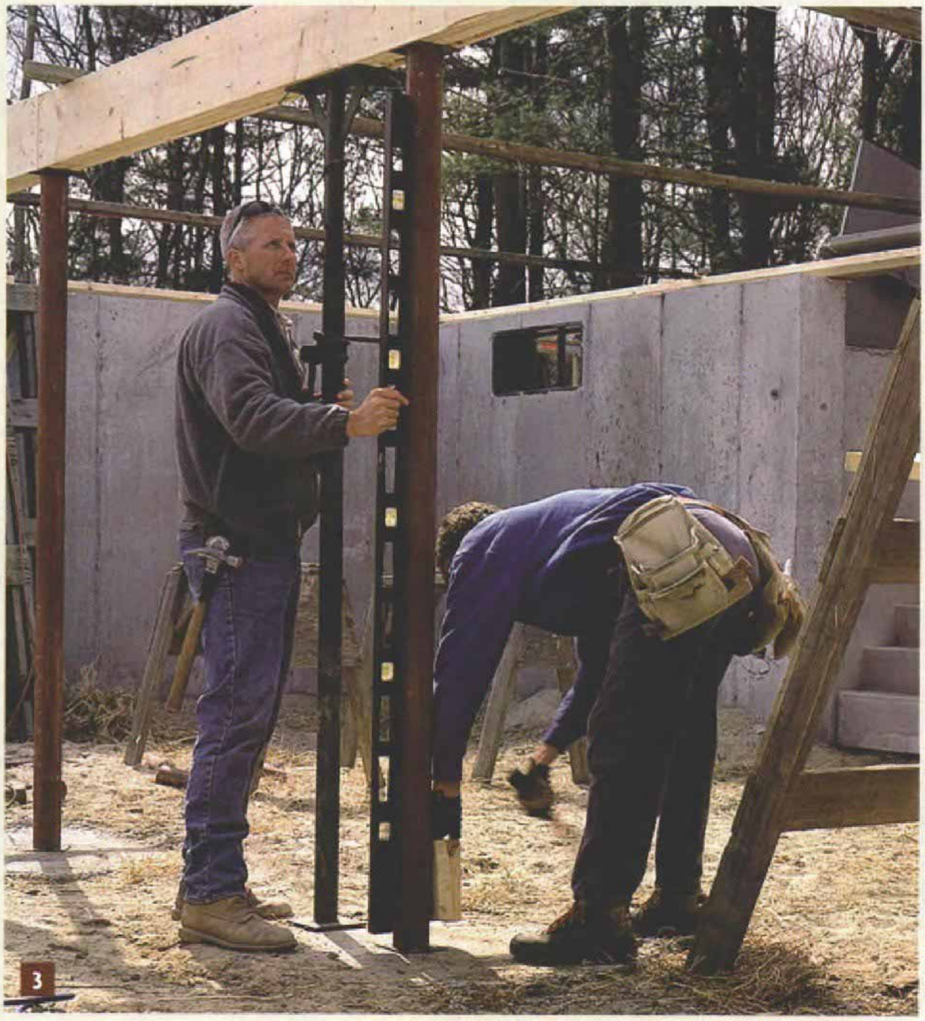
It's best to cut longer columns first so that if one is cut too short, it can be recut and substituted for one of the shorter columns. A large pipe cutter is the fastest and easiest way to cut a column, but it's an expensive tool to own and not always available to rent. An alternative is using a metal-cutting blade in a reciprocating saw or circular saw. But all cutting options begin with an accurate cutline around the circumference of the column.

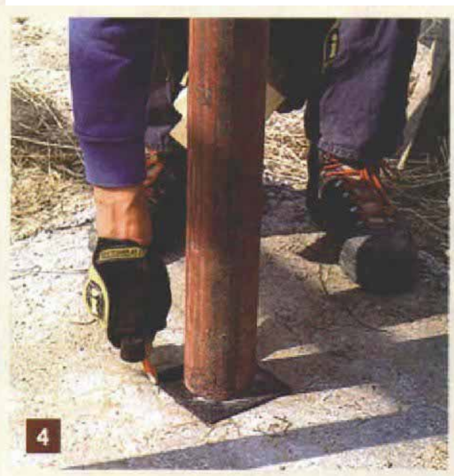
The easiest way to draw the cutline is to wrap a large piece of paper around the column (photo 1], keeping an edge of the paper lined up on the mark and then matching the edge of the paper to itself as it wraps around the column. A pencil line follows the edge of the paper.

We gently cut through the metal skin of the column, following our line (photo 2). When we're most of the way through the steel, a light tap with a hammer breaks off the waste piece. If the concrete core of the column breaks off beyond the cutline, a few hammer taps on the concrete chips off the excess.

If the top plate hasn't been welded to the column, we fasten it to the underside of the beam. To let each column







1 Paper makes the perfect cutline. A sheet of paper with the edge set at the measurement and then wrapped around itself creates a continuous line for cutting around the column.

2 That's a big pipe cutter. A large pipe cutter is the easiest and fastest way to cut a steel column to length. A circular saw or reciprocating saw with a metal blade can also be used.

3 Perfectly plumb. After the support column and plates are inserted under the beam, one crew member taps the column into plumb while another keeps his eye on the level.

4 Column base belongs here. After the column has been plumbed, the position of the column base is marked on the footing in case the column is bumped before the basement slab locks it into place.

slip in more easily, we raise the beam about ⅛ in. with the screw jack. The column is then slid into place and set on the baseplate. Next we roughly plumb the column and lower the jack until the column starts to bear the weight of the beam. The bottom of the column can then be tapped into place while it's plumbed with a level (photo 3). When the column is set, we make index marks around the baseplate just in case it gets bumped out of place during construction (photo 4).

If the slab hasn't been poured, the base of the column can be secured to the footing with a couple of masonry nails. If the slab has already been poured over the footings, we install lag shields into the concrete and then bolt down the baseplate of the column. As a final step, the column is welded to the top and bottom plates. We usually make a continuous weld around the ends of the column with a MIG welder. The small tabs on the plates should not be trusted to keep the column in place.
—R. A. and M. G.