Flitch Beam Retrofit

For a long-span, high-strength beam, flitch steel met the need and the budget

by Eric Borden

On a recent remodel job, the clients had asked for some extensive interior renovations and a first-story addition with a deck above. Access to the new deck would be through patio doors replacing the second-story living room windows. It all seemed pretty straightforward. Then they said, "We would like to remove this wall." "How much of the wall?" I asked, innocently. "All of it," they replied.

As I glanced at 20 feet of first-story exterior concrete block wall with visions of glulams and temporary walls forming in my brain, the client adds, "And we would like the ceiling to be flat." My vision of a drop girder fades. Then inspiration strikes — I could use a glulam in place of the rim joist if I hid the extra height up inside the second-story exterior wall! I'm doing great, right up to the point where I mentally try to install the new patio door. As the glulam vision explodes, replaced by a knot in the pit of my stomach, I hear myself telling the clients, "No problem."

After considering a career change, I decide that I'd better consult an architect. When I tell him about 20 feet of loadbearing concrete block wall, the addition, and the existing second-floor joists, he says, "No problem," and goes on to explain how a 16-inch, wide-flange steel I-beam should do it. That's when I tell him about the patio door. If this wasn't enough, the client also wants a new first-floor entry door, so now one end of the beam has to be supported by a header. We needed

Flush-Mounted Flitch Steel

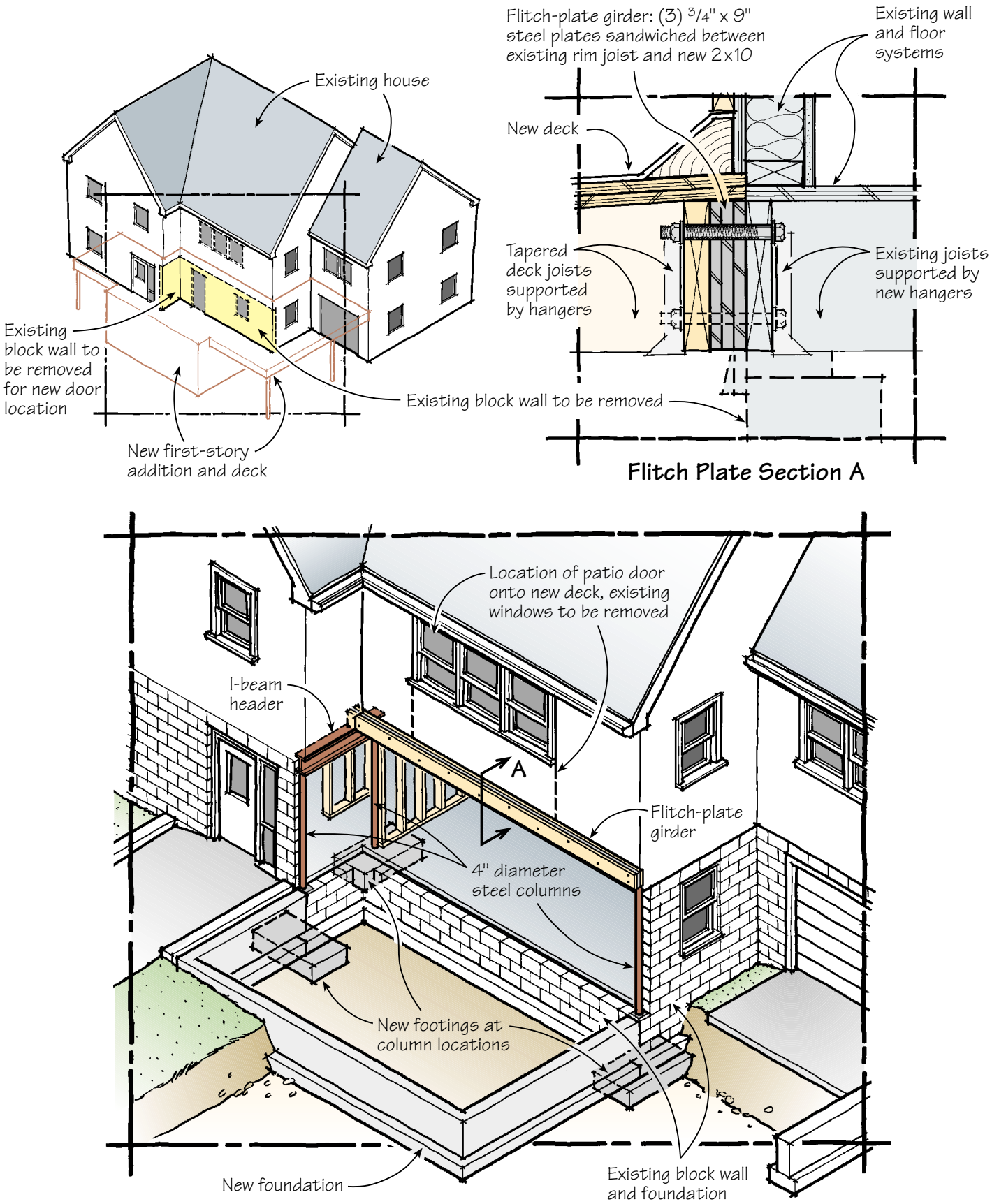

Figure 1. A flitch-plate girder would carry the existing exterior wall and the new deck joists, with one end of the girder carried by a steel header over the new doorway. The steel was shallow enough to allow for a smooth ceiling below and a patio door above.

something strong, inexpensive, readily available, and no taller than a 2x10.

Old Technology to the Rescue

Our solution was to use a flitch-plate beam made with three pieces of plate steel sandwiched between two 2x10s (see "Flitchplates," 9/92). One end of the flitch beam would be supported on a column, with the other end set on a steel I-beam header supported by two steel columns. The flitch beam would carry the exterior wall of the two-story house, leaving room for both the flush ceiling and the patio door above, while the I-beam would serve as a header for the new door (see Figure 1).

Preparation

Because the existing footings were too small to carry the increased point load, we excavated another 12 inches beneath the existing foundation for the new outside column footings. The inside column footing (also 12 inches deep, under the interior end of the door header) would not be subject to frost, so it could be set level with the existing floor. We dry-sawed the slab at these locations, then excavated the spot footings and the footings for the addition at the same time. After the inspection, we filled the forms with 4,000-psi concrete and completed the 8-inch block masonry stemwalls for the addition.

We now measured for the steel, 19 feet even for the flitch plates, and 4 feet 6 inches for the W8x18 I-beam header. (When you refer to steel I-beams, the first number denotes the height; the second number is the weight per foot. In this case, our header was 8 inches high by 4 1/2 feet long at 18 pounds per foot, so it weighed 81 pounds.) In measuring for the columns, we subtracted out the depth of the I-beam header, as well as the thickness of the base plates.

Ordering the Steel

Armed with these measurements and a set of blueprints, it was time for me to visit Arnold Steel in Lakewood, N.J. I have used steel several times before, and I've found that the time spent in his shop is time well spent. Steel is his

Figure 2. The steel I-beam header for the new passage door rested temporarily on the existing block wall (above) and one of two permanent steel columns (left).

Figure 3. A new rim joist was installed to receive the first steel plates, seen here resting on the pump jacks.

Figure 4. As the plates were lifted into place, they rested on bolts installed from the inside (left). A 2x10 completed the sandwich (right).

business, and he has an understanding of the fabrication process that I do not. Several times he has suggested changes that helped facilitate the installation. In this case, the original design called for two 1-inch plates and one 1/2-inch plate, all 9 1/4 inches high. We changed this to three 3/4-inch plates so we could work with uniformly-sized material (always a good idea when possible). Plus we wouldn't have to deal with the weight of a one-inch steel plate. We also made the plates 9 inches wide instead of 9 1/4 inches so they would fit between the 2x10s with no trouble. These design modifications were approved by the architect.

The steel plates would be match-drilled with 3/4-inch-diameter holes, 2 inches from the top and bottom edges of the plates, with double holes 6 inches in from either end and then at 2 feet on-center in a staggered pattern. The flange of the I-beam header would get two 1/2-inch holes for fastening the 5 1/2x5 1/2-inch cap plates on the 1/4x4-inch tubular steel columns. The column for the other end of the flitch plate would also have a welded cap plate, but would need no bolt holes because the column wouldn't be able to move once it was installed inside the existing wall.

Figure 5. Once the flitch beam was bolted together, the support column was installed. Note the nonshrink grout at the bottom, used to fill the gap between the base plate and the concrete.

We knocked off 1/4-inch from the overall height of the columns to allow for positioning. We would shim and fill the gap with nonshrink grout.

While placing the order, I found out that the steel fabrication would take three days and that each of the 19-foot-long flitch plates would weigh 475 pounds. I returned to the site to double-check the dimensions.

Always Have a Plan

Along with figuring out how to lift nearly 1,500 pounds of beam 8 feet up into position, we also had to consider site security and weather protection, since we would be putting a big hole in the side of the house. The pour for the new floor would be coordinated around the removal of the wall, and we preferred not to remove the wall until we had installed the beam. We decided to sneak up on it.

Steel header. After removing the top course of block over the location of the proposed door, we hoisted the 81-pound I-beam into position by hand, shimmed it to finish elevation, then stood a column up under the interior end (Figure 2, previous page). We bolted the column to the header and fastened the base plate, held up at the

Figure 6. Metal hangers added support to the original joists as the block wall was removed (above). Installing the second column under the header allowed that section of the block wall to be removed (right).

correct elevation with steel shims, using concrete wedge-anchors hammered into predrilled holes in the new footing. After checking the beam elevation, we tightened down the bolts and filled the 1/4-inch space under the bottom plate with nonshrink grout.

Efficient handling of the 450-pound steel plates without injury was a primary concern. For this, we had our lumber package dropped close to the existing house prior to the steel delivery. Then we could slide each plate off the truck onto the lumber pile (on the flat and properly oriented so the holes would match), down a couple of 2x10s, and right onto two concrete blocks at the base of the wall where the plates would be installed. We leaned the three plates up on edge against the block wall and braced them with 2x4 stakes so they couldn't fall over. Then we set up two Qual-Craft pump jacks (Qual-Craft, 1551 Central St., Stoughton, MA 02072 781/334-1000) for lifting the steel.

New rim. We replaced the existing rim joist, which had been notched for hvac ductwork (Figure 3, page 41). This required no shoring, since the floor joists were still resting on the block exterior wall. We nailed the new rim joist to the existing floor joists and second-floor shoe plates, and were ready to raise the first steel flitch plate into position.

Hoisting the Flitch Plates

After double-checking the stability of the 2x4 pump jack uprights, my helper and I placed the first plate onto the jacks by hand, and raised it with one man operating the jacks while the other stood back to watch for potential problems. After reaching the proper height, we slid one end of the plate onto the steel header and supported the other end on 2x4 blocks (Figure 4). This whole process took about twenty minutes.

This first plate now served as a template to drill the 3/4-inch bolt holes into the new rim joist. We slid two of the bolts into place from the inside, which held the plate in position. We then let the jacks down and pumped the second plate into position onto the bolts, this time running a couple of nuts down to snug the plates tight to each other. Once the second plate was in position, we installed the third plate the same way, added a 2x10, and bolted the steel and wood sandwich tightly together.

All that remained for this girder to become a bearing member was to install the end column and the other column for the I-beam header at the inside corner of the building. To do this, we cut away just enough of the supporting concrete block wall to set the columns (Figure 5).

Finishing Up

Now that the new girder was in place, we proceeded to frame the addition, hanging new floor joists from the face of the girder (Figure 6). We then completed the sheathing and window installation, drying in and securing the site. Now we could remove the block wall, but because the original floor joists rested on the block, we would need to support the joist ends in hangers. By removing 6-foot sections of wall at a time and installing hangers on the exposed joist ends, we were able to gradually transfer the floor load to the flitch plate, avoiding the need for additional temporary shoring.

Fast, Easy, Inexpensive, and Strong

Using steel proved to have many advantages: It was readily available, easy to fabricate, and we were able to install it without any elaborate temporary supports for the structure. Installation went without a hitch, and was accomplished quickly once we had a game plan: From the moment the steel arrived on site to the time we completed the installation was eight hours of work for two people. Plus, we gave our clients what they wanted without blowing the budget: Including fabrication and delivery, the cost of the steel was $1,500.

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