



by Rick McCamy

Last fall, my employer signed a contract to remodel a kitchen in San Ramon, Calif. It was my job as project manager to work out the details with the client and manage the actual construction.

The home was a 1980s single-story contemporary with a long bearing ridge and high vaulted ceilings. A wall approximately 14 feet wide by 18 feet tall supported one end of the ridge and separated the kitchen from a family room at the back of the house. Except for a soffit (which we planned to remove), the only break in this vast expanse of drywall was a 5-foot-wide doorway (see Figure 1, next page). Although it wasn't part of the original plan, the customers told me they were thinking about putting French doors into this opening.

I suggested increasing the size of the opening instead; this would result in a better traffic pattern and give the kitchen a more spacious feeling. It would also let in light from the family-room windows and create a view into the landscaped yard beyond. The owners liked the idea.

The only catch was that the wall carried a large section of roof and was one of the major shear walls in the house.

# Retrofitting an Engineered Shear Panel

Prefab panels made it possible to open up the floor plan by removing part of an interior shear wall

## Need for Shear Walls

Shear walls are designed to resist the forces exerted on buildings by high winds and earthquakes. They resemble regular framed walls but are secured to the foundation with heavy hold-down bolts or straps and are stiffened by a layer of plywood fastened with a specified tight nailing pattern. On the West Coast, shear walls are the main

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**Figure 1.** In the original house, built in the 1980s, a 5-foot-wide doorway linked the kitchen and family room; the author suggested enlarging this opening.

earthquake-resistant component used in residential construction.

We wanted to create a new 9-foot-wide by 8-foot-tall opening in the existing shear wall, which required stamped drawings from an engineer. I faxed elevations of the wall with the existing and proposed door openings to civil engineer Lee McCleary, of Walnut Creek, Calif., who laid out what it would take to open up the wall.

I estimated the cost of the additional work, presented it to the clients, and came away with a signed change order.

**Existing conditions.** The existing shear wall was framed with 2x6 studs and sheathed on the kitchen side with  $\frac{3}{8}$ -inch plywood nailed 3 inches on-center. It was supported by 2x8 joists and a sill that landed on a concrete stem-wall

**Figure 2.** The wall between the two rooms was a shear wall; it's shown here after the soffit and some of the drywall and plywood shear sheathing were removed. The 4x6 post to the left of the opening is tied to the foundation by a heavy cast-in hold-down.







**Figure 3.** Manufactured shear panels are made from either steel or a combination of wood and steel. At far left, Simpson's Wood Strong-Wall panel strengthens and stiffens a wall containing a garage-door opening — a common application. In the project at left, a Hardy panel allows the contractor to include more window area than would be possible with conventional shear walls. In these installations, the panels sit on a mudsill or directly on the foundation.

foundation. In addition to studs and a header, the wall contained three 4x6 posts connected to the foundation with cast-in anchor bolts (Figure 2, previous page). Since they would be in the way of the new opening, the posts and anchors had to come out.

According to McCleary, we could take out part of the wall, but only if we replaced the shear value of the area removed.

### Shear Panels

With the new, wider passageway, only 30 inches of wall would remain at either side of the opening — far too little to provide the necessary shear value with conventional framing. McCleary's solution was to replace the end walls with manufactured shear panels, factory-built wall sections that are significantly

stronger than site-built shear walls.

Shear panels are frequently used in high-wind and seismic zones to stiffen "weak," narrow sections of wall, allowing builders to devote more wall area to door and window openings. While shear panels can be installed almost anywhere in a building, the most common location is in the narrow section of wall on either side of a garage door (Figure 3).

Several manufacturers make shear panels, among them Simpson Strong-Tie, Hardy Frames, Shear Transfer Systems, Trus Joist, and R.H. Tamlyn & Sons. The panels are made from wood with a small amount of steel; from steel with a small amount of wood; or entirely from steel. Stock-size shear panels measure anywhere from 12 to 80 inches wide and from 78 to 153 inches tall. For an extra

charge, most manufacturers will produce custom heights.

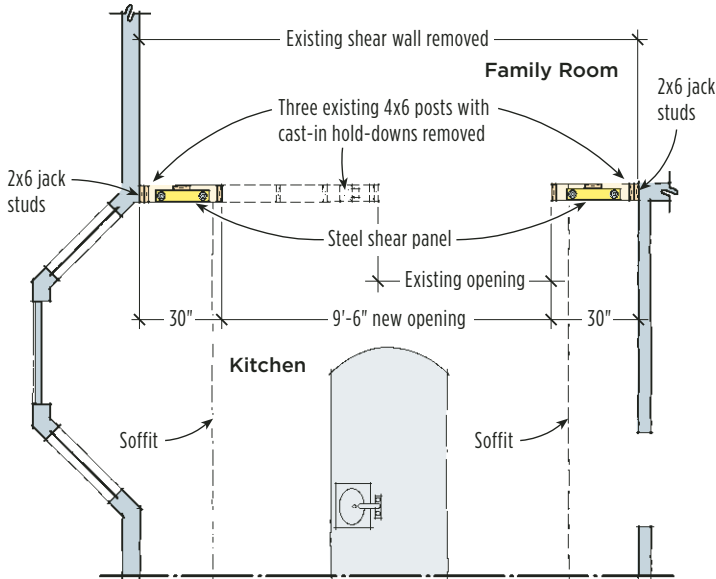
Since tract builders buy panels by the truckload, I assume they get them at a good discount. A small builder should expect to pay \$200 to \$400 per panel at a lumberyard or supply house.

### Design Constraints

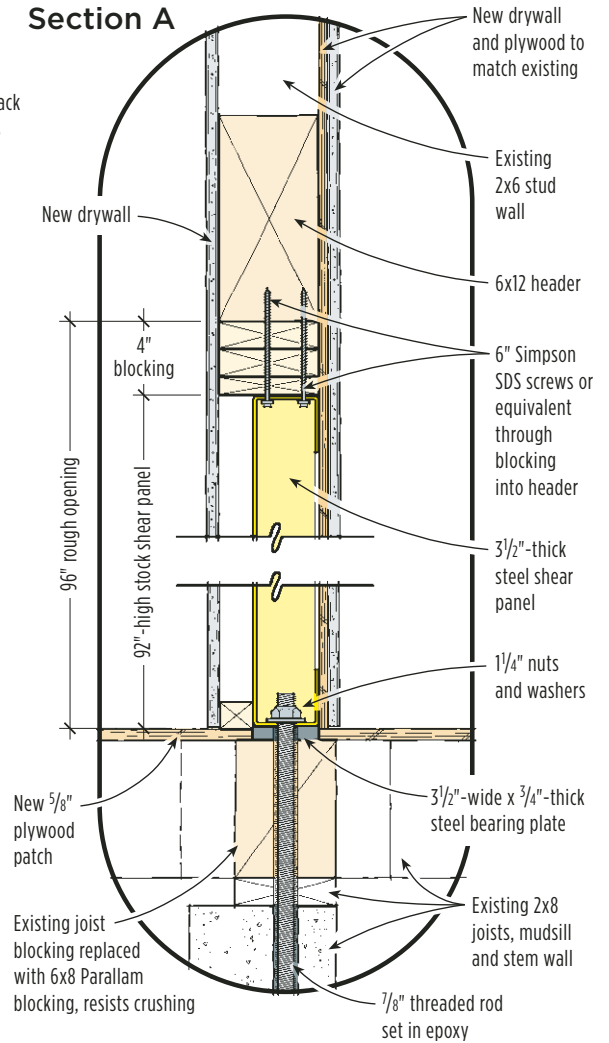
In most instances, shear panels are bolted directly to the foundation or slab, but on this remodel we wanted to attach the shear panels to the wood floor to avoid the complication of cutting out and resupporting joists. Although installation is simpler and shear values are higher when you bolt panels directly to a foundation or concrete slab, floor installations are necessary when you're using panels on the upper levels of multistory buildings.

## Connection Details

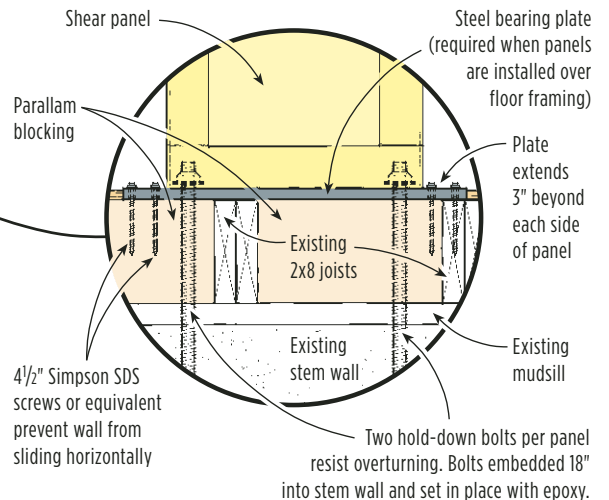
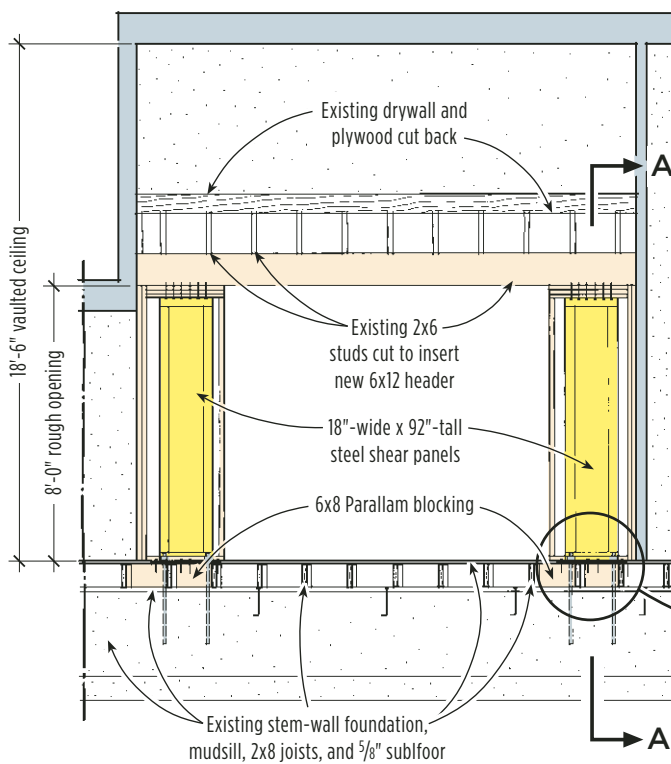
Floor Plan



Section A



Shear Wall Elevation





**Figure 4.** The author's crew used diagonal 2x6 braces to support the load above the shear wall while structural work was under way. To avoid having to maneuver the massive header through the braces, the workers prepositioned it on the floor and built the shoring around it.

At first, McCleary considered using Simpson's Wood Strong-Wall, but when he calculated the load he found that any wood panel wide enough to meet the shear requirement would not fit in the available 30-inch space. And whereas the steel version of this product — the Steel Strong-Wall — was strong enough to work in the available space, it was not yet approved for installation on top of framed floor systems.

**The right panel for the job.** Hence, McCleary specified Hardy Frame Panels, steel shear panels strong enough to replace the missing shear value, narrow enough to fit the space, and rated for use over floors framed with wood or light-gauge steel (see illustration, previous

page). Steel panels are stronger than similar-sized panels made from wood.

Had the end walls in this house been wider, we could have chosen from a variety of wood shear panels, all of which are rated for use over framed floors.

### Preliminary Work

Since we wanted to complete the structural work as soon as possible, we purchased all the materials in advance. Fortunately, they were all stock items: two Hardy Frame Panels, four lengths of 7/8-inch threaded rod, a 6x12 Douglas fir header, a 6x8 Parallam to block joist bays, and multiple tubes of Simpson's Epoxy-Tie Set adhesive.

As soon as we got permits, we began

demolition. We had already removed the soffit and enough drywall to see inside the lower portion of the wall, but we were not certain what was at the top. To be on the safe side, we assumed that the wall carried the roof, and we made plans to shore it up before removing any structural components. First, however, we placed the new header against the side of the shear wall so that the shoring would not interfere with our attempts to maneuver the header into position (Figure 4).

**Shoring and demo.** I picked a height well above where we needed to cut the studs to insert the new header and removed the drywall and plywood below that line. Then we nailed horizontal 2x6



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cleats to both sides of the wall. Next, we wedged long 2x6 supports between the blocks on the floor and the cleats on the wall and nailed them into place. Since the supports came up at an angle, there would be room to work below.

To prevent the supports from bowing, we tied them together with diagonal bracing and ran perpendicular braces to the floor. The shoring did not take long to complete and was quickly approved by McCleary.

The demo work was pretty simple; the wall contained some electrical wiring but no plumbing or ducts. We rerouted the electrical and removed the existing studs by cutting them off at the elevation of the new header. The last step — removing the subflooring from the areas where the

panels would sit — gave us the access we needed to drill holes for anchor bolts and to install new joist blocking.

### Installing the Header

The header was to run the full length of the wall and rest on jack studs at either end. The shear panels would sit directly on the floor framing and be blocked tight to the header above.

Our first task was to lift the 6x12 header into position. To avoid wrenching our backs, we hung a block and tackle from an eyebolt we'd put in the wall and used it to hoist the header most of the way (Figure 5). When the header got close, we used our shoulders to lift one end onto a jack stud. We lifted the other end the same way, but because

cripple studs were now bearing down on the new header from above, we had to angle the jack stud under the header and persuade it into position with a sledgehammer. This brought the header tight to the bottom of the cripple studs, where we secured it with nails.

At this point, the header was carrying the vertical load, but the wall still lacked the necessary lateral stability.

### New Anchor Bolts

Shear panels come in a variety of sizes. The ones we used were 18 inches wide by 92 inches tall and 3½ inches thick; other brands come in both 3½- and 5½-inch thicknesses.

The design called for two hold-down bolts (7/8-inch threaded rod) per panel to



**Figure 5.** The crew used a block and tackle (above) to hoist the header high enough to get a worker's shoulder under one end and lift it onto a jack stud. With cripples bearing down on the header along its span, it was necessary to wedge the other end of the header into position by beating the angled jack stud in with a sledge (right).





**Figure 6.** The crew hit rebar while drilling holes for new anchor bolts. Since moving the holes was not an option, they used this special rebar drilling bit from Simpson to cut through the metal.



**Figure 7.** The rod on the right has already been installed through Parallam blocking and into an 18-inch-deep hole in the concrete foundation below. The glue-coated rod on the left was just removed from its hole so that the author could pump in an additional load of epoxy.

be embedded 18 inches into the foundation stem wall and glued in place with epoxy. With the supplied template, we marked the location of the bolts and used a rotary hammer to drill the required 1-inch holes.

Partway in, we hit rebar. In other circumstances, we might have shifted the

holes, but the bolts for a shear panel must be in precise locations. So, to get through the rebar, we used one of the special rebar-cutting bits sold by Simpson (Figure 6).

**Stronger blocking.** Before drilling holes in the stem wall, we had removed the existing 2x8 joist blocking from under the

areas where the panels would go. This was necessary for a couple of reasons: The blocking would interfere with drilling, and the blocks would not be strong enough to resist the crushing force of the panels when the bolts were tightened.

Once the holes were drilled, we replaced the 2x8 blocks with stronger



**Figure 8.** A carpenter places a required steel bearing plate (above) over anchor rods glued in the previous day. The panel will fit over the rods and land on the plate. At right, the crew wedges the top of the panel against solid blocking on the underside of the header.



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pieces of 6x8 Parallam. The blocks, too, were drilled so that the anchor rod could fit through.

**Special inspection.** In new construction, anchor bolts are positioned before the foundation is poured, so the inspector can see if they are properly installed.

In retrofits, however, the anchors are epoxied into drilled holes, which makes it hard to know how strong the connection actually is.

Our local building department requires a special inspection to verify that new anchor bolts are securely attached.

One option is to hire an inspection company to perform pull tests on bolts after they are installed. Instead, we verified the installation by having the engineer — McCleary — come to the site to watch us do the work.

First, he measured the holes to make sure they were the right depth. After that, we used a Simpson hole-cleaning brush (basically a wire bottlebrush) to knock loose material from the sides of the holes. Then we used a copper pipe connected to a shop vac to vacuum out the debris. We finished by blowing out the holes with a second pipe connected to a compressed air hose.

**Gluing in the rods.** Next, we used a special mechanical “caulking” gun to pump a two-part Simpson adhesive (Epoxy-Tie Set) into the holes. At McCleary’s request, we inserted the rods and jiggled them up and down to clear air bubbles. We also



**Figure 9.** In this view down the open side of the shear panel, the installation is complete; nuts and washers are on the anchor rods, and screws pass through holes in the bearing plate into the joists and blocking below. The upper end of the panel (not visible) is screwed to the header above.



**Figure 10.** The crew completed the structural work by studding in the panels (left) and replacing the missing plywood shear sheathing on the kitchen side of the wall (above).



twisted them in the holes make sure they were completely coated with epoxy (Figure 7, page 7). In a couple of cases, we temporarily removed the rods and pumped in more adhesive.

Once the adhesive was ready, we simply inserted the rods — all the way to the bottom of the holes — and left them alone until the epoxy set. McCleary provided us with a document for the building department stating that the anchors were installed as designed and in accordance with the epoxy manufacturer's specifications.

### Attaching the Panels

The following day, we installed the panels. We began by dropping a thick steel bearing plate over each pair of rods. The bearing plates (supplied by the manufacturer) are necessary when you install Hardy's panels over raised floor systems. Each plate extends a few inches beyond the left and right sides of the panel and has holes through which you are required run a specified number of 1/4-inch-diameter wood screws. The screws prevent the wall from sliding horizontally, and the anchor bolts resist overturning.

Once the plates were installed, we stood the panels up over the bolts (Figure 8, page 8); as expected, the panels stopped a few inches short of the header.

We could have eliminated this gap by ordering taller, custom-sized panels, but that would have delayed the job. Instead, we used stock panels and packed the space above with 2-by blocking before screwing through to the header from inside the panels. This is permissible within specified limits, which vary by brand and model. McCleary told us to use Simpson's self-drilling SDS screws — 6-inch screws in the header above and 4 1/2-inch screws in the joists and blocking below (Figure 9, previous page).

The epoxy set a few hours after we



**Figure 11.** Opening up the shear wall modernized the floor plan and made the kitchen feel brighter and more spacious.

pumped it in place, but it needed 24 hours to fully cure before we could apply pressure to the bolts. A couple of days later, we placed washers and 1 1/4-inch nuts on the bolts and tightened them against the bottom of the panels. After making the mistake of thinking we could find a 1 1/4-inch deep-well socket at an auto-parts store, we ended up having to go back to the shear-panel supplier to get one.

Once we had tightened the bolts, finishing the wall was simply a matter of studding in around the panels and replacing any plywood missing from the kitchen side (Figure 10, facing page). With the drywall on, it looked like any other wall in the house (Figure 11) — when in fact it will be one of the main structural elements holding up the building if an earthquake occurs.

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*Rick McCamy designs and manages residential remodels in Walnut Creek, Calif.*

## Shear-Panel Manufacturers

**Hardy Frames**  
800/754-3030  
[www.hardyframe.com](http://www.hardyframe.com)

**R.H. Tamlyn & Sons**  
800/334-1676  
[www.tamlyn.com](http://www.tamlyn.com)

**Shear Transfer Systems**  
877/743-2762  
[www.shearmax.com](http://www.shearmax.com)

**Simpson Strong-Tie Co.**  
800/999-5099  
[www.strongtie.com](http://www.strongtie.com)

**Trus Joist**  
800/338-0515  
[www.trusjoist.com](http://www.trusjoist.com)