Seismic Support for Old Foundations

by John Scoggins

In the aftermath of California's recent Loma Prieta and Northridge earthquakes, there is a heightened awareness of the need to strengthen existing wood-framed residences. Insurance companies are enforcing stricter guidelines to qualify for earthquake insurance, as well as requiring seismic retrofits before issuing renewal policies. Many cities and counties in California have also adopted new ordinances in their building codes to address seismic safety.

After the 1989 Loma Prieta quake, the average cost to repair houses that bucked off their foundations was $25,000 to $35,000. Many homes were so badly damaged that they were written off completely and had to be demolished. By contrast, the average cost to provide sill bolts and cripple wall bracing to an undamaged house ranges from $1,500 to $2,500. The cost-effectiveness of correcting these deficiencies is indisputable.

The city of Santa Barbara, Calif., where my company does most of its work, has a voluntary residential seismic retrofit program that simplifies the permit process for homeowners. The city offers standard preapproved plans and details that help the homeowner save on engineering costs.

Retrofit Evaluation

When I inspect a house for a seismic upgrade, I start with the foundation. The foundations I see range from poorly mortared sandstone and brick to unreinforced block or poured concrete. In some cases, there is no foundation at all — just a series of wood posts resting on masonry pads set on the ground. (In such cases, it's just a matter of time before the whole house

To anchor sills and stem walls, use special steel connectors and tools designed for tight quarters

is sitting on the ground.)

When there is a foundation, I check the strength of the concrete, block, brick, or stone by drilling a test hole or chipping at the surface with a steel bar. I have to find out if the masonry is hard enough to hold a bolt or other hardware.

Working up, I next explore the condition and placement of existing hold-down bolts attaching the mudsill to the foundation. I also look for rot and termite damage to wood members. In many cases, there are no sill anchors at all; in other cases, the mudsill is too rotten for the anchors to do any good.

Many homes in our area have cripple walls — short stud-framed walls that sit on the stemwall foundation and support the floor framing above. Strong cripple walls are critical for earthquake resistance. Not only must they be anchored to the foundation and secured to the framing above, but they must also receive shear panel sheathing to handle the severe lateral forces that a quake causes. At the top, the cripple wall has to be secured with hardware clips to the floor framing above. I inspect the cripple walls for rot, and make sure they are framed properly to receive shearwall panels.

Probably the most common condition I run into, however, is an unsecured mudsill sitting on a foundation with the floor joists resting directly on it. Such low-clearance situations make retrofit work difficult and typically require special hardware.

The Basic Retrofit

Once I have defined the problem, the next step is to choose the proper metal connectors to tie the foundation to the mudsill or cripple wall plate.

Every retrofit job is different. Let's look at a basic job first — a firm masonry foundation with a sound cripple wall, having insufficient anchors but plenty of room to work. For areas that can be easily reached by an impact drill, we typically drill 5/8-inch holes through the plates and about 4 1/2 inches into the foundation. We then insert lengths of 1/2-inch threaded steel rod, epoxied into place (see Figure 1). This is the least expensive solution.

Advantages of epoxy. Because most of the foundations we see are made of old concrete, we prefer the epoxy anchoring system to expansion bolts, which might crack the stem wall as they expand. We use Simpson's Epoxy-Tie Adhesive Anchor system (Simpson Strong-Tie, 4637 Chabot Dr., Suite 200, Pleasanton, CA 94588; 800/999-5099). The epoxy costs $22 for fifteen 5/8-inch-diameter holes. The dispenser costs over $100, but can be rented for around $5 a day.

Before epoxying either threaded-rod or the Simpson anchors, it is important to clean out the predrilled holes. We scrub the hole with a nylon brush and then blow out the residue with compressed air. The hole

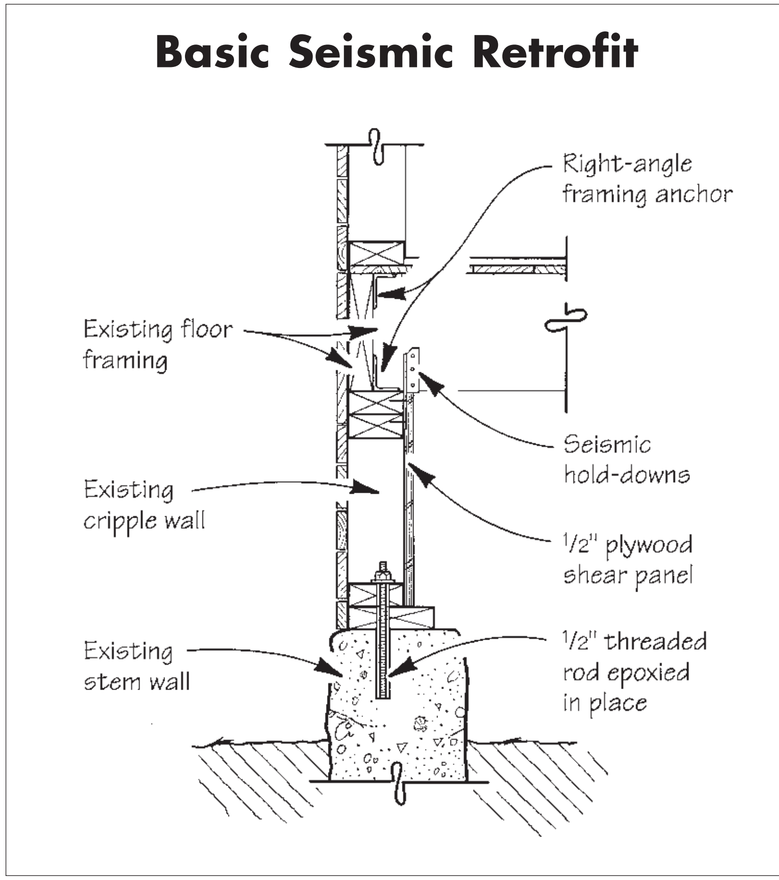

Figure 1. Where there is good access, the least expensive retrofit involves threaded rod anchors epoxied in place, plywood shear paneling, and framing anchors between the top of the cripple wall and the floor framing.

Figure 2. The Simpson FA series anchors are useful in tight quarters for anchoring the mudsill to the foundation wall. The side plate bolts to the foundation wall with epoxied threaded rod; the top can be nailed with a palm nailer.

Pouring a New Stem Wall

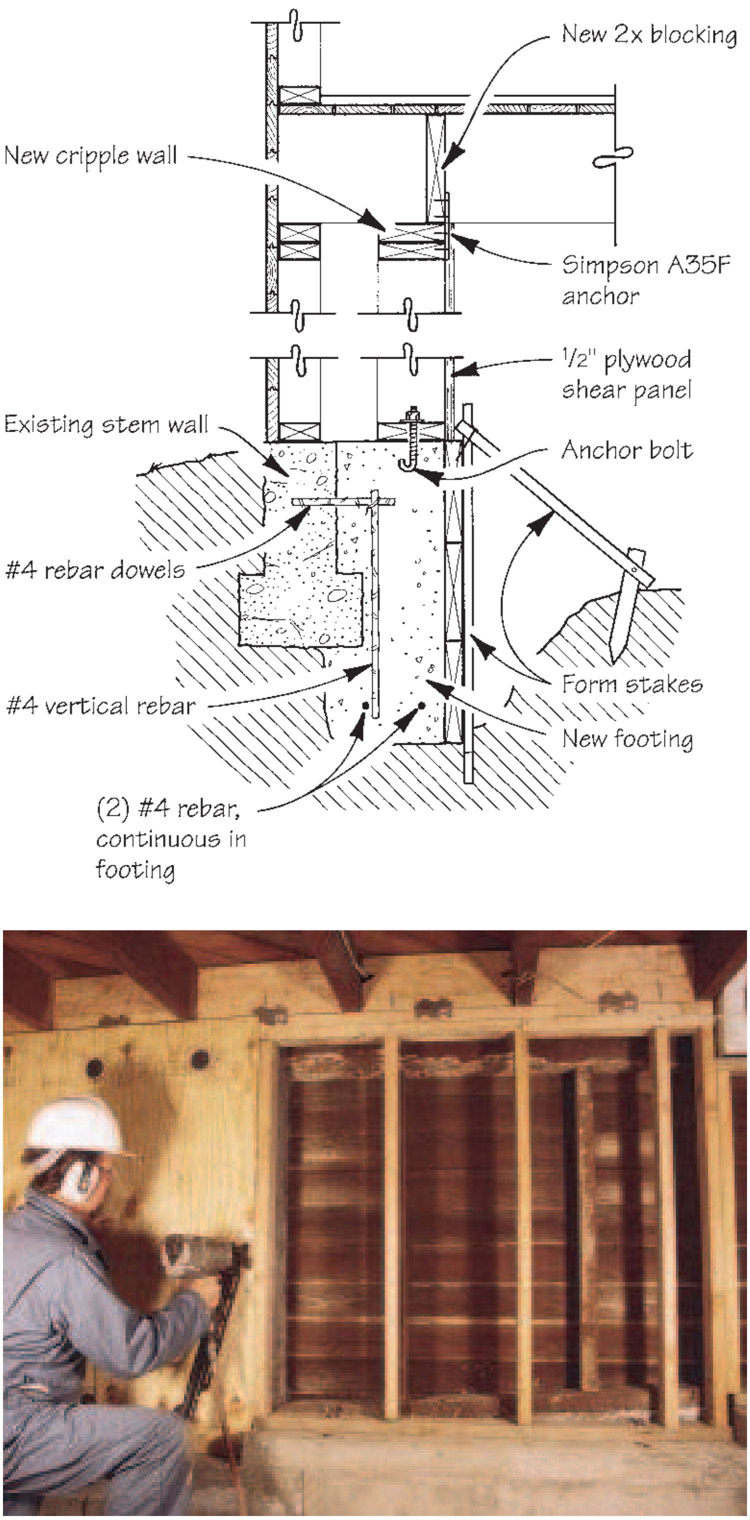

Figure 3. In cases where the old foundation is too weak to hold anchors, it's necessary to pour a new wall. In the case shown here, a new stepped stem wall was poured tight to the existing one, with new cripple walls built on top. Simpson A35F clips secure the cripple wall to solid blocking between the floor joists above (see photo).

must be perfectly clean: Any dust will reduce the epoxy's bond. It's also important to monitor the mixing of the two-part epoxy. A consistent gray color indicates a proper mix, which means the epoxy will cure to full strength.

After filling the hole half full with epoxy, we insert the anchor and slowly turn it until it contacts the bottom of the hole. We wait a full day until the epoxy cures before disturbing the anchor.

Cripple Walls

Once the epoxied anchors are in place and the sill is bolted down, we turn our attention to the cripple walls. Here, we follow the guidelines provided by the City of Santa Barbara, which recommend that 4-foot-wide 1/2-inch structural sheathing be installed at corners and every 25 feet along the house's length. Shear panels are also installed at the sides of any access doors or vent openings. The city also recommends that the length of each shear panel should be at least twice its height. The required fastening schedule is 8d nails 6 inches on-center on the edges and 12 inches on-center in the field. This work goes quickly with a pneumatic nailer.

The next step is to drill 3-inch holes into the plywood at the top and bottom of each stud bay to allow for ventilation. To keep rodents out, we cover the holes with 1/4-inch hardware cloth.

Finally, at the top of the cripple wall, we usually install Simpson H1s or H5s to every other joist to secure the floor framing to the cripple wall plate.

Limited-Access Retrofit

Limited access — when an unbolted sill sits right on top of the stem wall in a tight crawlspace, for instance — usually dictates the use of more expensive connectors.

Occasionally, we get lucky and find that the floor is framed with 2x12 joists. This gives us enough room to use our Hilti TE15 right-angle hammer drill in the restricted area between floor and plate. Then we can drop in an epoxied threaded-rod anchor or a Simpson RFB retrofit bolt. More often, however, the joists are smaller, so we have to use a Simpson FA6 or FA8, an L-shaped 12-gauge steel connector that rests on top of the plate and laps over the side of the stem wall (Figure 2). This configuration allows us to drill into the concrete horizontally, instead of having to position the drill upright. The top of the FA anchor can be nailed to the plate with a pneumatic palm nailer.

These FA anchors aren't cheap; they cost around $6 to $8 each, so we try to limit the number we use. Plus, they require us to drill two holes, whereas dropping in threaded rod requires only one hole. But in tight quarters, there's no better choice.

Pouring a New Foundation

Unfortunately, sometimes the foundation isn't stable enough to hold bolts, so we have to pour a new concrete stem wall. A recent retrofit job illustrates the point. When I first visited this residence, I was pleased to find two rare conditions for a retrofit —- a very comfortable clearance and a lighted crawlspace. The owner wanted recommendations for strengthening the subfloor framing and a labor-and-materials bid for bolting his cripple walls to the existing concrete foundation.

This particular house sat on a sloped lot, but instead of stepping the foundation, the builder simply sloped the stem wall to follow the grade — making it much more vulnerable to slipping in a quake. The cripple walls were inadequately bolted and unbraced. Even worse, the foundation concrete had been mixed with unwashed aggregate and beach sand and was in very poor condition. It was obvious the existing concrete would not hold an anchor bolt, let alone hold up under seismic stress.

One alternative was to raise the house on large steel I-beams, remove the existing foundation, then form and pour a new one — an expensive proposition. But once we determined that the existing floor was level, we decided instead to pour a new stepped foundation tight to the inside of the existing one (Figure 3).

We first excavated for a new footing, slightly "undermining" the existing footing. Then we drilled and placed #4 rebar dowels in the old stem wall on 4-foot centers. In the new footing trench, we installed continuous #4 rebar around the perimeter, and attached it to the dowels with short vertical pieces of rebar.

After pouring the new foundation, we plated and framed new cripple walls around the perimeter. These were bolted to the new foundation with standard 5/8-inch J-bolts. To connect the floor to the new cripple wall, we blocked between the existing floor joists directly over the cripple wall and used Simpson A35F metal brackets to connect the blocking to the double top plates. We covered the cripple wall with 1/2-inch structural-1 plywood edge-nailed 6 inches on-center, with 12-inch centers in the field.

Posts and Piers

Many of the houses we work on have a center girder supported by a series of posts and piers. The posts are typically resting on the piers with no mechanical anchor and are attached to the girders above with nails only. In that case, we install new 2-foot-square by 1-foot-deep pier footings between existing posts. We also replace any posts located under girder splices.

To form the new pier footings, we lay a grid of four #4 rebar pieces beneath a precast block that comes with embedded straps for attaching to the post (Figure 4). After pouring the new piers, we install new posts, strapped at the bottom and connected at the top with a plywood gusset. Finally, we use Simpson H-series clips to tie the floor joists to the girders. ■

Reinforced Post Footing

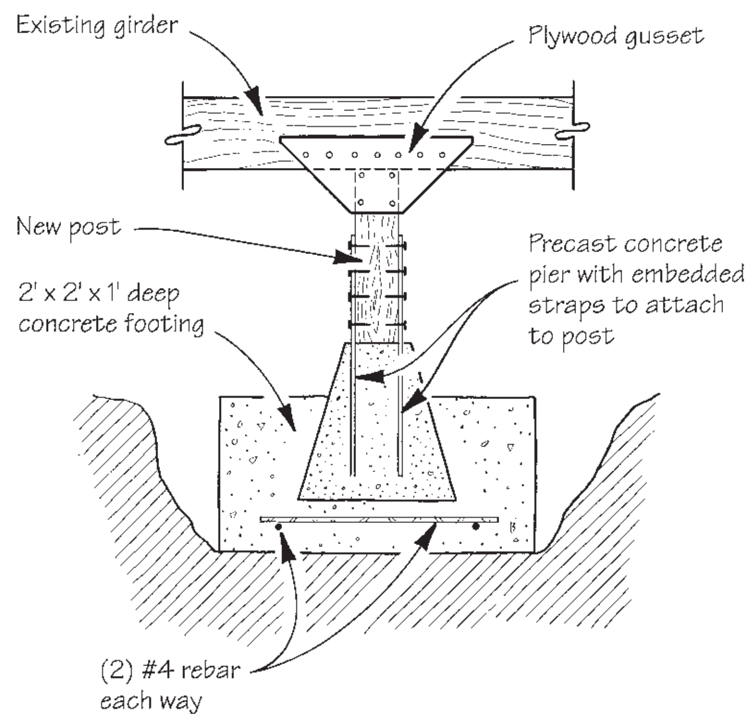

Figure 4. New post-and-pier supports are built in place using precast pier blocks set in a 2-foot-square concrete footing. Note how the original post, at right in the photo, has no mechanical anchorage.

__John Scoggins__ is a field representative for Allen Associates, a remodeling and home-building company in Santa Barbara, Calif.