Replacing a Slab Foundation

When the original builder flubs a foundation, someone else has to clean up the mess

by Mark Reinmiller

As an engineer specializing in residential construction and repair consulting, I'm often called upon to help contractors faced with difficult structural problems. In one recent project, I was asked to develop a repair plan for a 30-year-old house in a suburb north of Philadelphia that had some serious long-term settlement problems.

The main portion of the house was built over a full basement, with an attached garage on a slab. A laundry room, powder room, and family room had been built on a second slab, behind and several inches higher than the garage slab.

The foundation beneath the main-house basement was solid, as was the perimeter foundation under the garage. (We later learned that the footings for the perimeter walls were as much as 7 feet below grade — several feet deeper than usual for this area.) But the slabs in the garage section had been poured over a thick layer of uncompacted fill left over from grading the lot. Over the years, the concrete as well as the drive had settled 3 to 8 inches, leaving the steel-mesh-reinforced slabs intact but suspended from their edges like trampolines in a frame.

The sinking garage slab had left a huge gap at the base of the garage doors (**see Figure 1, page 2**), and the doorway from the main house to the laundry room was so badly distorted the door would no longer open, forcing the homeowners to gain access by walking around through the garage. The settlement was also responsible for a pronounced sag in the second-story master bedroom above the garage.

Figure 1. Careless site preparation at the time of construction left this 30-year-old home with a sinking driveway, a cracked and leaking sewer line, and failed slabs in the garage and the family room behind it (top). The gap beneath the garage door (above left and left) was a full 8 inches high at the right-hand side. At the back of the garage, the laundry-room wall was separating from the slab (above).

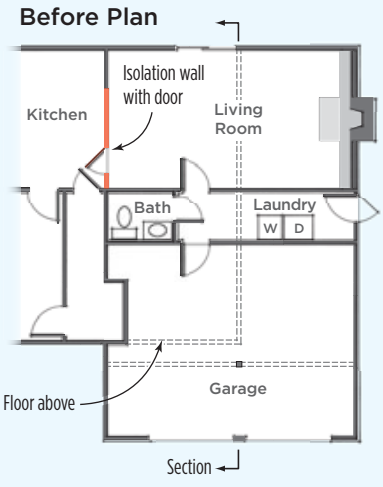
Taking Stock

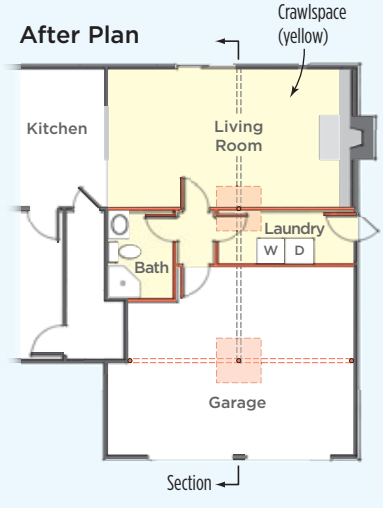
To see what was going on beneath the garage slab, we made two holes in the concrete and took a series of flash images in all directions with an ordinary handheld digital camera. It's an extremely simple method, but I find that a digital camera often works better than a flexible micro-inspection camera like the Ridgid SeeSnake, which has such a small field of view that it can be hard to tell what's going on. The camera flash lights up a wide area and provides clear images that can easily be saved to a computer.

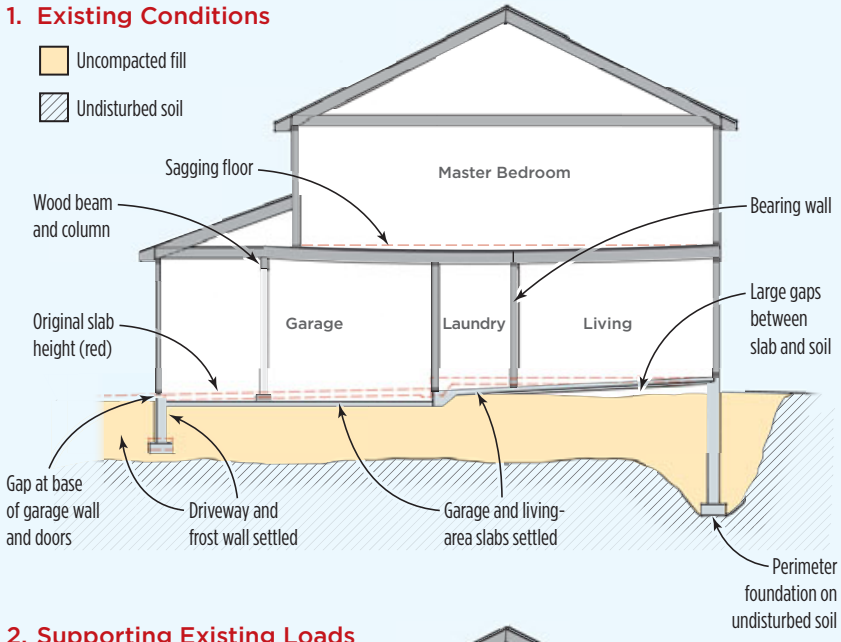
In addition to confirming a wide gap between the soil and the slab, the images revealed that the drain to the powder-room basin had separated from the building sewer line (**Figure 2**). This wasn't much of a surprise, since an earlier video inspection by a plumbing contractor had already shown that the sewer line sloped back toward the house, leaving it prone to backing up. When we eventually dug out the soil around the pipe, we found that the cast-iron sewer line was sheared completely in half where it passed through the garage. Fortunately, the broken ends must have remained in close contact with one another, because there was no obvious sewage odor, even though

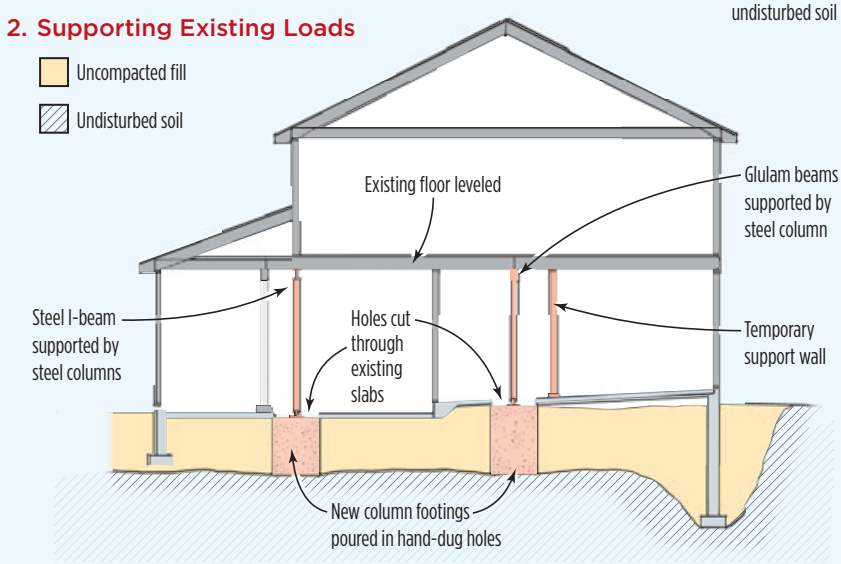
Figure 2. With the drywall stripped from the laundry-room and family-room walls, the sag in both slabs is evident (left). Note the inspection hole in the concrete, which allowed the author to take this photo (right), which shows a large gap between the slab and the soil beneath and, at the back, a disconnected waste line.

Before the contractor could remove and replace the settled slab, he had to support the second-story loads. He did this by cutting through the slab in two places, placing footings on undisturbed soil, and posting down from above. This also provided an opportunity to correct a misplaced load path by positioning a new steel I-beam in the garage ceiling directly under the master-bedroom wall above (the original beam was offset by 2 feet). Once the new supports were in place, the slab was demolished and replaced, with a new slab in the garage and a wood-frame floor over an accessible crawlspace in the living space.









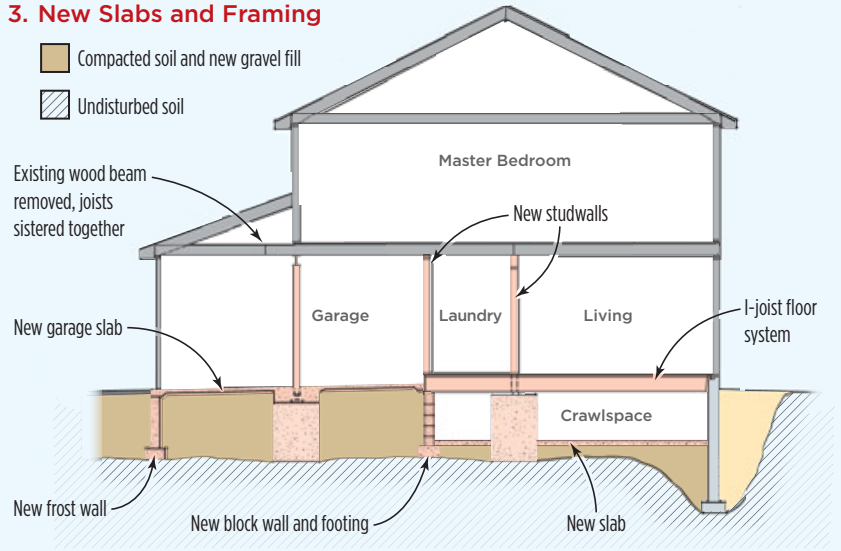


Figure 3. To prevent demolition dust from spilling into the living space beyond (left), the contractor built a temporary wall with a passage door (right).

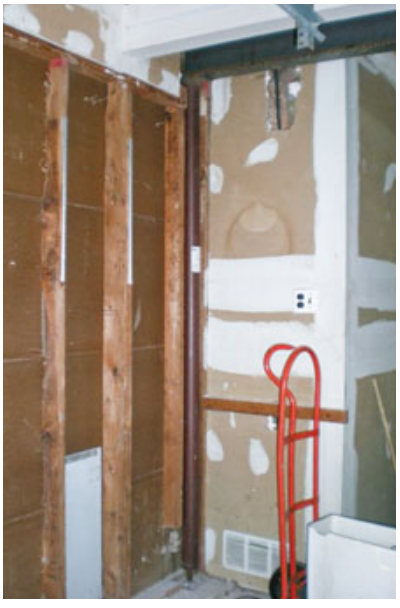


Figure 4. This drywall-covered built-up wood beam (top) was offset 2 feet from the front eaves wall it was meant to support. To correct the faulty load path, a new steel I-beam, supported by steel posts at each end (right), was installed in the correct place. A new footing was poured for a steel post at midspan (above).

the surrounding soil was very wet.

Bad bearing. The initial investigation also revealed that there was no footing under the studwall between the laundry room and the family room; this wall carried the floor load from the bedroom overhead. And we found that a wood girder in the garage ceiling that was supposed to carry the second-floor eaves wall was actually 2 feet in front of it, placing a large point load on the upstairs floor joists. A column at midspan was bearing directly on the sagging slab below, without benefit of a footing.

New Footings and Beams

The unsupported garage slab obviously needed to be replaced, and the second-story loads would have to be to be shifted to suitable footings. We considered trying to save the family-room floor slab, but ultimately decided to remove it, too. The homeowners reported that the space was cold in the winter, so we suspected that the heating pipes beneath the slab had been damaged, and perhaps the drainage and water-supply pipes as well.

After exploring several options, we decided to break up and remove the existing slabs and excavate the loose fill beneath. Once we reached undisturbed soil, we'd pour a strip footing and build a new foundation wall at the back of the garage. We'd then fill the garage area with

clean compacted gravel and pour a new slab. On the other side of the new foundation wall, beneath the laundry room and family room, we'd leave a crawlspace and frame a new floor system above (see illustration, page 3).

Working in an occupied house while performing a major renovation can be a hassle for everyone. In this project, the kitchen in the main part of the house opened directly onto the family room. To prevent the demolition and excavation from spilling into the kitchen, we first framed a wall between the rooms and sheathed it with OSB (**Figure 3, page 4**). Portable ventilation fans in a sliding-glass door opening at the rear of the family room and in the laundry room helped control exhaust fumes from the equipment used during excavation.

Steel in the right place. The first order of business, before we could begin excavating, was to get the second-story loads onto proper footings. We started with the front eaves wall. The fact that the original carrying beam was in the wrong location worked in our favor, since it allowed us to put the new beam in place without having to remove the old one.

We thought about going with a steel I-beam beefy enough to span the entire 20-foot width of the garage, but the large beam required would have been too difficult to jockey into position. Instead, we chose a beam big enough to support just the dead load over the full span. Once it was in place, supported by steel columns at each end, the excavation contractor cut through the existing slab and hand-dug a hole for a footing at midspan, finally reaching undisturbed soil 54 inches below the slab (**Figure 4, page 4**). After pouring the concrete, we placed a new steel column that broke the span in half so the new I-beam could safely carry the combined live and dead loads.

With the front of the second floor supported, we turned our attention to the bearing wall between the laundry room and family room. We felt that cutting through the slab to install a continuous footing would be too risky, because it would leave the second-floor joists without adequate support while the work progressed. Instead, we built a temporary support wall parallel to the existing wall, about 2 feet away. Like the original wall, the temporary wall rested directly on the sagging slab, but it was nailed to a heavy pressure-treated plate to distribute the load as uniformly as possible (**Figure 5**). We then removed the old wall, cut through the slab and poured a new footing, and supported the floor loads with a pair of glulam beams that butted together over a new column at midspan. We considered using another full-length steel beam, but decided, given the relatively confined space, that it would be much more difficult to maneuver than a pair of glulams. Also, the glulams were easier to integrate into the wood frame walls at each end.

Once the second floor was fully supported, the temporary wall was dismantled and we began to remove the slab so we could excavate the unconsolidated soil underneath.

Figure 5. Before removing the improperly supported bearing wall in the family room, the GC built this temporary support wall (top). Note the wide bottom plate, meant to spread the load as much as possible over the settling slab. Once the bearing wall was gone, a pair of glulam beams was installed overhead, supported at midspan by a steel post on a new footing (above).

Figure 6. With the second-story loads permanently supported, slab demolition (above left) and excavation (above) could take place. Because the exterior framing sat on top of the slab, it was simpler to cut the concrete cleanly at the inside edge of the perimeter wall. The weight of the brickwork above the family room hearth (left) proved sufficient to hold the hearth extension in place until new support walls could be provided in the crawlspace below.

Figure 7. A new steel-reinforced footing, anchored to holes drilled in the existing perimeter wall (above left) supports a block foundation wall between the laundry room and garage (above). An access opening between the new crawlspace and the existing basement (left) was cut with a concrete saw equipped with a diamond blade. Note the sump cover.

Figure 8. The existing hearth extension gained additional support from a pair of short block walls and the short steel column visible at far right of photo (above). The column's upper end was tightened against the cantilevered section of slab; a few squirts of polyurethane foam prevent squeaks between the slab and the OSB floor sheathing (above right). After the new laundry and family-room floor was framed and sheathed, the garage area was backfilled with compacted gravel in preparation for the new slab (right).

Demolition and Excavation

Dealing with the garage slab was a straightforward matter of breaking it into manageable chunks with demolition hammers and hauling away the rubble (**Figure 6, page 6**). But removing the laundry-room and family-room slab was complicated by the fact that its edges extended over the top of the side and rear foundation walls. Both the exterior wall framing and the fireplace brickwork at the end of the family room sat on top of the slab, and removing that portion of it would add a lot of work and expense.

Instead, the mason's crew cut the slab as close to the inside face of the exterior walls as possible. After making an initial cut with a gas-power concrete saw, they trimmed it back closer to the wall with an electric concrete saw. This left a suitable ledge for the sill plates that would later support the family-room floor joists.

We wanted to save the fireplace hearth extension, which was in pretty good shape. I suggested supporting the hearth with temporary supports before the slab was removed. But the mason thought that the weight of the fireplace bearing on the outer edge of the slab would be enough to hold it in place while we worked around it, and was willing to rebuild the fireplace if events proved him wrong. He was right.

Once both slabs were hauled away, the crew excavated the soil below the floor slabs with the aid of a skid steer and a small backhoe. We then poured a steel-reinforced footing and built a block wall at the rear of the garage to provide support for the new floor joists and to separate the crawlspace from the fill below the garage floor slab (**Figure 7, page 6**).

Finishing Up

After replacing the damaged cast-iron sewer pipe with PVC, we filled the excavated area below the old garage slab with crushed stone, applied in lifts and thoroughly compacted with a plate compactor. A new frost wall was also poured at the front of the garage.

In addition to pouring a new garage slab, we poured a second slab in the new crawlspace, and provided access by cutting an opening from the adjoining basement with a concrete ring saw (**Figure 8**). The masons also built two short support walls beneath the cantilevered hearth extension, adding a steel column at the one unsupported corner for good measure.

The new floor system above the crawlspace was framed with I-joists. At the garage end, they sit on the new garage wall and are closed off with a pressure-treated lumber header; at the other end they're supported by top-mounted joist hangers and a ledger fastened to the original perimeter wall.

All of the structural work was completed in approximately three weeks, with the remaining carpentry and finish work taking three additional weeks. The owners were very happy with the results.

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