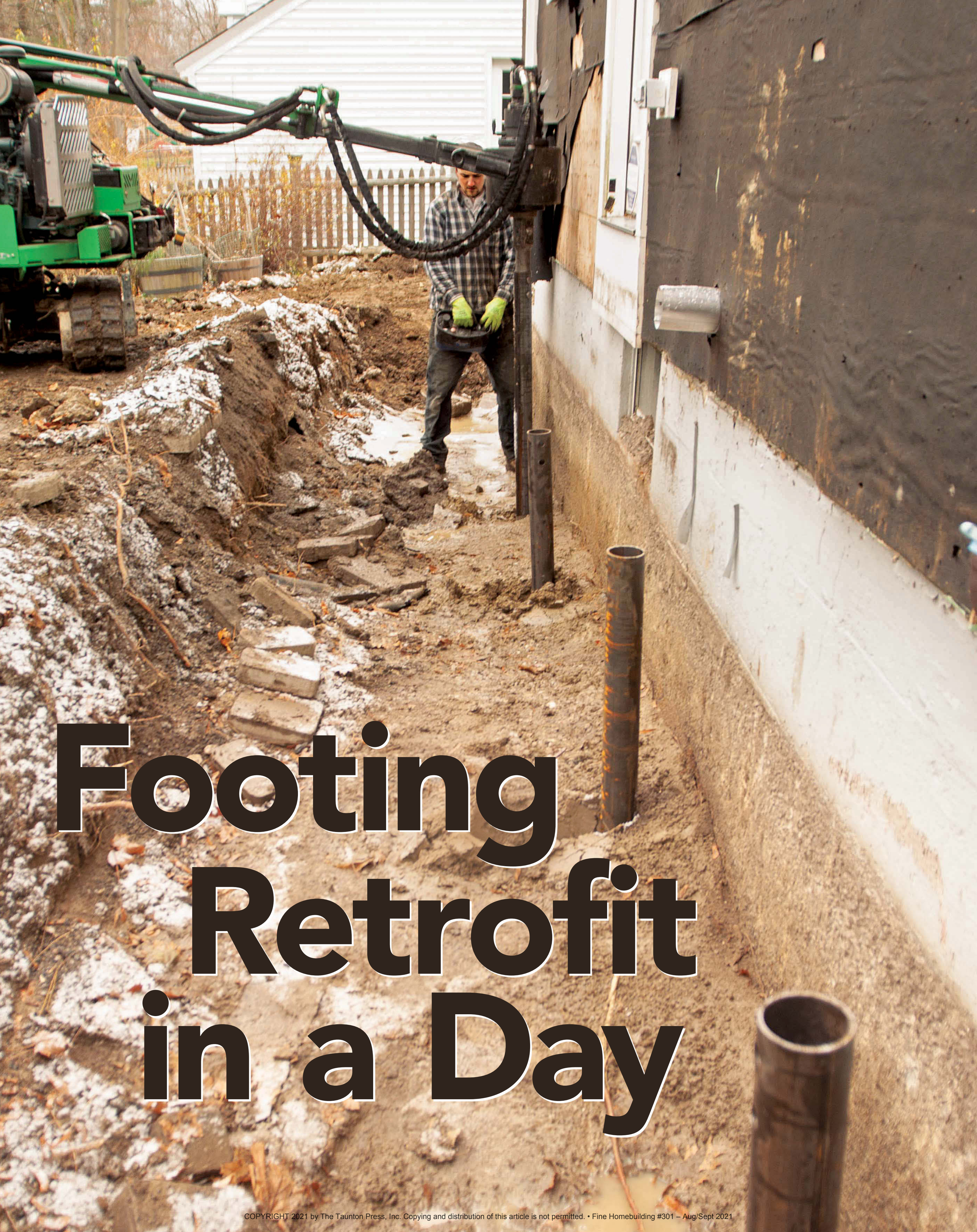


Footing Retrofit in a Day

Using helical piers to add footings to an old house is faster, less disruptive, and comparable in cost to excavating and pouring concrete

BY DAN KOLBERT

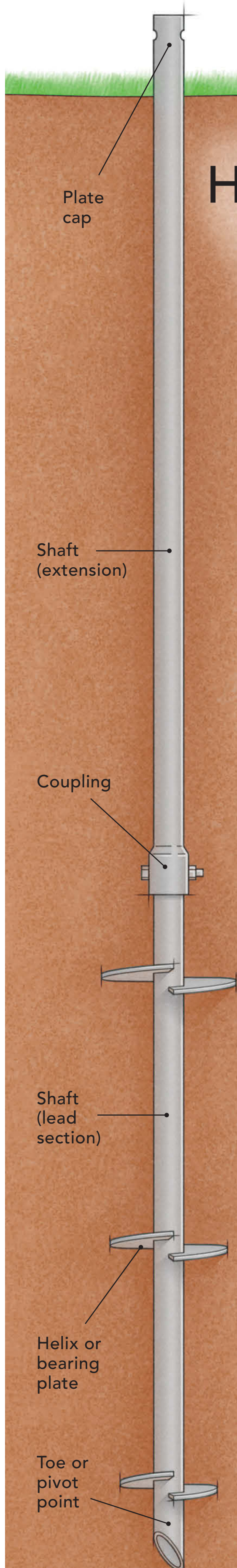
Maine has the oldest housing stock in the country, so dealing with hidden conditions before we can start with the contracted work is par for the course. At best, this means some wiring needs to be updated during a kitchen remodel, a header needs to be beefed up, or we run into some rot when replacing windows or doors. It's not uncommon, however, for us to find that more costly structural issues need to be addressed. Worst-case scenarios often involve the foundation.

When the problem is all the way down at the footing, the work is usually riskier, dirtier, and more expensive than a lot of other repairs. This helical-pier solution to a footing retrofit solved for two of those challenges—we didn't have to shore up the house or worry about trench safety, and we didn't have much digging to do. The cost was about the same as retrofitting a concrete footing, but the work got done faster and less intrusively.

Support for additional loads

We'd been hired for an "add-a-level," turning a 1951 Cape with an unfinished attic into a two-story home with a big mono-pitch roof. Most of the structural work was straightforward—we were using clear-span I-joists to frame the new second-story floors and the same for the new roof rafters. This means that all the additional loads were on the existing bearing walls. Joe Leasure, our structural engineer, gave us specs for the headers we needed for the increased load, which we met by adding jacks to the existing headers and hiding new LVLs in the rim of the second floor. Leasure also told us to inspect the footings before starting the project.

We were planning to rent an excavator to help with the roof demo, so we waited until we had it on-site to check out the footings. I haven't dug out very many existing foundations, so I didn't have any idea of the likelihood of our foundation meeting what we typically assume to be required in our area—concrete footings at least 16 in. wide by 8 in. deep, set on clay with a bearing capacity of 2000 psf (lb. per sq. ft.).



HELICAL PIERS ARE LIKE BIG SCREWS

There are technical differences between ***pier foundations*** and ***pile foundations***. One is depth. Piles tend to be used in situations where little bearing capacity is found in the first few feet of soil and an atypically deep footing is necessary. For all but the trickiest sites, piers are more common in residential construction. Nevertheless, you may hear the terms used interchangeably, particularly in the case of helical piers, also called helical piles. That's because they are often used in situations where deep footings are needed in commercial construction.

Helical piers are not a new technology, but have been slow to be adopted by residential builders. That may be changing as more dealers and franchises come online. Helical piers can be used as footings for decks, as footings beneath new homes, and for repair work, as shown here. They are quick to install, disturb the site very little, and can be sized to support just about any load.

A helical pier is like a big screw with a shaft and bearing plates. Soil conditions and loads determine the necessary depth of the pier and diameter of the helixes, also called bearing plates. Helixes are only found on the lead section of the pier, and extensions are added when needed to drive the pier deeper. Bearing capacity can be verified by the amount of torque required to drive the pier during installation. At the top of the pier is a cap to which various heads can be attached. Usually welded to the cap or somewhere along the shaft, the head may be a bracket that can be bolted to a foundation, like the ones shown here, or it could be a base for a deck post, for example. *—Brian Pontolilo, editorial director*

For more on helical piles, see "It's Time to Consider Helical-Pile Footings," on Finehomebuilding.com.

Drawings: Peter Wojcieszek

PIER INSTALLATION, STEP BY STEP

Helical piers can be a one-stop solution for footings. The same company that installs the piers may also do the engineering. And they'll likely get the job done in a day, as was the case with this footing retrofit.

PILE DRIVER
Helical piers are installed with a hydraulic machine that screws the pier into the ground. For most residential jobs, a small machine can be used, which makes site access possible for many applications.

ANGLED IN
Because the crew is working tight to an existing home, the piers are driven on an angle for proper placement. When the full depth of the pier is reached, the top is pushed toward the foundation.

TORQUE CONTROL
The installer controls the machine from a handheld device and can even monitor torque to verify the pier has reached the necessary bearing capacity.

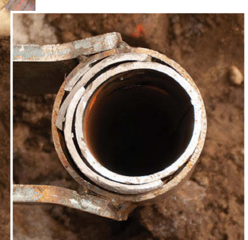
Unfortunately, we discovered that not only were our footings not up to spec, they were nonexistent. The house showed no signs of movement or cracks, so it seems the foundation had worked for the existing structure. But we couldn't add more load onto it safely.

We could have retrofitted conventional concrete footings to meet the required load, but the one time I did that—on a 19th-century brick warehouse—we had to work around the building in a pretty labor-intensive process. To avoid undermining the foundation, we dug out and exposed 2-ft. sections of the bottom of the wall, left 2 ft. of undisturbed earth, dug out another 2 ft., left 2 ft., and so on, all around the perimeter. Once we had poured the new concrete footings in the excavated sections, we started again on the areas we had left to support the building as we worked.

I didn't want to go through all of that work again on this project, and even if we could have maneuvered an excavator into the small backyard, the owner did not want us to dis-

MOUNTING BRACKETS
A large bracket is slipped over the top of the helical pier. The crew uses a hammer drill to drive pilot holes and then bolts the bracket to the foundation with concrete anchors.

TOPPED OFF
The pier is cut flush with the top of the bracket with a portable bandsaw.



WELDED ON
The filler material is added for a tight fit, and the bracket is welded to the pier for a strong connection.

turb their gardens. That's when I remembered my experiences with helical piers: We built a small guest house in a flood zone on helical piers to avoid having a basement in a risky location. We also used them for project involving a bathroom addition on an urban house with mature plantings. And I knew, from a friend who installs helical piers in Alaska, that they are often used to repair foundations damaged by earthquakes and melting permafrost.

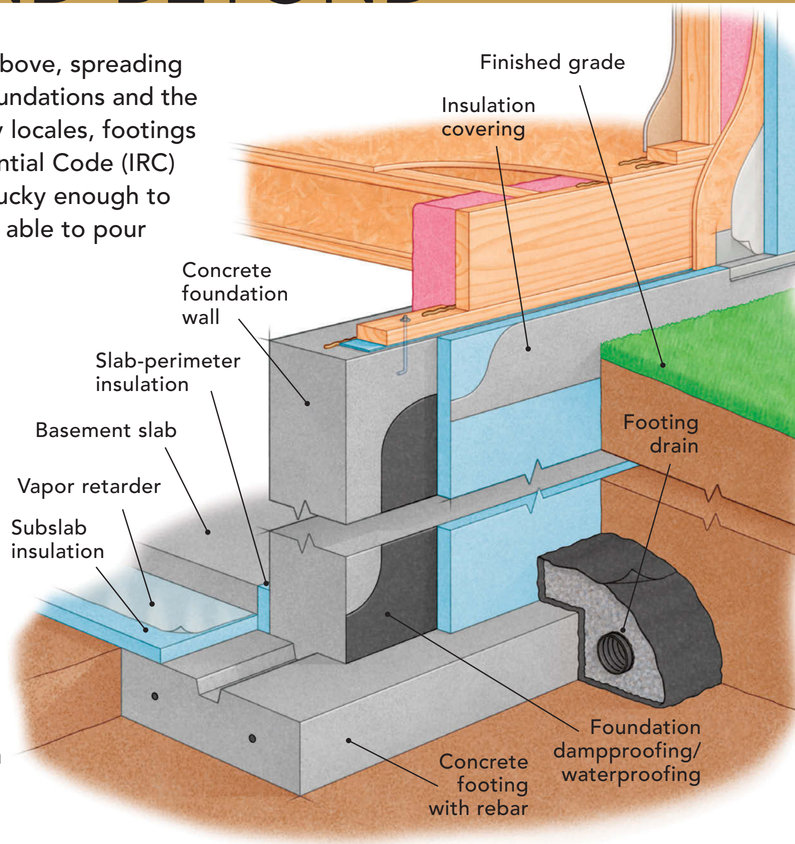
So I called Michael Brochu, who installed the piers on my other projects. He owns the Maine franchise of Quebec-based Techno Metal Post (TMP). They have franchises in nine countries in Europe and North America, with in-house engineering to help with projects.

Piers and brackets do the trick

Brochu started by driving a sample pier. The bearing capacity of a helical pier is determined by the diameter of the helix and the measured torque required to drive the pier. With

FOOTING BASICS AND BEYOND

Footings support foundation walls and the weight of the building above, spreading the load of the structure evenly on the soil below and preventing foundations and the structures they support from buckling, sinking, or cracking. In many locales, footings are made of steel-reinforced concrete, but the International Residential Code (IRC) also allows footings to be made from crushed stone, and builders lucky enough to be working in parts of the U.S. with predictably stable soils may be able to pour extrathick foundation walls and skip separate footings altogether.



Poured-concrete footings

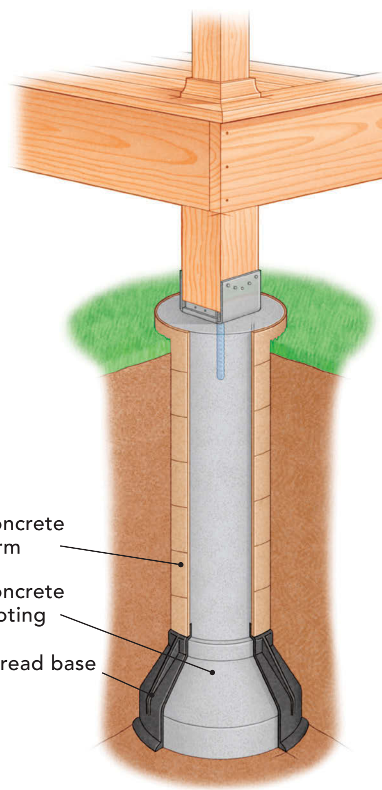
Frost-depth steel-reinforced concrete footings are common in many parts of the country, particularly beneath basement foundations as shown here. Water-management strategies and insulation levels will vary by site and climate zone.

Soil type is an important consideration

Footing design springs from two variables: the weight of the structure and the bearing capacity of the soil. The heavier the building and the lower the capacity of the soil, the beefier the footing must be. As spelled out in Section 401 of the IRC, the presumed load-bearing capacity of soil ranges from a high of 12,000 psf (lb. per sq. ft.) for crystalline bedrock to as little as 1500 psf for clay and certain types of silty soils. When a building inspector suspects that the bearing capacity is less than 1500 psf, a soils investigation may be required.

Depending on the number of stories, the weight of the walls, snow loads, and the bearing capacity of the underlying soil, concrete footings for light-frame construction can range from 12 in. by 6 in. to 30 in. by 10 in. At the extreme end of the scale—a three-story house with masonry walls, snow loads of 70 psf, and poor soils—concrete footings may be as massive as 49 in. deep and 19 in. wide. The IRC requires that footings be no less than 12 in. below undisturbed ground and placed below the local frost line.

The code also permits crushed-stone footings. As with concrete footings, the bearing capacity of the underlying soil and the weight of the structure guide design. Crushed-stone footings for a two-story house—assuming the light-frame walls of the house weigh 1800 lb. per ft.—range from 6 in. by 15 in. to just 4 in. deep and 13 in. wide, depending on the soil. The crushed stone must be consolidated with a plate vibrator in lifts no deeper than 8 in. Crushed-stone footings are what Superior Walls likes to see for its precast concrete wall sections. They're also used for permanent wood foundations.



Concrete-pier footings

Commonly used for decks and porches, poured-concrete piers can also be used for frost-depth footings for homes and other buildings. A spread base may or may not be needed depending on soil bearing capacity.

Let experience and location be your guide

Rhode Island builder and editorial advisor Mike Guertin is often able to do his own soil tests with the help of a penetrometer (a device that measures soil strength), or he relies on published soil classifications for the area. Soils in the areas where he's used to working generally don't require the help of an engineer, so Guertin takes his cue on sizing footings from the prescriptive tables published in the IRC. In some situations, soil conditions are such in Rhode Island that Guertin can pour a 12-in.-wide foundation wall without separate footings. Walls might be poured on a 6-in. bed of crushed stone, or simply on undisturbed soil. With the right soil conditions, the 12-in. width of the wall meets the minimum footing requirements in the building code.

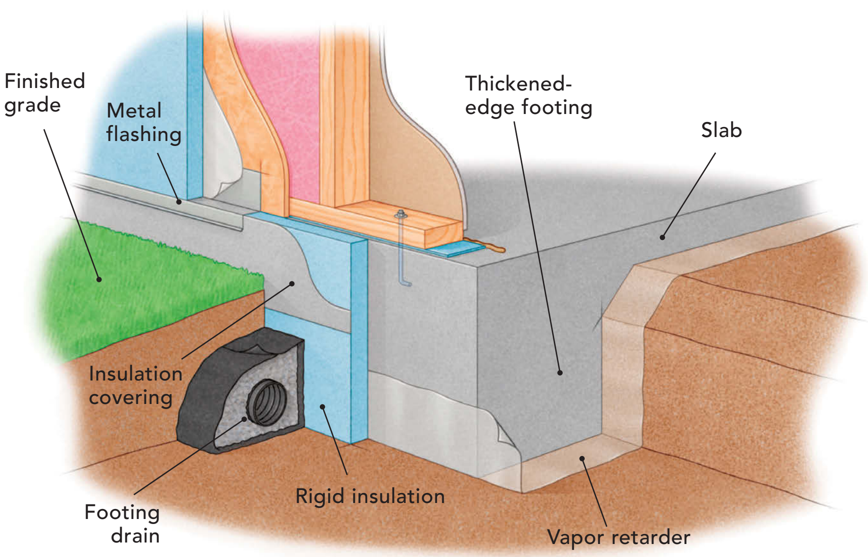
If Guertin is building houses on easy street, consider the difficulties that Texas-based designer Armando Cobo routinely faces in coming up with footings for the extremely expansive soils in parts of Texas where he works. There, he says, builders concern themselves with the "potential vertical rise," or PVR, of the soil on a lot—how much the soil will go up (and then down) when it rains. The PVR determines the type of footing and foundation that will work on a particular lot.

When the PVR is estimated at 4 in. or less, a slab-on-grade foundation may work just fine. Between 4 in. and 8 in. of PVR, builders often go to a waffle slab, a monolithic pour with boxlike recesses cast into the bottom of the slab that absorb soil expansion when it rains, Cobo explained. This type of slab looks exactly like what comes out of a waffle maker, hence its name. When the PVR on the site is higher, say 10 in. to 12 in., a waffle slab might be supported by concrete-pier footings. Post-tensioned slabs—in which integral steel cables are tightened after the slab has been cast—are another common solution to lots with problem soils, as are pier-and-beam foundations.

Slab foundations are another option

Most slab-on-grade foundations are poured as monolithic structures—the footings are an integral part of the foundation. A slab foundation can speed up the construction schedule and reduce the amount of concrete that must be ordered. One variety is the thickened-edge slab. Around the outside of the foundation, the concrete might be 10 in. or 12 in. thick, while concrete in the middle of the slab would be less than half that. The idea is that the thicker edge bears the weight of the exterior walls, just as a separately poured concrete footing would. Frost-protected shallow foundations and raft slabs are similar, but use rigid insulation to prevent frost from getting underneath the slab.

—Scott Gibson, contributing writer



Thickened-edge slab

This type of slab-on-grade foundation allows builders to form the footing and foundation in one pour. Depth and dimensions of the thickened edge will depend on frost depth and soil-bearing capacity. Insulation R-values and location as well as necessary drainage will vary.

Leasure's specs and the info from the test pier, the TMP engineer was able to design a system and tell Brochu the torque he needed to achieve during installation. Our site, like much of Portland, Maine, is marine clay, so we hit the torque relatively quickly. In sandier or unstable soil, you might have to add extensions to the pier to drive deep enough to achieve the required torque.

Based on the results of the test pier, the TMP engineer determined that we would need 12 piers with 12-in. helixes driven about 10 ft. deep. To prepare for the work, we rented a small excavator and dug a 2-ft.-deep trench along the two bearing walls, the front and back of the house. This allowed us to keep the piers and brackets hidden below grade when we backfilled.

Next Brochu and crew showed up with their hydraulic driver and the piers. To stay tight to the foundation, they drove the piers at a slight angle, and then pushed the tops toward the foundation when they'd reached the depth they needed. They slid brackets over the tops of the piers and, maintaining pressure on the piers with the driver, bolted the brackets to the foundation walls. Brochu recorded all the torque readings on each pier in case anyone needs documentation in the future.

If we'd had to lift any sections of the foundation, at this point they would have bolted temporary plates above the piers and used regular hydraulic bottle jacks set on top of the piers to push the house up. But because there were no signs of movement, we were just shoring up in preparation for the increased load of the second-floor addition.

Once all the brackets were bolted on, the crew cut off the pier flush with the top of the bracket and welded the piers to the brackets. We then backfilled and were able to proceed with the job. Other than the fresh excavation, no hints of the work done remained.

Versatile and cost effective

This house had a specific problem for us to solve, but you can use this helical-pier technique to repair other foundation systems as well. Slabs on grade are relatively easy. Block walls are harder because you need to attach to the footings, since the block itself will separate if you lift from them. As I mentioned, you can also use helical piers to lift and level foundations.

On the project shown here, the cost of the work was about $14,000. That included renting an excavator, setting the piers, and digging and backfilling the trenches. We saved time and didn't have to pour any concrete, and perhaps the most helpful thing was that we didn't disturb the interior at all. □

Dan Kolbert is a builder and remodeler in Portland, Maine. Photos by Scott Gibson.