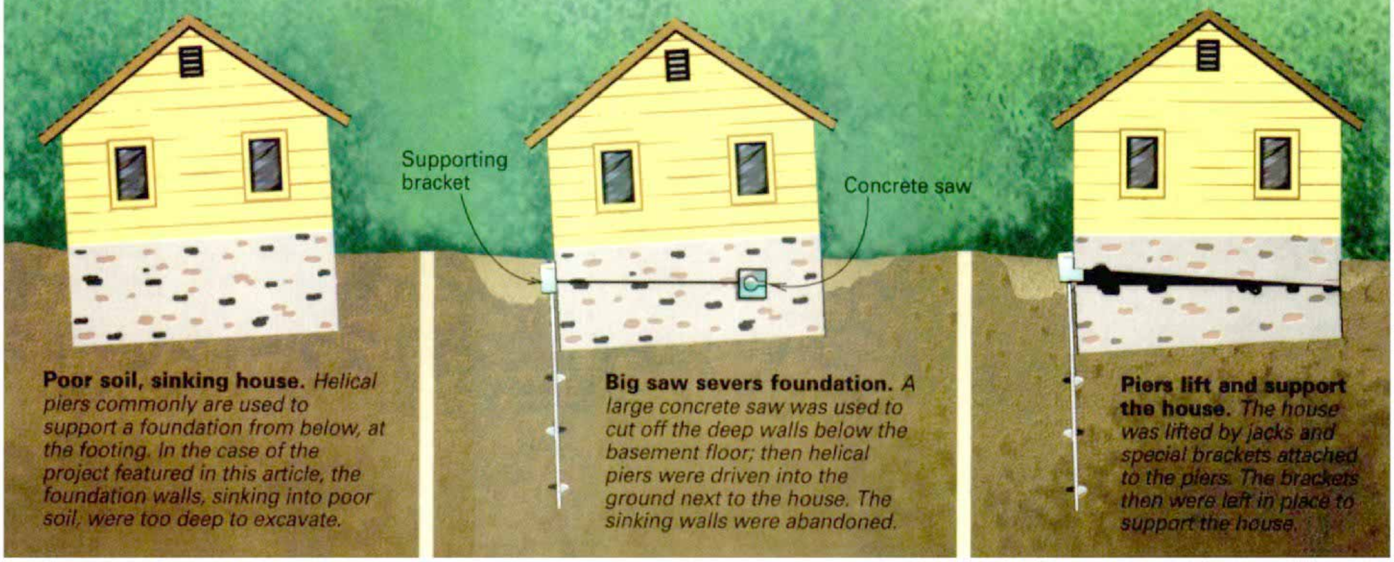
Fixing a House With a Bad Foundation

Helical piers go in like giant drywall screws to support a sinking house and a new addition

by Jerry McSweeney and Eric McGaw



Poor soil, sinking house. *Helical piers commonly are used to support a foundation from below, at the footing. In the case of the project featured in this article, the foundation walls, sinking into poor soil, were too deep to excavate.*

Big saw severs foundation. *A large concrete saw was used to cut off the deep walls below the basement floor; then helical piers were driven into the ground next to the house. The sinking walls were abandoned.*

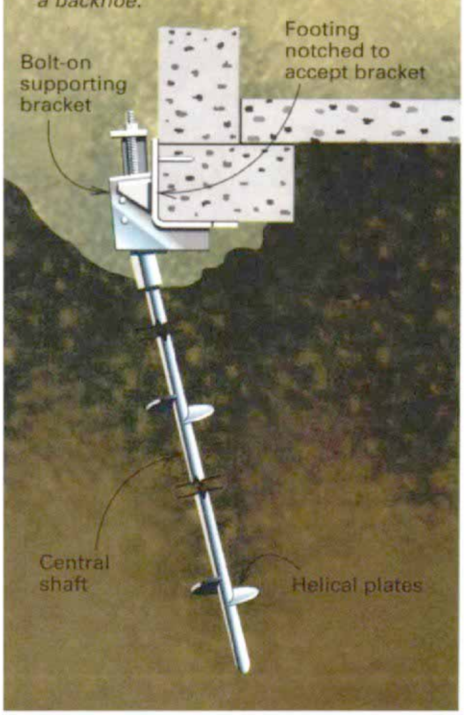
Piers lift and support the house. *The house was lifted by jacks and special brackets attached to the piers. The brackets then were left in place to support the house.*

Much to the disappointment of everyone involved and after months of planning and preparation, it looked like a job in our favorite neighborhood was in danger of being canceled. The plan was to build a 1,200-sq. ft. addition and to remodel the cramped interior of an 85-year-old house in Toronto's Beach district, a historic neighborhood with narrow lots. But as we were about to build, we discovered the soil below the existing house was too soft to support the house and the proposed addition. There was neither the room nor the money for deep excavations, and in this dense, old neighborhood, impact-driven piles were out of the question.

A house built on landfill—The project architect, Peter Gabor of Gabor & Popper of Toronto, called in a structural engineer and ordered soil testing as soon as he saw the house, which had a visible tilt, cracked bricks and signs of a sinking foundation. When the test results came back, however, the news was worse than expected. The soils report confirmed substandard soil but went on to describe poor soil conditions and substandard bearing conditions to depths ranging from 22 ft. to 26 ft. below grade.

A simple load-bearing device

Helical piers are driven into the ground by a hydraulic motor, often attached to a backhoe.



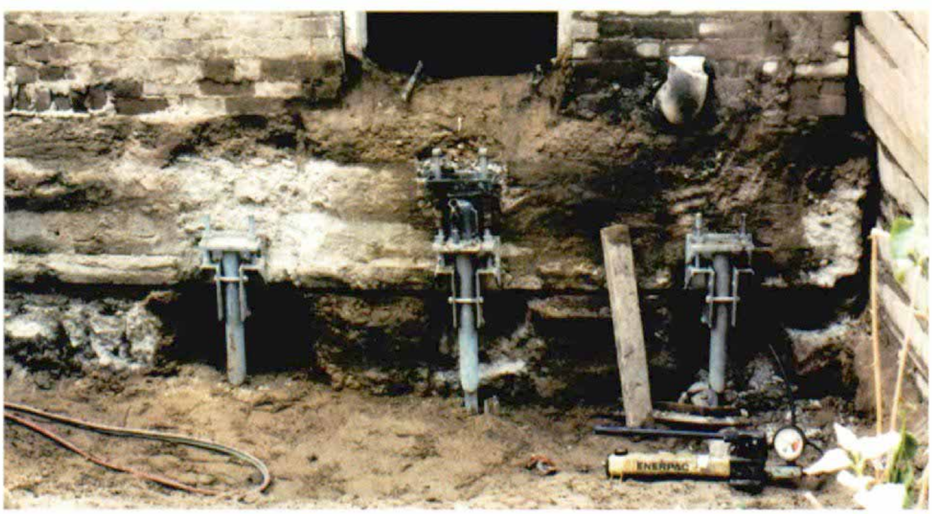
Research revealed that the poor soil conditions stemmed from landfill practices during the early 1900s. This lot was one of many on old creek beds and streambeds that had been filled with cast-off slag from coal-burning industries, utilities and residences to provide building lots to a growing lakeshore town.

While they were working independently in the search for an alternative, our staff members and the structural engineer for the project, Tom Zenik of TEK Engineering of Toronto, both discovered helical piers (drawing left; sidebar p. 95). A helical pier is not a complicated device. It consists of a steel shaft about 7 ft. long with helical plates welded to it. The piers, which are often used to support telephone poles and utility towers, function something like screws when their shafts are turned.

We had never used them before, and to our knowledge, no other residential builder in Toronto had used them. The city approved their use, but only after thorough testing (more on

Drawings: Mark Hannon

A big wrench drives the piers. Two installers from W. C. Pietz Ltd. of Toronto drive a helical pier next to a foundation wall using a hydraulic motor called a power, or digger, head. The installer above is standing on a support arm, similar to a huge ratchet-wrench handle, to help to keep the power head from turning.



Brackets strong enough to hold up a house. Brackets that tie helical piers to the foundation are designed to accept a heavy-duty hydraulic jack (photo above). With several piers sharing the load, a section of a house can be supported or lifted (photo left). As the foundation is raised, nuts on the bracket are tightened, locking the bracket in place.

Piers were tested on site. In a test required by the Toronto building department to rate the strength of helical piers, three piers were driven into the ground 7 ft. o. c. A steel I-beam was bolted to the two outside piers, and a jack was placed between the center pier and the beam. The piers withstood pressure from the jack, and the city issued a building permit.

Separating a house from its foundation. A large concrete saw was used to cut the foundation walls free from the house. The walls had been sinking into soft soil and were too deep to support from below. Above the cut, the house was raised by a series of helical piers.

this later). The cost of the piers was reasonable, especially in light of the alternatives. We installed 19 piers at a cost of about $1,200 (Canadian) each, including labor and materials. The addition has been completed for two years now, and there are no visible signs of settling.

Piers driven by large or small machinery- Two types of hydraulic devices can twist piers into the ground. The first device is a hydraulic rotor head that fits on the working arm of a front-end loader in place of a shovel or bucket. The other device, which has the advantage of operating in areas not accessible to heavy machinery, resembles an oversize (10 ft. long) ratcheting wrench (top photo, p. 93). The arm is braced against a substantial strong point, such as a wall, and the rotor head is turned by high air pressure from a generator-powered compressor.

Installation of the piers is similar using a front-end loader or the portable device. The first helical-pier section is attached to the driving head and bored into the ground. As the end of the first pier section reaches grade level, the driving head is disengaged from the pier shaft, and a 3-ft. long extension is mounted on the shaft. The driving head is then reattached, and the helical pier is bored another 3 ft. into the ground. This process of adding sections and boring is continued until bearing soil is reached.

As the pier comes in contact with bearing soil, the helical plate begins to meet more and more resistance. Calculations based on the torque of the hydraulic head and the amount of resistance experienced by the pier flange determine the bearing capacity of the soil. In practical applications, experienced installers often develop a feel for when bearing soil has been reached.

Once the pier has been installed, an L-shaped steel bracket is slipped over the end of the pier and under the foundation. The bracket is designed so that it can be used with a hydraulic jack to lift a settled foundation (bottom photos, p. 93). As the jack lifts, beefy nuts and bolts on the bracket are tightened to take up the slack.

Satisfying the building department—Because helical piers had not been used before in Toronto for the kind of job we were doing, the city building department required that they be tested before a building permit was issued.

The test, to determine whether the piers would support the load we intended to place on them, took place on the job site. We wanted to ensure that soil conditions would be comparable.

The test procedure was developed and agreed on by the city of Toronto; the contractor we hired to supply and install the piers, W. C. Pietz Ltd. of Toronto (67 Industrial Parkway N., Aurora, Ont., Canada L4G 4C4; 905-727-2424); and the pier manufacturer, A. B. Chance Company of Canada Ltd. (100 Howden Road, Scarborough, Ont., Canada M1R-3G1; 416-288-9444). The Canadian firm's parent company, A. B. Chance Co. (210 N. Allen St., Centralia, Mo. 65240; 573-682-5521), pioneered the use of the piers. The test was paid for by A. B. Chance.

To conduct the test, we installed three piers in a straight line, 7 ft. o. c. (top photo, facing page). A steel I-beam 16 ft. long and 12 in. tall was laid across the three piers and fastened to the two end piers. A hydraulic jack with a pressure gauge was placed between the center pier and the beam. After we set up a transit to determine if the beam stayed true, the jack was pumped.

The engineers were interested in what was happening to the beam and to the end piers, but their primary focus was on the center pier. The test simulated the forces that the house would exert on the piers as it was lifted.

In separate tests, the jack was loaded and left at 13 tons, 15 tons and 18 tons. The steel I-beam twisted and deflected, but the piers didn't move. After witnessing the test and receiving written reports from TEK Engineering of Toronto, the city issued a building permit.

Lifting the old house and supporting the new addition—We saw two applications for helical piers on this project. The first was to lift, level and stop further movement of the existing house. The second was to support the footing for the new addition.

The plan for supporting the new addition was to install the helical piers 4 ft. o. c. directly below the forms for the new footings and exterior walls. The new 8-in. by 24-in. concrete footing running around the perimeter walls would tie into these piers and be reinforced with rebar to create a below-grade beam. In retrospect, this part of the work was straightforward. The piers went in fairly quickly, complicated only by the problems of a tight site and an excavation in extremely sandy soil.

The second part of the installation—lifting, leveling and preventing further settling of the existing house—proved to be a greater challenge. The plan was to excavate the footing, to install piers at regular 4-ft. intervals and then, using the L-brackets and jacks, to raise and level the house. As if the task were not tough already, events conspired to heighten the difficulty.

Excavation revealed more problems—On the first two basement walls, we encountered standard residential-foundation construction: a poured-concrete wall built on regular footings not much more than 4 ft. below basement grade. However, the footings below the third and fourth walls of the basement were much deeper. Extensive excavations to depths of 8 ft. failed to disclose the bottoms of these wall-like footings. On this side of the house, we were excavating from inside the basement, and any further digging was hindered by space constraints; the earth was piled up to the ceiling behind us.

After considerable discussion, we decided that the simplest and least expensive solution would be to cut the house free from the two buried and sinking foundation walls. A local concrete-sawing outfit assured us that such a cut was possible and offered to do the job for the contract price of $1,900.

Freeing the house from its foundation—The concrete workers mounted steel saw guides along the length of each foundation wall and then attached their horizontal panel saw to the guides (bottom photo, facing page). The diamond-tipped blade they used was ¼ in. thick and 33 in. in dia., and it cost $3,000. We followed the concrete saw as it made its way around the house, installing piers and supporting brackets every 4 ft. At this point, no attempt to lift the house was made; the piers and brackets simply were put in place.

The process went smoothly until the cuts were 99% complete, when the house settled and pinched the $3,000 blade with apparent finality. In retrospect, it was an obvious error not to keep the concrete separated with steel shims. The folks from A. B. Chance and W. C. Pietz quickly got busy with their jacks and in no time had the house moving up and the sawblade free.

Around and around the foundation we went, cranking the jacks a bit at a time. One of the foundation walls began to bulge, so we stopped and braced it with framing lumber before going further. Later, the wall was reinforced with full-length, through-bolted steel channel.

After lifting the house 3 in., we apparently pushed a couple of the piers too far, and they began to bend. We removed these, replaced them and went no further. We had achieved our primary goal, which had been to stabilize the house. Any progress we were able to make toward leveling the original house was taken as a bonus. The piers come in different sizes, and the ones we used were fine for supporting the new construction and some areas of the house. But it might have been advisable to use a larger, stronger pier in the areas that needed to be lifted the most. The shafts on the piers we used were 1¼ in. across, and the helical plates were ⅝ in. thick. The supporting L-brackets were fixed in place with their two locking nuts, and the foundation work was completed. □

Jerry McSweeney and his partner, Wayne Walder, have operated Walder & McSweeney Contracting in Toronto for 15 years. Coauthor Eric McGaw is a manager for the contracting firm. Photos by Andrew Parker.

Helical piers originally supported lighthouses

by Reese Hamilton

A variation of the helical pier probably was first used in the early 1800s to support lighthouses in the sandy soil along the cost of England. The invention in 1833 of what was then known as a "screw pile" has been attributed to Alexander Mitchell, a blind English brickmaker.

The technology attracted little commercial attention until the 1950s, when Missouri-based A. B. Chance Company began selling the devices as anchors for telephone-pole guy wires. Since then, helical piers have been used to support the basement floor of the Art Institute of Chicago, the roof of a high school in Boulder, Colorado, and the foundation of a four-story condominium complex in Connecticut. Now, similar piers are made by other manufacturers, including Joslyn Manufacturing Company (9200 W. Fullerton Ave., Franklin Park, Ill. 60131; 800-323-0742).

Whether they're used in tension as soil anchors or in compression as foundation supports, the design of the devices basically is the same. There's the helical plate, which draws the anchor or pier into the ground and keeps it there, and the central supporting shaft.

As the helical plate slices through the ground, the soil around the pier shaft is disturbed to some degree. This action has raised concern among some engineers who fear the soil will become too soft to support the pier shaft and keep it from bending. A spokesman for A. B. Chance said the concern is understandable but unnecessary, providing that the load-bearing capacity of a pier is not exceeded. The company has done extensive research that shows there is no need to provide lateral support to the shaft

Helical piers come in different sizes and in different shaft types. A. B. Chance makes round-shaft piers from ¾ in. to 10 in. in dia. and square-shaft piers from 1⅞ in. to 2¼ in. across.

Various brackets can be installed on the aboveground end of the piers, broadening their application. There are brackets designed to support a building from below, to keep a building from sliding down a hillside, to keep a retaining wall in check, to straighten a buckled foundation wall or to raise a settled slab.

***—Reese Hamilton, an assistant editor for* Fine Homebuilding.**