One Test is Worth a Thousand Expert Opinions

by Raymond A. DiPasquale

In small projects with light loads and "known" soil materials, foundation decisions are made by the architect, engineer or contractor at the beginning of every project (and hopefully well before the first bit of earth is turned).

In most cases, the foundation systems they select perform as anticipated. In other cases, those occasional pockets of subterranean mystery that deviate from the norm—the local dump that has long been abandoned and filled in so it looks innocent from the surface, the perched high-water table, or the hydraulic, "quick," condition—see to it that they *don't* work.

Because in the study of earth materials we often are dealing with the unknown, foundation "engineering" is more of an art than a science. As such, it requires good judgment, experience, and a healthy sprinkling of common sense.

There are enough surprises in our business without encouraging more. The time to discover there is a "soils" problem is *not* when the contractor takes the first bite of earth—it's during the preliminary design phase. And the least expensive way to determine whether a problem exists is with a backhoe.

In small and light buildings, the nature of the upper layers of soil influences the foundation behavior. These upper layers can be explored with test pits alone.

A test-boring program, conducted for heavy and "important" buildings, gives the designer valuable information about what is directly in line with the test hole. If there are enough borings, the designer can create subsurface profiles.

There are enough surprises in our business without encouraging more. You can save money and avoid embarrassment when someone on the building team has the foresight to dig a simple test pit at the very beginning.

Because the test-boring information is valid only at the location it is taken, however, test pits always should be taken along with the borings so that ground information between the borings can be supplied. It is wrong to make general conclusions about the overall subsurface conditions on the basis of test borings alone.

Inadequate sites can be abandoned, owners can save a lot of money and designers can avoid embarrassment when someone on the building team has the foresight to dig a simple test pit at the very beginning.

Test-Pit Guidelines

At least five test pits should be dug for a typical rectangular building of 3,000 square feet. Add another pit for about every 750 square feet of building plan area over 3,000. Locate a pit in the vicinity of each corner, and one or two in the center, of the plan. The pit should be as deep as the backhoe is capable of digging it—12 to 14 feet or so.

Do not put a pit where you expect the foundation to actually be constructed. Test pits are considerably deeper than the final foundation, so you would have to backfill and thoroughly compact them to avoid potential future settlement. And it would be sadly ironic if you had a foundation problem result from the tests you conducted in an effort to avoid them in the first place.

The designer always should be present when a test pit is being dug. Observe the following:

- After the topsoil is stripped, note the depth of the soil type (gravel, sand, silt, clay or a combination). If rock is encountered or there is refusal, note the depth. This information should all be recorded on a printed log form. (Write to me at *New England Builder* if you want a sample form.)
- Note the depth at which groundwater is encountered. Be sure to wait several minutes for the groundwater to appear, especially if the soil is fine-grained (silts and clays).
- Note the time it takes for the excavation to fill, as this is an indication of the percolation rate.
- Note the ease of digging and whether the sides of the trench stand vertically or slough off.
- Take bag samples from the sides of the pit for further laboratory analysis if necessary. If the material is cohesive (clay) at the level of foundation bearing, use a pocket penetrometer to establish the approximate bearing capacity. Push the penetrometer into the sides of the clay in the pit, or test a reasonably undisturbed chunk scooped up by the backhoe. You can obtain a penetrometer from Soiltest, Inc., 2205 Lee St., Evanston, Ill. 60202; phone 312/869-5500 or toll-free at 800/323-1242.

The type, condition and density of the soil in place and the location of the groundwater as revealed by the test pit will give the designer and contractor a good idea of the allowable bearing value to use for the foundation design, and they will flag any potential problems that may be encountered during construction or after the structure is in place.

If the test pit shows soft and unstable material and high water, call in a geotechnical expert and get a full-scale subsurface-exploration program under way: test borings, soil samples and laboratory analysis.

Tackling the 'Unknowns'

In the litigious environment that surrounds the building industry, participants in the process have to practice defensively. There is no reason for the "unknowns" beneath the ground to remain that way when there are many means and methods available to eliminate them.

The one factor that contributes to foundation failures and distress more than any other is a change in the water table. Since bearing capacity is directly related to the presence of water in the voids of the soil, a change in the water table subsequent to construction can drastically affect the ability of the soil to tolerate building loads.

The location of the water table fluctuates with the seasons, so it's essential that an exploration program provide a way to monitor these changes over time. A test boring can have a well point installed so that periodic readings can be taken, or test pits can be dug periodically to verify the water level. If the designer knows the range of variation in the subsurface water level, the foundation can be designed to handle the worst case—not only for bearing, but also for water penetration through the foundation walls.

Prevention is as much a part of the failures scene as the postmortem study of actual incidents designed to tell us what went wrong. Just as you wouldn't expect a surgeon to operate on your heart without an X-ray, you shouldn't attempt to build something of value on a piece of "unknown" real estate. ■

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