Clean Fill Wanted

Look before you leap into building on filled sites—or risk cracked foundations and lawsuits later on.

by M. Daniel Gordon

Few foundation topics generate as much confusion as does building on filled sites. Many home owners and contractors—and even some engineers—assume that filled sites offer good foundation support, particularly for residential or light-commercial structures. The assumption is that if someone took the time to fill a site, it must be better than it was before. This contrasts sharply with my experience, so my first reaction to a filled site is generally, How bad is the problem?

When dealing with a filled site, a prospective developer or contractor should keep in mind the roadside signs that say Clean Fill Wanted. These signs exemplify the uncertainties you face with a filled site: how was the site filled, and what happens when it is later developed?

There are probably as many different reasons for wanting fill as there are signs. The fill may be to provide a level area for parking cars or storing material, or to provide space for a garden or play area. In some instances, a site is filled to cover up a swampy depression or poor soil, such as peat. Some people mistakenly believe that hiding the problem solves it.

The range in the quality of fill is even wider. People take what they can get: loam, silt, wood, ash, building rubble from demolition projects—sometimes even sand and gravel! The home owners, farmers, and others who do the filling are often unaware that engineering is required, or they are unwilling to spend the money to construct an engineered fill. Or perhaps an engineered fill isn't needed at the time. At any rate, the result rarely conforms to good construction practice.

An Engineered Fill

What is an engineered fill? While each site and building must be assessed individually, when planning an engineered fill you should generally:

1. Have a geotechnical engineer assess the underlying soils.
2. Know the nature of the structure to be built on top of the fill.
3. Establish criteria for fill materials and the degree of compaction.
4. Remove organic soils or other deleterious material before placing the fill.
5. Place the fill on top of appropriate subgrade soils in thin lifts that are mechanically compacted to the specified densities.
6. Have a geotechnical engineer monitor and test the fill materials and the degree of compaction.

Clearly, most fills on undeveloped sites do not satisfy these criteria. The questions that then arise are: (1) What soils are present below the fill? (2) What fill materials were used? (3) Was the fill compacted?

First you should figure out why the area was filled. Poor quality soils frequently lie under the fill. So even if the fill satisfies all the other requirements of an engineered fill—a rare case—poor subgrade soils could still damage the foundation.

The second concern is the quality of the fill material. "Clean," "solid," or "good" fill are ambiguous terms with no technical meaning. The developer should assess the quality of the material that was used. Trash, wood, stumps, cinders, and ash, for example, are not appropriate for use below structures, even if compacted.

A growing concern is whether environmentally hazardous materials are present in the fill. Contaminated soils may require removal at costs far greater than the value of the entire project. Prospective developers should test for hazardous materials when purchasing the property—and, in fact, many mortgage lenders now require this. "Clean fill" has begun to take on a whole new meaning.

Compaction

The third concern is whether the fill was compacted. I am frequently told: "The fill has been there for a year"—or ten years—"Is that enough compaction?" In almost all instances, the answer is no. Natural processes do not provide enough compaction for fill to support structures.

"Ponding" (or "flooding") the fill area is not a recommended method of compaction. This procedure cannot be systematically controlled, and its effectiveness is hard to gauge. Most fills have not been systematically compacted, and should be considered inadequate unless proved otherwise.

Assessing compaction *after* the fill has been placed is expensive and time-consuming. Moreover, it is fraught with unknowns because, under the best of circumstances, only a small fraction of the fill can be tested. There's no guarantee that the tested area represents the entire fill. And a small, uncompacted area can significantly damage a structure.

Unknown Fill

So far, this discussion has assumed that the prospective developer knows that the site was filled. Often, however, contractors are not aware that they are building over fill. In some cases it is difficult to distinguish between fill soils and natural soils.

To guard against problems, you must research the site. Possible sources of information are old topographic site plans, USGS topographic maps, previous owners, neighbors, or local contractors.

Have a geotechnical engineer monitor explorations on all sites where fill is suspected. In fact, a professional review of soil conditions is a good idea on all house sites—and is required by code in many areas.

Case Studies

A common attitude in residential construction is "It's only a house, with no real load on it." This section will show the shortsightedness of that approach—particularly on filled sites.

The severity of the problems varied, but in all of these cases it would have been cheaper to build the foundations right initially than it was to repair them later (and, in some cases, pay for the lawyers).

Compressible soils—frequently peat or other organic soils—that are left below fill are probably the most common cause of problems on filled sites. The fill frequently appears to be good quality "gravel," which misleads contractors into assuming that the bearing conditions are good. But the problem is still present *below* the foundation.

Case One. On one site (see Figure 1), a peat deposit—eight feet thick in places—was supposedly excavated from the site, and the excavation was backfilled with sand and gravel fill. The contractor had performed test borings before construction, and presumably verified that the peat had been removed. A shallow foundation was built bearing on the sand and gravel backfill.

Less than a year later, one end of the house had to be underpinned with caissons and needle beams to stabilize a three-quarter-inch crack in the foundation. Although the footings were on the sand and gravel, peat still remained under part of the house. It is not known whether this problem resulted from improperly locating the house over the excavated area, or from inaccuracies in the boring logs.

Case Two. Poor fill *material* can also cause settling in light structures.

On this site, the ground originally sloped 10 or 12 feet across the lot. To level the site, the lot was filled with material from nearby areas. In addition,

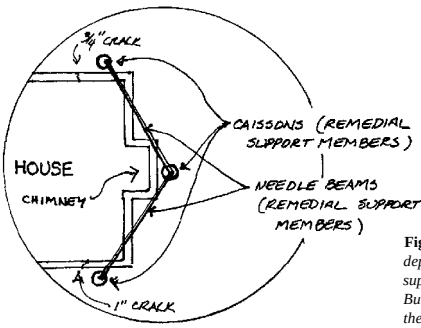
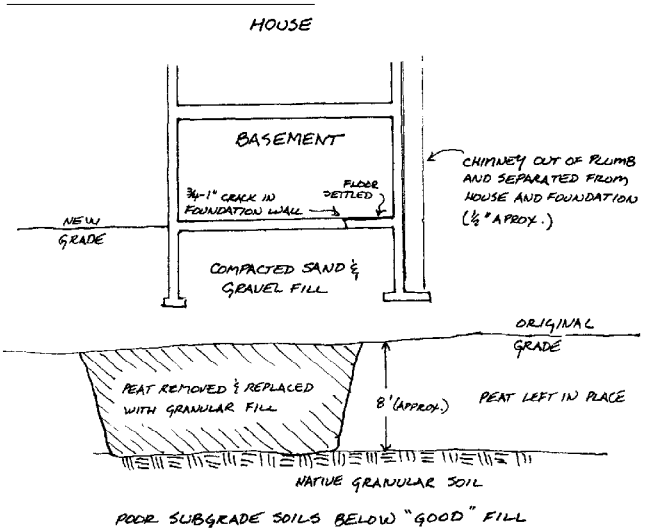


Figure 1. *"Good fill" hid a peat deposit up to 8 feet thick that was supposedly removed from this site. But part of it remained and cracked the foundation, which later had to be stabilized with caissons and needle beams.*



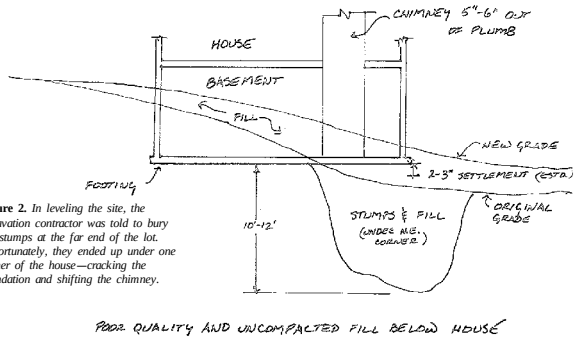


Figure 2. *In leveling the site, the excavation contractor was told to bury the stumps at the far end of the lot. Unfortunately, they ended up under one corner of the house—cracking the foundation and shifting the chimney.*

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When the basement area was excavated, it extended into both natural soils and fill. Because the soils were similar, the contractor did not realize that part of the house was built on top of fill.

The result was substantial settling of the foundation and slab. The chimney separated from the house, and one corner of the house settled and cracked. Subsequent investigation revealed stumps below the corner of the house to depths of 10 to 12 feet. Figure 2 shows the soil profile below the house.

Case Three. In the next case, a small retail building was built over a landfill site (trash, rubbish, what have you). The building was a one-story, steel-frame structure with small spans and light column loads. Again, it was "*only* a one-story building."

The columns and the building were to be supported on piles, with the floor slab constructed on grade. A layer of "compacted" fill was placed over the rubbish fill to raise the grade.

Shortly after construction began, the slab started to settle. In an effort to salvage the sinking slab; the builder added occasional layers of concrete, building it up to 10 inches thick in some places. In one section, the floor slab and a column settled about one and a half feet. This column was not supported on piles, but on an oversized footing.

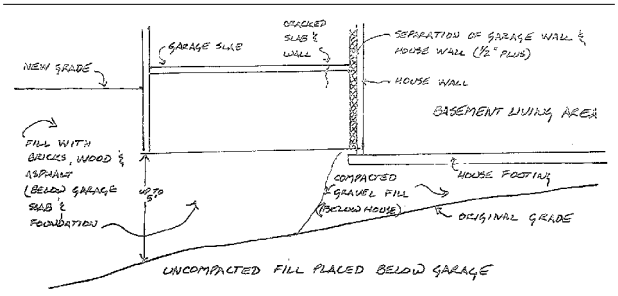


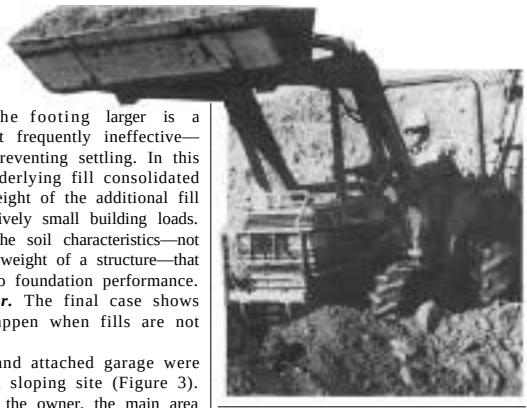
Figure 3. *In leveling this site, fill material was properly placed and compacted under the house. But under the garage, the fill was sloppy. It later consolidated—and the slab and walls cracked.*

Making the footing larger is a common—but frequently ineffective—method of preventing settling. In this case, the underlying fill consolidated under the weight of the additional fill and the relatively small building loads. often, it is the soil characteristics—not the size and weight of a structure—that are critical to foundation performance.

Case Four. The final case shows what can happen when fills are not compacted.

A house and attached garage were located on a sloping site (Figure 3). According to the owner, the main area of the house was built partially on a granular fill that had been properly placed and compacted in thin lifts by the contractor.

The garage, however, was built over an uncompacted mixture of topsoil, subsoil, sand, silt, asphalt, and other materials. Later, the foundation walls and slab at the rear of the garage significantly settled and cracked, due to the consolidation of the uncompacted fill.



Apparently, the contractor had considered the garage foundation less important than the main house foundation—but the owners didn't share this view.

Buyers Beware

In summary, prospective developers should approach filled sites with a skeptical and critical eye. A general recommendation is to avoid building on top of any fill that cannot be proved to be an engineered fill.

Beyond that, developers must be aware that the risk of finding hazardous wastes in soil or groundwater is real—and clearly greater in filled sites. This should be considered when evaluating the feasibility of a project.

Finally, these foundation problems on small construction projects demonstrate the fallacy of the "it's only a house" philosophy. Because a structure is small or lightly loaded does not mean that an engineering evaluation of a site is not warranted. An ounce of prevention, in these cases, could have saved pounds of costly callbacks. ■

M. Daniel Gordon is a consulting geotechnical engineer in Newton, Mass.