



- **Implementing Carbon Fiber Strips for Added Support**  
**Implementing Carbon Fiber Strips for Added Support Exploring the Function of Steel I Beams in Reinforcement Evaluating Helical Pier Installations for Stability Understanding the Role of Push Piers in Foundation Repair Assessing Poly Foam Injection as a Repair Option Addressing Wall Bowing with Specialized Bracing Systems Incorporating Reinforced Footings in Existing Structures Using Fiber Reinforced Polymers for Structural Upgrades Recognizing Different Methods for Load Bearing Enhancement Integrating Modern Engineering Software for Precise Calculations Exploring Innovative Jacking Mechanisms for Floor Leveling Seeking Guidance from Structural Engineers for Advanced Repairs**
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**Obtaining Local Building Permits for Foundation Work Meeting OSHA Regulations During Excavation Projects Understanding City Ordinances That Affect Repair Plans Coordinating Structural Engineer Reviews for Compliance Navigating Inspections from Municipal Authorities Adhering to Safety Protocols on Residential Job Sites Prioritizing Protective Equipment for Repair Crews Managing Noise and Debris Regulations in Urban Areas Recognizing Liability Concerns in Construction Zones Complying with Floodplain Requirements in Vulnerable Regions Satisfying Documentation Requirements for Property Records Maintaining Ethical Practices in Foundation Repair Services**
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# Enhancement

\* Identifying Foundation Problems Suitable for Carbon Fiber Reinforcement

\* **Defining Load Bearing and its Importance in Residential Foundations**

Okay, let's talk about load bearing in residential foundations, and why it's such a big deal, especially when we're thinking about how to make things stronger.

French drains redirect water away from homes to prevent foundation damage [foundation repair service market](#) concrete block.

Imagine your house as a giant stack of building blocks. The foundation is the very bottom block, the one that's got to hold up \*everything\* above it – the walls, the roof, the furniture, even you and your family walking around. That's load bearing in a nutshell: the ability of the foundation to safely support all those weights and pressures.

Why is this so important? Well, if the foundation can't handle the load, bad things happen. We're talking about cracks in the walls, sloping floors, doors and windows that stick, and in really severe cases, even structural collapse. A failing foundation isn't just unsightly; it's dangerous and can devalue your home significantly.

Think of it like this: a weak foundation is like building a house on sand. It might look okay at first, but over time, the shifting and settling will cause problems. A strong, properly designed load-bearing foundation, on the other hand, is like building on solid rock. It provides a stable base that will keep your home safe and secure for years to come.

So, when we start talking about methods for enhancing load bearing – things like adding rebar to concrete, using different types of foundation systems, or even soil stabilization techniques – we're really talking about ways to make that bottom block stronger and more reliable. We're essentially reinforcing the foundation's ability to handle the immense weight and pressure of the house above, ensuring its longevity and the safety of everyone inside. It's about more than just building a house; it's about building a home that lasts.

\* **Common Foundation Problems Leading to Load Bearing Issues**

Okay, so you're thinking about load-bearing walls and how things go wrong at the foundation level, right? It's like building a house on shaky ground – literally. The foundation is the heart of the whole load-bearing system, and when it starts to crumble, things can get dicey fast.

Think about it this way: common foundation problems are like the villains in this story. The

biggest baddie is settlement. This happens when the soil under your house compacts unevenly. Now, all soils settle a little, but when it's uneven, it can lead to cracks in your foundation walls and slab. These cracks aren't just cosmetic; they weaken the whole structure and redistribute the load in ways it wasn't designed for. Suddenly, that load-bearing wall is carrying more weight on one side than the other, putting immense stress on the framing above.

Another troublemaker is hydrostatic pressure. This happens when water builds up around your foundation from poor drainage or a high water table. The water pushes against the foundation walls, and over time, this constant pressure can cause them to bow inward or even crack. Again, this weakens the foundation's ability to support the load above, potentially causing walls to buckle or sag.

And we can't forget about soil erosion. Rainwater runoff and poor landscaping can wash away soil from around the foundation, creating voids and undermining its stability. This is especially problematic near load-bearing walls because the soil directly beneath them is critical for transferring the weight of the structure to the ground.

Finally, sometimes it's just plain old poor construction. Improperly compacted soil, inadequate footing size, or using substandard materials during the initial foundation pour can all lead to problems down the line. These underlying issues are often the reason why a foundation starts to fail prematurely.

So, these foundation problems, settlement, hydrostatic pressure, erosion, and poor initial construction, are the usual suspects when it comes to load-bearing issues. Identifying them early is crucial because they can lead to serious structural problems if left unchecked. That's why understanding the signs of foundation distress is so important for anyone concerned about the structural integrity of their home.

### **\* Understanding Soil Stabilization Techniques for Enhanced Load Bearing**

Okay, so we're talking about making soil stronger, right? I mean, anybody who's ever tried to build a sandcastle knows that soil isn't always the most reliable stuff. Sometimes it's mushy, sometimes it crumbles, and sometimes it just can't handle much weight. That's where soil stabilization comes in – it's all about tweaking the soil's properties so it can bear more load, like supporting a building, a road, or even just a really impressive garden wall.

Think of it like this: you've got a bunch of different tools in your toolbox, and each one is good for a different job. Soil stabilization is similar, with several techniques to choose from depending on the type of soil you're working with and what you need it to do.

One common method is compaction. It's basically squishing the soil particles closer together, which makes it denser and stronger. You see road crews doing this all the time with those big rollers. Then there's chemical stabilization, where you add things like lime or cement to the soil. These react with the soil particles, bonding them together and creating a

much more stable material. It's like adding glue to your sandcastle!

Another approach is mechanical stabilization. This involves mixing different types of soil together to get the properties you want. For instance, you might mix clay soil with sand to improve drainage and increase its load-bearing capacity. It's like baking a cake – you're blending different ingredients to get the right texture and strength.

Geosynthetics, like geotextiles and geogrids, are also becoming increasingly popular. These are basically fabrics and grids made from synthetic materials that you lay down in the soil to reinforce it. They act like a skeleton, providing extra support and preventing the soil from shifting or settling.

Choosing the right method depends on a bunch of factors: the type of soil, the climate, the cost, and what you're actually trying to build. What works great for a small parking lot in Arizona might be totally unsuitable for a large highway in Alaska.

So, understanding these different soil stabilization techniques is crucial for any construction project. It's all about making sure the ground beneath our feet is strong enough to support whatever we're building on top of it. Without it, well, things could get pretty shaky!

### **\* Exploring Piering Methods: Steel Piers, Helical Piers, and Concrete Piers**

Okay, so you've got a structure, and it's...sagging a bit. Or maybe you're building something new and want to make sure it *\*stays\** put for the long haul. That's where load-bearing enhancement comes in, and often, that means thinking about piers. Think of them as strong, silent heroes, transferring the weight of your building to more stable soil deep down. But which kind of hero do you need? Let's explore a few common options: steel piers, helical piers, and concrete piers.

Steel piers are like the seasoned veterans of the pier world. They're typically hydraulically driven into the ground in sections, using the weight of the structure itself to help push them down. They're durable, predictable, and can often reach significant depths, making them a solid choice when you need to hit bedrock or a really firm bearing stratum.

Helical piers are a bit different – picture a giant screw being twisted into the earth. These guys have helical-shaped plates welded to the shaft, which pull the pier down as it rotates. They're great in situations where you need to avoid vibration (sensitive equipment nearby?) or when access is a bit tricky. Plus, the installation process often allows you to verify the load-bearing capacity as you go, which is pretty neat.

Then there are concrete piers. These can be formed and poured in place, or precast and driven into the ground. They're often a good option for larger, heavier loads, and can be particularly cost-effective for new construction where you have the space and time to properly cure the concrete. The method of installation can vary considerably, affecting the suitability for different soil conditions and project constraints.

Ultimately, choosing the right type of pier depends on a bunch of factors: the soil conditions, the size and weight of the structure, the budget, and even the accessibility of the site. Consulting with a qualified geotechnical engineer and a foundation specialist is absolutely key. They can assess your specific needs and recommend the best piercing method to ensure your structure stands strong for years to come. Think of them as your personal piercing superheroes!

### **\* Chemical Grouting and its Role in Strengthening Soil and Foundations**

Okay, so you're thinking about beefing up soil and foundations, right? There are tons of ways to do it, but one that often gets overlooked is chemical grouting. Basically, it's like injecting a special sauce into the ground to make it tougher.

Imagine you've got soil that's a bit weak, maybe sandy or with lots of voids. It's not ideal for holding up a building or even a road. Chemical grouting is where you pump a liquid grout – think a special mix of chemicals that react and solidify – into those weak spots. This grout fills the gaps, binds the soil particles together, and essentially turns a crumbly mess into a much stronger, more stable mass.

The cool thing about chemical grouting is that it's pretty versatile. You can use different types of grout depending on the soil type and what you're trying to achieve. Some grouts create a really strong, rigid bond, while others are more about filling voids and preventing water flow.

So, what's its role in strengthening things? Well, first off, it increases the soil's bearing capacity, meaning it can handle more weight. This is crucial for foundations, especially if you're dealing with poor soil conditions. It also reduces permeability, so water can't easily seep through and weaken the structure. And, it can even be used to stabilize slopes and prevent landslides.

Think of it like this: if your house was built on a wobbly table, chemical grouting is like adding extra legs and reinforcing the joints. It's a subtle but powerful way to make sure everything stays put, even under pressure. It's not always the first solution that comes to mind, but for certain soil conditions, chemical grouting can be a real game-changer for strengthening soil and foundations.

### **\* Carbon Fiber Reinforcement for Increased Load Capacity**

Okay, so we're talking about beefing up structures to handle more weight, right? And one of the cooler ways to do that these days is by using carbon fiber reinforcement. Think of it like giving your aging bridge or building a super-strong exoskeleton.

Essentially, we're sticking carbon fiber materials – usually in the form of sheets, strips, or

even wraps – onto the existing structure. Now, carbon fiber isn't just any material; it's incredibly strong for its weight. It's like, way stronger than steel, but much lighter. This means we can add significant strength without adding a ton of extra weight, which is a huge advantage. Imagine trying to reinforce an old bridge by just piling on more concrete – it would likely collapse under its own increased weight!

The way it works is pretty neat. The carbon fiber is bonded to the existing structure with a special adhesive. When the structure is under load, the carbon fiber shares the stress. It basically takes on a significant portion of the load, reducing the strain on the original material, whether that's concrete, steel, or even wood. This prevents cracking, bending, or even catastrophic failure.

You see this being used a lot in bridge repair, strengthening columns in buildings, and even in aerospace applications. It's really versatile because it can be applied to a wide range of shapes and sizes. Plus, it's relatively quick to install compared to some other reinforcement methods, which means less disruption.

Of course, it's not a magic bullet. It's more expensive than some traditional methods, and the application process needs to be done very carefully to ensure a good bond. But for structures where weight is a concern, or where you need a really strong and durable fix, carbon fiber reinforcement is a seriously effective option for increasing load capacity. It's basically giving structures a new lease on life and allowing them to handle a whole lot more than they were originally designed for.

### **\* Selecting the Appropriate Load Bearing Enhancement Method**

Choosing the right way to make something stronger, especially when it's holding a lot of weight, is a big deal. We're talking about load-bearing structures – things like bridges, buildings, even aircraft. You can't just slap some extra steel on and hope for the best. You need to understand the problem first, and then pick the solution that fits.

Think of it like this: your car tire is low. Do you just keep pumping air in? Maybe. But what if there's a nail in it? Pumping air is a temporary fix, not a real solution. Similarly, with load-bearing structures, we need to diagnose the weakness before prescribing a treatment. Is the material degrading over time, like concrete crumbling? Is there a design flaw causing stress in particular areas? Or maybe the structure is just being asked to carry more weight than it was originally designed for.

Once you know *\*why\** the structure needs help, you can look at different methods. Fiber Reinforced Polymers (FRP) are like a high-tech bandage, wrapping around concrete or steel to add strength. They're great for corrosion problems because they don't rust. Steel plates can be bolted or glued on to reinforce weak spots, a bit like adding muscle. Grouting, injecting special materials into cracks, can fill voids and restore integrity. And sometimes, you might need to completely replace a section, like getting a new tire that's actually built to handle the road.

The trick is matching the method to the specific need. FRP might be perfect for a bridge column that's suffering from corrosion, but overkill for a simple floor beam that just needs a little extra support. Steel plates might be a cost-effective solution for a warehouse upgrade, but too heavy and cumbersome for a delicate historic building.

So, picking the right load-bearing enhancement isn't just about throwing money at the problem. It's about understanding the root cause, weighing the different options, and choosing the solution that's both effective and appropriate for the situation. It's a bit of engineering detective work, really.

### **\* Case Studies: Successful Load Bearing Enhancement Projects**

Okay, so we're talking about beefing up structures, right? Making them handle more weight than they were originally designed for. And we want to look at some real-world examples to get a feel for how it's actually done. Makes sense. It's one thing to read about different techniques, but seeing them applied in action is where the rubber meets the road.

Think of it like this: you've got a building, maybe an old warehouse someone wants to turn into swanky apartments. The original design might have been fine for storing boxes, but now you're talking about people, furniture, and all the extra weight that entails. Or maybe you've got a bridge that needs to handle heavier trucks than it was built for back in the day.

That's where load-bearing enhancement comes in. And it's not a one-size-fits-all kind of thing. The right method depends on a whole bunch of factors: the type of structure, the existing materials, the extent of the required upgrade, the budget, and even the disruption to the existing use.

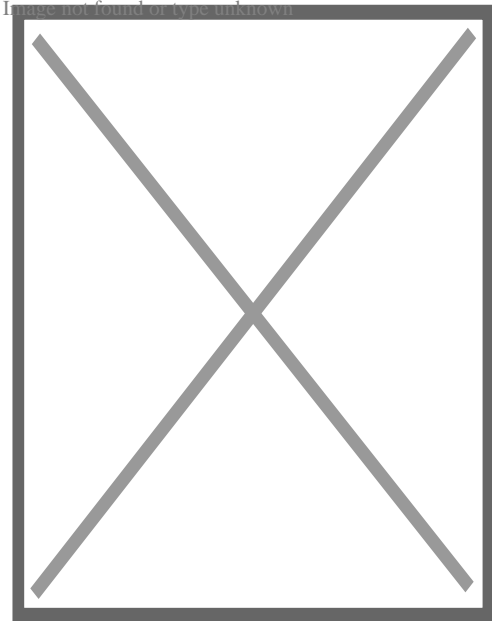
So, let's look at some imaginary, but realistic, cases. Imagine an old brick building. One successful enhancement might involve adding steel flitch plates to the existing wooden beams. These plates are basically steel strips bolted onto the sides of the beams, adding significant strength without drastically altering the building's character. It's a relatively non-invasive approach. Another successful case might involve wrapping concrete columns with carbon fiber reinforced polymers (CFRP). This is like giving the column a super-strong hug. The CFRP adds strength in tension, which is crucial for resisting bending and buckling.

Or consider a concrete bridge deck that's showing signs of distress. A common solution is to apply an overlay of high-performance concrete. This adds a new layer of strength and protection to the existing deck, distributing the load more effectively. Another bridge scenario might involve external post-tensioning. By adding high-strength steel cables along the exterior of the bridge and then tensioning them, you effectively compress the concrete, making it much stronger and resistant to cracking.

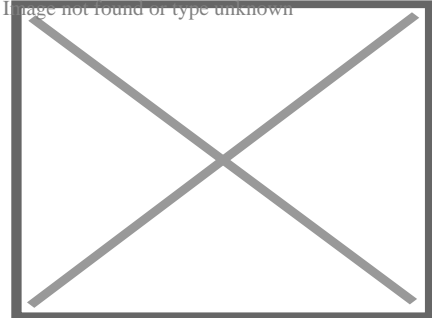
Each of these examples showcases a different method and highlights the importance of tailoring the solution to the specific problem. The "successful" part isn't just about adding more strength; it's about doing it efficiently, cost-effectively, and with minimal disruption. It's about understanding the nuances of each technique and knowing when to apply which one.

These case studies, even the imaginary ones, help us start to see those nuances and become more aware of the toolbox available for load-bearing enhancement. They show the art and science of making structures stronger, safer, and more adaptable to changing needs.

**About geotechnical engineering**

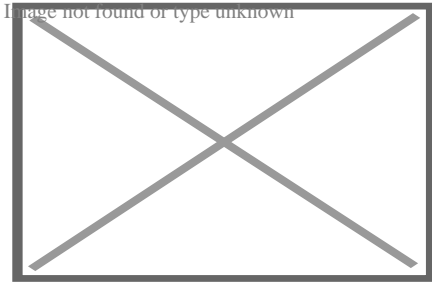


Boston's Big Dig presented geotechnical challenges in an urban environment.



Precast concrete retaining wall





A typical cross-section of a slope used in two-dimensional analyzes.

**Geotechnical engineering**, also known as **geotechnics**, is the branch of civil engineering concerned with the engineering behavior of earth materials. It uses the principles of soil mechanics and rock mechanics to solve its engineering problems. It also relies on knowledge of geology, hydrology, geophysics, and other related sciences.

Geotechnical engineering has applications in military engineering, mining engineering, petroleum engineering, coastal engineering, and offshore construction. The fields of geotechnical engineering and engineering geology have overlapping knowledge areas. However, while geotechnical engineering is a specialty of civil engineering, engineering geology is a specialty of geology.

## History

[edit]

Humans have historically used soil as a material for flood control, irrigation purposes, burial sites, building foundations, and construction materials for buildings. Dykes, dams, and canals dating back to at least 2000 BCE—found in parts of ancient Egypt, ancient Mesopotamia, the Fertile Crescent, and the early settlements of Mohenjo Daro and Harappa in the Indus valley—provide evidence for early activities linked to irrigation and flood control. As cities expanded, structures were erected and supported by formalized foundations. The ancient Greeks notably constructed pad footings and strip-and-raft foundations. Until the 18th century, however, no theoretical basis for soil design had been developed, and the discipline was more of an art than a science, relying on experience.<sup>[1]</sup>

Several foundation-related engineering problems, such as the Leaning Tower of Pisa, prompted scientists to begin taking a more scientific-based approach to examining the subsurface. The earliest advances occurred in the development of earth pressure theories for the construction of retaining walls. Henri Gautier, a French royal engineer, recognized the "natural slope" of different soils in 1717, an idea later known as the soil's angle of repose. Around the same time, a rudimentary soil classification system was also developed based on a material's unit weight, which is no longer considered a good indication of soil type.<sup>[1]</sup><sup>[2]</sup>

The application of the principles of mechanics to soils was documented as early as 1773 when Charles Coulomb, a physicist and engineer, developed improved methods to determine the earth pressures against military ramparts. Coulomb observed that, at failure, a distinct slip plane would form behind a sliding retaining wall and suggested that the maximum shear stress on the slip

plane, for design purposes, was the sum of the soil cohesion,  $c$ , and the normal stress on the slip plane and  $\tan(\phi)$  of the soil. By combining Coulomb's theory with Christian Otto Mohr's 2D stress state, the theory became known as Mohr-Coulomb theory. Although it is now recognized that precise determination of cohesion is impossible because it is not a fundamental soil property, the Mohr-Coulomb theory is still used in practice today.<sup>[3]</sup>

In the 19th century, Henry Darcy developed what is now known as Darcy's Law, describing the flow of fluids in a porous media. Joseph Boussinesq, a mathematician and physicist, developed theories of stress distribution in elastic solids that proved useful for estimating stresses at depth in the ground. William Rankine, an engineer and physicist, developed an alternative to Coulomb's earth pressure theory. Albert Atterberg developed the clay consistency indices that are still used today for soil classification.<sup>[1][2]</sup> In 1885, Osborne Reynolds recognized that shearing causes volumetric dilation of dense materials and contraction of loose granular materials.

Modern geotechnical engineering is said to have begun in 1925 with the publication of *Erdbaumechanik* by Karl von Terzaghi, a mechanical engineer and geologist. Considered by many to be the father of modern soil mechanics and geotechnical engineering, Terzaghi developed the principle of effective stress, and demonstrated that the shear strength of soil is controlled by effective stress.<sup>[4]</sup> Terzaghi also developed the framework for theories of bearing capacity of foundations, and the theory for prediction of the rate of settlement of clay layers due to consolidation.<sup>[1][3][5]</sup> Afterwards, Maurice Biot fully developed the three-dimensional soil consolidation theory, extending the one-dimensional model previously developed by Terzaghi to more general hypotheses and introducing the set of basic equations of Poroelasticity.

In his 1948 book, Donald Taylor recognized that the interlocking and dilation of densely packed particles contributed to the peak strength of the soil. Roscoe, Schofield, and Wroth, with the publication of *On the Yielding of Soils* in 1958, established the interrelationships between the volume change behavior (dilation, contraction, and consolidation) and shearing behavior with the theory of plasticity using critical state soil mechanics. Critical state soil mechanics is the basis for many contemporary advanced constitutive models describing the behavior of soil.<sup>[6]</sup>

In 1960, Alec Skempton carried out an extensive review of the available formulations and experimental data in the literature about the effective stress validity in soil, concrete, and rock in order to reject some of these expressions, as well as clarify what expressions were appropriate according to several working hypotheses, such as stress-strain or strength behavior, saturated or non-saturated media, and rock, concrete or soil behavior.

## Roles

[edit]

# Geotechnical investigation

[edit]

Main article: Geotechnical investigation

Geotechnical engineers investigate and determine the properties of subsurface conditions and materials. They also design corresponding earthworks and retaining structures, tunnels, and structure foundations, and may supervise and evaluate sites, which may further involve site monitoring as well as the risk assessment and mitigation of natural hazards.<sup>[7][8]</sup>

Geotechnical engineers and engineering geologists perform geotechnical investigations to obtain information on the physical properties of soil and rock underlying and adjacent to a site to design earthworks and foundations for proposed structures and for the repair of distress to earthworks and structures caused by subsurface conditions. Geotechnical investigations involve surface and subsurface exploration of a site, often including subsurface sampling and laboratory testing of retrieved soil samples. Sometimes, geophysical methods are also used to obtain data, which include measurement of seismic waves (pressure, shear, and Rayleigh waves), surface-wave methods and downhole methods, and electromagnetic surveys (magnetometer, resistivity, and ground-penetrating radar). Electrical tomography can be used to survey soil and rock properties and existing underground infrastructure in construction projects.<sup>[9]</sup>

Surface exploration can include on-foot surveys, geologic mapping, geophysical methods, and photogrammetry. Geologic mapping and interpretation of geomorphology are typically completed in consultation with a geologist or engineering geologist. Subsurface exploration usually involves in-situ testing (for example, the standard penetration test and cone penetration test). The digging of test pits and trenching (particularly for locating faults and slide planes) may also be used to learn about soil conditions at depth. Large-diameter borings are rarely used due to safety concerns and expense. Still, they are sometimes used to allow a geologist or engineer to be lowered into the borehole for direct visual and manual examination of the soil and rock stratigraphy.

Various soil samplers exist to meet the needs of different engineering projects. The standard penetration test, which uses a thick-walled split spoon sampler, is the most common way to collect disturbed samples. Piston samplers, employing a thin-walled tube, are most commonly used to collect less disturbed samples. More advanced methods, such as the Sherbrooke block sampler, are superior but expensive. Coring frozen ground provides high-quality undisturbed samples from ground conditions, such as fill, sand, moraine, and rock fracture zones.<sup>[10]</sup>

Geotechnical centrifuge modeling is another method of testing physical-scale models of geotechnical problems. The use of a centrifuge enhances the similarity of the scale model tests involving soil because soil's strength and stiffness are susceptible to the confining pressure. The centrifugal acceleration allows a researcher to obtain large (prototype-scale) stresses in small physical models.

## Foundation design

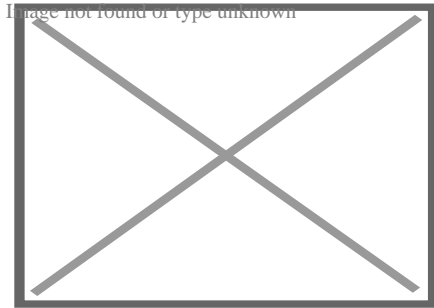
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Main article: Foundation (engineering)

The foundation of a structure's infrastructure transmits loads from the structure to the earth. Geotechnical engineers design foundations based on the load characteristics of the structure and the properties of the soils and bedrock at the site. Generally, geotechnical engineers first estimate the magnitude and location of loads to be supported before developing an investigation plan to explore the subsurface and determine the necessary soil parameters through field and lab testing. Following this, they may begin the design of an engineering foundation. The primary considerations for a geotechnical engineer in foundation design are bearing capacity, settlement, and ground movement beneath the foundations.<sup>[11]</sup>

## Earthworks

[edit]



A compactor/roller operated by U.S. Navy Seabees

See also: Earthworks (engineering)

Geotechnical engineers are also involved in the planning and execution of earthworks, which include ground improvement,<sup>[11]</sup> slope stabilization, and slope stability analysis.

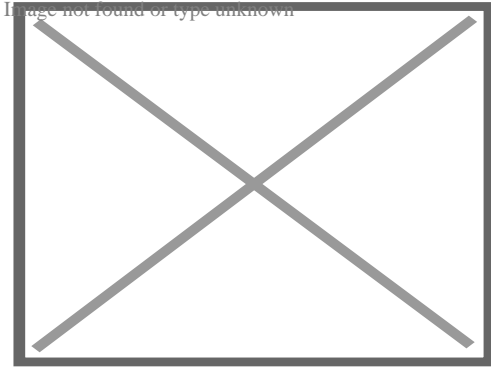
### Ground improvement

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Various geotechnical engineering methods can be used for ground improvement, including reinforcement geosynthetics such as geocells and geogrids, which disperse loads over a larger area, increasing the soil's load-bearing capacity. Through these methods, geotechnical engineers can reduce direct and long-term costs.<sup>[12]</sup>

### Slope stabilization

[edit]



Simple slope slip section.

Main article: Slope stability

Geotechnical engineers can analyze and improve slope stability using engineering methods. Slope stability is determined by the balance of shear stress and shear strength. A previously stable slope may be initially affected by various factors, making it unstable. Nonetheless, geotechnical engineers can design and implement engineered slopes to increase stability.

## Slope stability analysis

[edit]

Main article: Slope stability analysis

Stability analysis is needed to design engineered slopes and estimate the risk of slope failure in natural or designed slopes by determining the conditions under which the topmost mass of soil will slip relative to the base of soil and lead to slope failure.<sup>[13]</sup> If the interface between the mass and the base of a slope has a complex geometry, slope stability analysis is difficult and numerical solution methods are required. Typically, the interface's exact geometry is unknown, and a simplified interface geometry is assumed. Finite slopes require three-dimensional models to be analyzed, so most slopes are analyzed assuming that they are infinitely wide and can be represented by two-dimensional models.

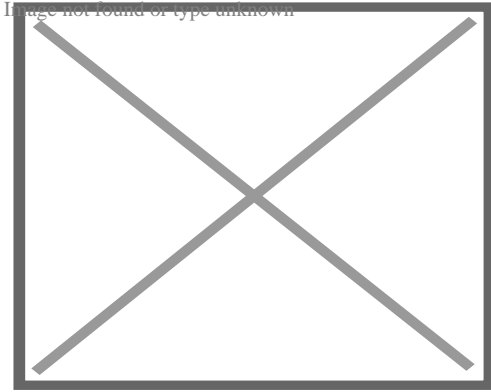
## Sub-disciplines

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# Geosynthetics

[edit]

Main article: Geosynthetics



A collage of geosynthetic products.

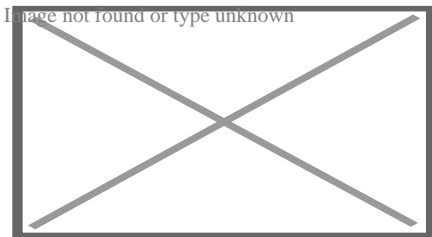
Geosynthetics are a type of plastic polymer products used in geotechnical engineering that improve engineering performance while reducing costs. This includes geotextiles, geogrids, geomembranes, geocells, and geocomposites. The synthetic nature of the products make them suitable for use in the ground where high levels of durability are required. Their main functions include drainage, filtration, reinforcement, separation, and containment.

Geosynthetics are available in a wide range of forms and materials, each to suit a slightly different end-use, although they are frequently used together. Some reinforcement geosynthetics, such as geogrids and more recently, cellular confinement systems, have shown to improve bearing capacity, modulus factors and soil stiffness and strength.<sup>[14]</sup> These products have a wide range of applications and are currently used in many civil and geotechnical engineering applications including roads, airfields, railroads, embankments, piled embankments, retaining structures, reservoirs, canals, dams, landfills, bank protection and coastal engineering.<sup>[15]</sup>

## Offshore

[edit]

Main article: Offshore geotechnical engineering



Platforms offshore Mexico.

*Offshore* (or *marine*) *geotechnical engineering* is concerned with foundation design for human-made structures in the sea, away from the coastline (in opposition to *onshore* or *nearshore* engineering). Oil platforms, artificial islands and submarine pipelines are examples of such structures.<sup>[16]</sup>

There are a number of significant differences between onshore and offshore geotechnical engineering.<sup>[16][17]</sup> Notably, site investigation and ground improvement on the seabed are more expensive; the offshore structures are exposed to a wider range of geohazards; and the environmental and financial consequences are higher in case of failure. Offshore structures are exposed to various environmental loads, notably wind, waves and currents. These phenomena may affect the integrity or the serviceability of the structure and its foundation during its operational lifespan and need to be taken into account in offshore design.

In subsea geotechnical engineering, seabed materials are considered a two-phase material composed of rock or mineral particles and water.<sup>[18][19]</sup> Structures may be fixed in place in the seabed—as is the case for piers, jetties and fixed-bottom wind turbines—or may comprise a floating structure that remains roughly fixed relative to its geotechnical anchor point. Undersea mooring of human-engineered floating structures include a large number of offshore oil and gas platforms and, since 2008, a few floating wind turbines. Two common types of engineered design for anchoring floating structures include tension-leg and catenary loose mooring systems.<sup>[20]</sup>

## **Observational method**

[edit]

First proposed by Karl Terzaghi and later discussed in a paper by Ralph B. Peck, the observational method is a managed process of construction control, monitoring, and review, which enables modifications to be incorporated during and after construction. The method aims to achieve a greater overall economy without compromising safety by creating designs based on the most probable conditions rather than the most unfavorable.<sup>[21]</sup> Using the observational method, gaps in available information are filled by measurements and investigation, which aid in assessing the behavior of the structure during construction, which in turn can be modified per the findings. The method was described by Peck as "learn-as-you-go".<sup>[22]</sup>

The observational method may be described as follows:<sup>[22]</sup>


1. General exploration sufficient to establish the rough nature, pattern, and properties of deposits.
2. Assessment of the most probable conditions and the most unfavorable conceivable deviations.
3. Creating the design based on a working hypothesis of behavior anticipated under the most probable conditions.
4. Selection of quantities to be observed as construction proceeds and calculating their anticipated values based on the working hypothesis under the most unfavorable conditions.
5. Selection, in advance, of a course of action or design modification for every foreseeable significant deviation of the observational findings from those predicted.
6. Measurement of quantities and evaluation of actual conditions.
7. Design modification per actual conditions

The observational method is suitable for construction that has already begun when an unexpected development occurs or when a failure or accident looms or has already happened. It is unsuitable

for projects whose design cannot be altered during construction.<sup>[22]</sup>

## See also

[edit]

-  Image:Engineeringportal Engineering portal
- Civil engineering
- Deep Foundations Institute
- Earthquake engineering
- Earth structure
- Effective stress
- Engineering geology
- Geological Engineering
- Geoprofessions
- Hydrogeology
- International Society for Soil Mechanics and Geotechnical Engineering
- Karl von Terzaghi
- Land reclamation
- Landfill
- Mechanically stabilized earth
- Offshore geotechnical engineering
- Rock mass classifications
- Sediment control
- Seismology
- Soil mechanics
- Soil physics
- Soil science

## Notes

[edit]

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## External links

[edit]

- Worldwide Geotechnical Literature Database
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Engineering

- History
- Outline
- List of engineering branches

**Civil**

- Architectural
- Coastal
- Construction
- Earthquake
- Ecological
- Environmental
  - Sanitary
- Geological
- Geotechnical
- Hydraulic
- Mining
- Municipal/urban
- Offshore
- River
- Structural
- Transportation
  - Traffic
  - Railway

**Mechanical**

- Acoustic
- Aerospace
- Automotive
- Biomechanical
- Energy
- Manufacturing
- Marine
- Naval architecture
- Railway
- Sports
- Thermal
- Tribology

**Electrical**

- Broadcast
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- Control
- Electromechanics
- Electronics
- Microwaves
- Optical
- Power
- Radio-frequency
- Signal processing
- Telecommunications

**Specialties  
and  
interdisciplinarity**

- Biochemical/bioprocess
- Biological



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## **Engineering education**

- Bachelor of Engineering
- Bachelor of Science
- Master's degree
- Doctorate
- Graduate certificate
- Engineer's degree
- Licensed engineer

## **Related topics**

- Engineer

## **Glossaries**

- Engineering
  - A–L
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- Aerospace engineering
- Civil engineering
- Electrical and electronics engineering
- Mechanical engineering
- Structural engineering

## **Other**

- Agricultural
- Audio
- Automation
- Biomedical
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  - Pharmaceutical
  - Rehabilitation
- Building services
  - MEP
- Design
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- Logistics
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- Mechatronics
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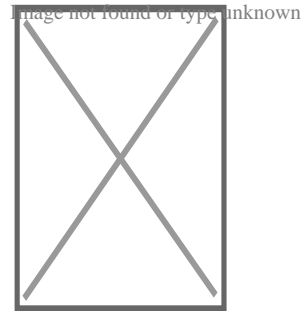
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## Soil science

- History
- Index

### Main fields

- Pedology
- Edaphology
- Soil biology
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- Soil zoology
- Soil ecology
- Soil physics
- Soil mechanics
- Soil chemistry
- Environmental soil science
- Agricultural soil science



## **Soil topics**

- Soil
- Pedosphere
  - Soil morphology
  - Pedodiversity
  - Soil formation
- Soil erosion
- Soil contamination
- Soil retrogression and degradation
- Soil compaction
  - Soil compaction (agriculture)
- Soil sealing
- Soil salinity
  - Alkali soil
- Soil pH
  - Soil acidification
- Soil health
- Soil life
- Soil biodiversity
- Soil quality
- Soil value
- Soil fertility
- Soil resilience
- Soil color
- Soil texture
- Soil structure
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  - Pore water pressure
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- Soil horizon
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- Soil moisture
  - Soil water (retention)



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### **Soil classification**

**World  
Reference  
Base  
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- Acrisols
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- Anthrosols
- Arenosols
- Calcisols
- Cambisols
- Chernozem
- Cryosols
- Durisols
- Ferralsols
- Fluvisols
- Gleysols
- Gypsisols
- Histosol
- Kastanozems
- Leptosols
- Lixisols
- Luvisols
- Nitisols
- Phaeozems
- Planosols
- Plinthosols
- Podzols
- Regosols
- Retisols
- Solonchaks
- Solonetz
- Stagnosol
- Technosols
- Umbrisols
- Vertisols

**USDA soil  
taxonomy**

- Alfisols
- Andisols
- Aridisols
- Entisols
- Gelisols
- Histosols
- Inceptisols
- Mollisols

## **Applications**

- Soil conservation
- Soil management
- Soil guideline value
- Soil survey
- Soil test
- Soil governance
- Soil value
- Soil salinity control
- Erosion control
- Agroecology
- Liming (soil)

## **Related fields**

- Geology
- Geochemistry
- Petrology
- Geomorphology
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- Hydrology
- Hydrogeology
- Biogeography
- Earth materials
- Archaeology
- Agricultural science
  - Agrology

## **Societies, Initiatives**


- Australian Society of Soil Science Incorporated
- Canadian Society of Soil Science
- Central Soil Salinity Research Institute (India)
- German Soil Science Society
- Indian Institute of Soil Science
- International Union of Soil Sciences
- International Year of Soil
- National Society of Consulting Soil Scientists (US)
- OPAL Soil Centre (UK)
- Soil Science Society of Poland
- Soil and Water Conservation Society (US)
- Soil Science Society of America
- World Congress of Soil Science

**Scientific journals**

- *Acta Agriculturae Scandinavica B*
- *Journal of Soil and Water Conservation*
- *Plant and Soil*
- *Pochvovedenie*
- *Soil Research*
- *Soil Science Society of America Journal*

**See also**

- Land use
- Land conversion
- Land management
- Vegetation
- Infiltration (hydrology)
- Groundwater
- Crust (geology)
- Impervious surface/Surface runoff
- Petrichor

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-  [Category:soil](#)
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-  [List of soil scientists](#)





















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Geotechnical engineering

Offshore geotechnical engineering

## Investigation and instrumentation

### Field (*in situ*)

-  Core drill
-  Cone penetration test
-  Geo-electrical sounding
-  Permeability test
-  Load test
  - Static
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  - Statnamic
-  Pore pressure measurement
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- Loam
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- Sensitivity

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- Shoring structures
  - Retaining walls
  - Gabion
  - Ground freezing
  - Mechanically stabilized earth
  - Pressure grouting
  - Slurry wall
  - Soil nailing
  - Tieback
- Land development
- Landfill
- Excavation
- Trench
- Embankment
- Cut
- Causeway
- Terracing
- Cut-and-cover
- Cut and fill
- Fill dirt
- Grading
- Land reclamation
- Track bed
- Erosion control
- Earth structure
- Expanded clay aggregate
- Crushed stone
- Geosynthetics
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  - Geosynthetic clay liner
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- Deep

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- Lateral earth pressure
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- Preconsolidation pressure

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- Landslide analysis
  - Stability analysis
  - Mitigation
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  - Slab stabilisation
- Bearing capacity \* Stress distribution in soil

## Numerical analysis software

- SEEP2D
- STABL
- SVFlux
- SVSlope
- UTEXAS
- Plaxis

## **Related fields**

- Geology
- Geochemistry
- Petrology
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- Geomorphology
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## **Construction**

### **Types**

- Home construction
- Offshore construction
- Underground construction
  - Tunnel construction

### **History**

- Architecture
- Construction
- Structural engineering
- Timeline of architecture
- Water supply and sanitation



**Professions**

- Architect
- Building engineer
- Building estimator
- Building officials
- Chartered Building Surveyor
- Civil engineer
- Civil estimator
- Clerk of works
- Project manager
- Quantity surveyor
- Site manager
- Structural engineer
- Superintendent

**Trades workers  
(List)**

- Banksman
- Boilermaker
- Bricklayer
- Carpenter
- Concrete finisher
- Construction foreman
- Construction worker
- Electrician
- Glazier
- Ironworker
- Millwright
- Plasterer
- Plumber
- Roofer
- Steel fixer
- Welder

- American Institute of Constructors (AIC)
  - American Society of Civil Engineers (ASCE)
  - Asbestos Testing and Consultancy Association (ATAC)
  - Associated General Contractors of America (AGC)
  - Association of Plumbing and Heating Contractors (APHC)
  - Build UK
  - Construction History Society
  - Chartered Institution of Civil Engineering Surveyors (CICES)
  - Chartered Institute of Plumbing and Heating Engineering (CIPHE)
  - Civil Engineering Contractors Association (CECA)
  - The Concrete Society
  - Construction Management Association of America (CMAA)
  - Construction Specifications Institute (CSI)
  - FIDIC
  - Home Builders Federation (HBF)
  - Lighting Association
  - National Association of Home Builders (NAHB)
  - National Association of Women in Construction (NAWIC)
  - National Fire Protection Association (NFPA)
  - National Kitchen & Bath Association (NKBA)
  - National Railroad Construction and Maintenance Association (NRC)
  - National Tile Contractors Association (NTCA)
  - Railway Tie Association (RTA)
  - Royal Institution of Chartered Surveyors (RICS)
  - Scottish Building Federation (SBF)
  - Society of Construction Arbitrators
- 
- India
  - Iran
  - Japan
  - Romania
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  - United States
- 
- Building code
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- Landscape architecture
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## **Engineering**

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- Building services engineering
- Civil engineering
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  - Construction engineering
  - Structural engineering
- Earthquake engineering
- Environmental engineering
- Geotechnical engineering


## **Methods**

- List
- Earthbag construction
- Modern methods of construction
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- Slip forming

- Building material
  - List of building materials
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- Design–bid–build
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  - List of tallest buildings and structures
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- Plasterwork
  - Damp
    - Proofing
  - Parge coat
  - Roughcast
    - Harling
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- Stonemasonry
- Sustainability in construction
- Unfinished building
- Urban design
- Urban planning

**Other topics**

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- United States
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- Israel

**About basement waterproofing**



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*Find sources: "Basement waterproofing" – news · newspapers · books · scholar · JSTOR (April 2017) (Learn how and when to remove this message)*

**Basement waterproofing** involves techniques and materials used to prevent water from penetrating the basement of a house or a building. Waterproofing a basement that is below ground level can require the application of sealant materials, the installation of drains and sump pumps, and more.

## Purpose

[edit]

Waterproofing is usually required by building codes for structures that are built at or below ground level. Waterproofing and drainage considerations are especially important in cases where ground water is likely to build up in the soil or where there is a high water table.

Water in the soil causes hydrostatic pressure to be exerted underneath basement floors and walls. This hydrostatic pressure can force water in through cracks, which can cause major structural damage as well as mold, decay, and other moisture-related problems.

## Methods

[edit]

Several measures exist to prevent water from penetrating a basement foundation or to divert water that has penetrated a foundation:

### French Drain

○

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### French drain

Interior wall and floor sealers

- Interior water drainage
- Exterior drainage

- Exterior waterproofing coatings
- Box type waterproofing<sup>[1]</sup>
- Foundation crack injections
- French drains
- Sump pump

## **Interior sealants**

[edit]

In poured concrete foundations, cracks and pipe penetrations are the most common entry points for seepage. These openings can be sealed from the interior. Epoxies, which are strong adhesives, or urethanes can be pressure injected into the openings, thus penetrating the foundation through to the exterior and cutting off the path of the seepage.

In masonry foundations, interior sealers will not provide permanent protection from water infiltration where hydrostatic pressure is present. However, interior sealers are good for preventing high atmospheric humidity inside the basement from absorbing into the porous masonry and causing spalling. Spalling is a condition where constant high humidity or moisture breaks down masonry surfaces, causing deterioration and shedding of the concrete surfaces.

Other coatings can be effective where condensation is the main source of wetness. It is also effective if the problem has minor dampness. Usually, interior waterproofing will not stop major leaks.

## **Interior water drainage**

[edit]

Although interior water drainage is not technically waterproofing, it is a widely accepted technique in mitigating basement water and is generally referred to as a basement waterproofing solution. Many interior drainage systems are patented and recognized by Building Officials and Code Administrators(BOCA) as being effective in controlling basement water.

A common system for draining water that has penetrated a basement involves creating a channel around the perimeter of the basement alongside the foundation footers. A French drain, PVC pipe, or other drainage system is installed in the newly made channel. The installed drain is covered with new cement.

The drainage system collects any water entering the basement and drains it to an internally placed sump pump system, which will then pump the water out of the basement. The Federal Emergency Management Agency (FEMA) recommends basement waterproofing with a water alarm and "battery-operated backup pump" as a preventive measure against the high cost of flooding.<sup>[2]</sup> Wall conduits (such as dimple boards or other membranes) are fastened to the foundation wall and extend over the new drainage to guide any moisture down into the system.

## Exterior waterproofing

[edit]

Waterproofing a structure from the exterior is the only method the U.S. International Building Code (IBC) recognizes as adequate to prevent structural damage caused by water intrusion.

Waterproofing an existing basement begins with excavating to the bottom sides of the footings. Once excavated, the walls are then power washed and allowed to dry. The dry walls are sealed with a waterproofing membrane,<sup>[3]</sup> and new drainage tiles (weeping tiles) are placed at the side of the footing.

A French drain, PVC pipe, or other drainage system is installed and water is led further from the basement.

## Polymer

[edit]

Over the past ten years, polymer-based waterproofing products have been developed. Polymer-based products last for the lifetime of the building and are not affected by soil pH. Polymer-based waterproofing materials can be sprayed directly onto a wall, are very fast curing, and are semi-flexible, allowing for some movement of the substrate.

## Causes of water seepage and leaks

[edit]

Water seepage in basement and crawl spaces usually occurs over long periods of time and can be caused by numerous factors.

- Concrete is one of the most commonly used materials in home construction. When pockets of air are not removed during construction, or the mixture is not allowed to cure properly, the concrete can crack, which allows water to force its way through the wall.
- Foundations (footings) are horizontal pads that define the perimeter of foundation walls. When footings are too narrow or are not laid deep enough, they are susceptible to movement caused by soil erosion.
- Gutters and downspouts are used to catch rain water as it falls and to discharge it away from houses and buildings. When gutters are clogged or downspouts are broken, rainwater is absorbed by the soil near the foundation, increasing hydrostatic pressure.
- Weeping tile is a porous plastic drain pipe installed around the perimeter of the house. The main purpose of external weeping tile is preventing water from getting into a basement. However, these pipes can become clogged or damaged, which causes excess water to put pressure on internal walls and basement floors.

- Water build up inside window wells, after heavy rain or snow, can lead to leaks through basement window seams. Window well covers can be used to prevent water from accumulating in the window well.
- Ground saturation is another common form of basement leaks. When the footing drain fails the ground around the basement can contain too much water and when the saturation point is met flooding can occur.

## Warning signs of water damage

[edit]

Signs that water is seeping into a basement or crawlspace often take years to develop and may not be easily visible. Over time, multiple signs of damage may become evident and could lead to structural failure.

- Cracked walls: Cracks may be horizontal, vertical, diagonal or stair-stepped. Severe pressure or structural damage is evident by widening cracks.
- Buckling walls: Usually caused by hydrostatic pressure. Walls appear to be bowed inward.
- Peeling paint: Water seeping through walls may lead to bubbling or peeling paint along basement walls.<sup>[4]</sup>
- Efflorescence: White, powdery residue found on basement walls near the floor.
- Mold: Fungi that usually grow in damp, dark areas and can cause respiratory problems after prolonged exposure.

## Foundation crack injections

[edit]

Foundation crack injections are used when poured concrete foundations crack, either from settlement or the expansion and contraction of the concrete. Epoxy crack injections are typically used for structural purposes while hydrophobic or hydrophilic polyurethane injections are used to seal cracks to prevent penetration of moisture or water. Concrete is both strong and inexpensive, making it an ideal product in construction. However, concrete is not waterproof.

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[edit]

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## About Cook County

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## Things To Do in Cook County

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### Photo

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### Sand Ridge Nature Center

4.8 (96)

### Photo

## River Trail Nature Center

4.6 (235)

## Photo

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## Palmisano (Henry) Park

4.7 (1262)

## Driving Directions in Cook County

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Driving Directions From Palmisano (Henry) Park to

Driving Directions From Lake Katherine Nature Center and Botanic Gardens to

Driving Directions From Navy Pier to

<https://www.google.com/maps/dir/Navy+Pier/United+Structural+Systems+of+Illinois%2C+187.6050944,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sunknown!2m2!1d-87.6050944!2d41.8918633!1m5!1m1!1sChIJ-wSxDtinD4gRiv4kY3RRh9U!2m2!1d-88.1396465!2d42.0637725!3e0>

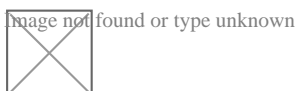
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## Reviews for

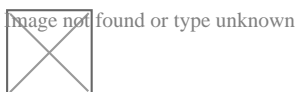
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**Jeffery James**

**(5)**

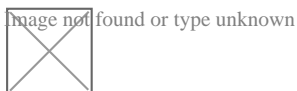
Very happy with my experience. They were prompt and followed through, and very helpful in fixing the crack in my foundation.



**Sarah McNeily**

**(5)**

USS was excellent. They are honest, straightforward, trustworthy, and conscientious. They thoughtfully removed the flowers and flower bulbs to dig where they needed in the yard, replanted said flowers and spread the extra dirt to fill in an area of the yard. We've had other services from different companies and our yard was really a mess after. They kept the job site meticulously clean. The crew was on time and friendly. I'd recommend them any day! Thanks to Jessie and crew.

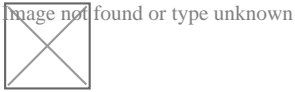


**Jim de Leon**

**(5)**

It was a pleasure to work with Rick and his crew. From the beginning, Rick listened to my concerns and what I wished to accomplish. Out of the 6 contractors that quoted the project, Rick seemed the MOST willing to accommodate my wishes. His pricing was definitely more than fair as well. I had 10 push piers installed to stabilize and lift an addition of my house. The project commenced at the date that Rick had disclosed initially and it was completed within the same time period expected (based on Rick's original assessment). The crew was well informed, courteous, and hard working. They were not loud (even while equipment was being utilized) and were well spoken. My neighbors were very impressed on how polite they were when they entered / exited my property (saying hello or good morning each day when they crossed paths). You can tell they care about the customer concerns. They ensured that the property would be put back as clean as possible by placing MANY sheets of plywood down prior to excavating. They compacted the dirt back in the holes extremely well to avoid large stock piles of soils. All the while, the main office was

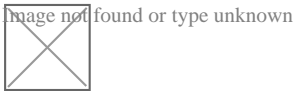
calling me to discuss updates and expectations of completion. They provided waivers of lien, certificates of insurance, properly acquired permits, and JULIE locates. From a construction background, I can tell you that I did not see any flaws in the way they operated and this an extremely professional company. The pictures attached show the push piers added to the foundation (pictures 1, 2 & 3), the amount of excavation (picture 4), and the restoration after dirt was placed back in the pits and compacted (pictures 5, 6 & 7). Please notice that they also sealed two large cracks and steel plated these cracks from expanding further (which you can see under my sliding glass door). I, as well as my wife, are extremely happy that we chose United Structural Systems for our contractor. I would happily tell any of my friends and family to use this contractor should the opportunity arise!



**Chris Abplanalp**

**(5)**

USS did an amazing job on my underpinning on my house, they were also very courteous to the proximity of my property line next to my neighbor. They kept things in order with all the dirt/mud they had to excavate. They were done exactly in the timeframe they indicated, and the contract was very details oriented with drawings of what would be done. Only thing that would have been nice, is they left my concrete a little muddy with boot prints but again, all-in-all a great job



**Dave Kari**

**(5)**

What a fantastic experience! Owner Rick Thomas is a trustworthy professional. Nick and the crew are hard working, knowledgeable and experienced. I interviewed every company in the area, big and small. A homeowner never wants to hear that they have foundation issues. Out of every company, I trusted USS the most, and it paid off in the end. Highly recommend.

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