Structural Engineer

- **Identifying Common Issues and Symptoms of residential foundations**
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  Spotting Early Warning Signs of Foundation Stress Recognizing Cracks and Shifts in Concrete Floors Understanding Sticky Doors and Window Alignment Pinpointing Sinking Spots around the Foundation Perimeter Tracking Water Intrusion as a Contributor to Structural Damage How Uneven Floors Reveal Deeper Foundation Concerns Identifying Subtle Changes in Exterior Walls When Hairline Drywall Cracks Indicate Movement Monitoring Seasonal Soil Movement for Foundation Clues Evaluating Soil Erosion and Its Impact on Stability Noting Shifting Porches and Deck Attachments Examining Sloping Floors for Underlying Settlement
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*** Understanding the Significance of Exterior Wall Inspection for Foundation Health**

Okay, let's talk about your house, specifically, the walls on the outside and why giving them a good once-over is surprisingly important for something you can't even see: your foundation. Preventative maintenance can reduce the need for extensive foundation repairs home foundation repair service interior design. Think of your exterior walls as the foundation's early warning system. They're often the first place subtle problems down below will telegraph their distress. We're not talking about major cracks that scream 'Houston, we have a problem!'. We're talking about the *subtle* changes, the things your eye might just gloss over if you're not paying attention.

Why bother, you ask? Well, your foundation is what's holding everything up, literally. If it starts to fail, even a little bit, it can lead to a cascade of problems. Ignoring these early warning signs can mean a small, relatively inexpensive fix turns into a major, wallet-busting renovation down the line. Nobody wants that.

So, what are we looking for? Pay attention to cracks, even hairline ones. Are they new? Have they gotten bigger? Are they vertical, horizontal, or stair-stepping? Stair-stepping cracks, which follow the mortar lines in brick or block walls, are often a sign of foundation settlement. Bulging or bowing walls are also a major red flag. Also, look for areas where the siding appears distorted or uneven. This could indicate that the wall beneath is shifting or sinking.

And don't forget to check around windows and doors. Are they sticking? Are there cracks radiating out from the corners? These can be signs that the wall around them is under stress due to foundation movement.

The key is to be observant and proactive. A regular exterior wall inspection, even just a quick walk-around a few times a year, can help you catch these subtle changes early. And if you do spot something that concerns you, don't hesitate to call in a professional. A foundation expert can assess the situation and recommend the best course of action, potentially saving you a lot of money and headaches in the long run. Think of it as preventative medicine for your house – a little attention now can save a whole lot of pain later.

*** Recognizing Normal vs. Abnormal Wall Features in Residential Structures**

Okay, so you're walking around a house, right? Maybe you're thinking about buying it, or maybe you're just doing a routine check. Either way, the walls are talking to you, even if you don't realize it. They're telling a story about the house's history, its health, and maybe even its future. The trick is learning to listen. And that means recognizing what "normal" looks like versus what screams "abnormal."

Think about it. A perfectly smooth, uniformly colored wall isn't necessarily normal. It's *ideal*, maybe, but real houses settle, they age, they breathe. So you're looking for subtle stuff. A slight bow in a long wall might just be imperfect framing. But if it's accompanied by cracks, especially stair-step cracks that follow the mortar lines in brick or block, that's a whole different ballgame. That suggests foundation movement, and that's a problem that needs professional attention.

Likewise, a little bit of staining around a window? Could be nothing more than rain runoff. But if that staining is excessive, or if the paint is blistering and peeling, that points to a moisture problem. Maybe a leaky window, maybe a problem with the roof diverting water incorrectly. Again, something worth investigating further.

And it's not just about the big obvious things. Sometimes, the subtle stuff is the most telling. A patch of slightly different colored brick could indicate a previous repair. That's not inherently bad, but you'd want to know *why* the repair was needed in the first place. Was it just cosmetic damage, or was there a structural issue that's been addressed?

Basically, you're trying to build a mental picture of what a healthy, well-maintained wall *should* look like, given the age and style of the house. Then, anything that deviates from that picture – a subtle discoloration, a slight bulge, an unusual pattern of cracks – becomes a clue. It's not about being an expert overnight, but about noticing the details, asking questions, and knowing when to call in someone who *is* an expert to take a closer look. Because those subtle changes in exterior walls? They can be the first whispers of bigger, more expensive problems down the road.

*** Common Types of Subtle Exterior Wall Changes Indicating Foundation Issues**

Okay, so you're walking around your house, maybe admiring the landscaping, and you glance up at the exterior walls. Everything *looks* fine, right? But sometimes, your foundation is trying to tell you something, and it's whispering, not shouting. Those whispers are often subtle changes to your exterior walls, and catching them early can save you a world of headache (and a mountain of money).

Think of it like this: your foundation is the bones, and the walls are the skin. If the bones shift, the skin's going to show it somehow. What are some of these subtle "skin" changes? Well, for starters, look for cracks. We're not talking about hairline cracks that are just settling – those are usually no big deal. We're talking about cracks that are wider than a pencil lead, or that are stair-stepping along brickwork, or that are appearing suddenly. These can indicate that the foundation is shifting and pulling on the walls.

Another thing to watch out for is bulging. If a section of your wall looks like it's pushing outwards, even slightly, that's a red flag. It might be harder to spot, so try looking at the wall from different angles, especially from a distance. Bulging often means there's pressure from the inside, maybe from soil expanding against the foundation wall.

Then there's sticking doors and windows. This might seem like an interior problem, but if doors and windows that used to open and close smoothly are suddenly sticking or jamming, it could be because the wall around them is shifting. The change in the wall's alignment puts pressure on the frames, making them difficult to operate.

Finally, keep an eye out for displaced siding or brick. If you notice that your siding panels are no longer flush, or that bricks are starting to separate and create gaps, it could be a sign that the wall behind them is moving. This is especially concerning if the displacement is accompanied by any of the other signs mentioned above.

The key takeaway is to be observant. Regularly walk around your house and really *look* at the exterior walls. Don't dismiss small changes as insignificant. If you spot something that doesn't look quite right, document it with photos and dates. If you're concerned, it's always best to call in a foundation expert to take a look. It's better to be safe than sorry when it comes to the stability of your home.

*** Techniques for Detecting Minor Cracks, Bulges, and Leans**

Alright, so you're walking around, checking out the exterior walls of a building, right? You're not looking for gaping holes or obvious collapses. You're hunting for the *subtle* stuff, the little whispers of trouble brewing. We're talking minor cracks, bulges you can barely see, and leans that might just be your eyes playing tricks on you. How do you even begin to find these ghosts of structural problems?

Well, first, forget just glancing. You need to really *look*. Start with good lighting – early morning or late afternoon sun can cast shadows that highlight small imperfections. Get up close and personal. Run your hand along the wall, feel for slight variations in texture that could indicate a patched crack or a subtle bulge. Trust your fingertips!

For cracks, think about patterns. Are they hairline and random (probably just cosmetic shrinkage)? Or are they stair-stepping along mortar joints (potentially a sign of foundation movement)? A crack that widens over time? Definitely keep an eye on that one. A crack width gauge can be a handy tool for monitoring movement.

Bulges are trickier. A long, straight edge (like a spirit level or a metal ruler) held against the wall can reveal subtle deviations from a true plane. Look for areas where the straight edge doesn't sit flush. Also, pay attention to how light reflects off the wall. An unexpected highlight or shadow might indicate a slight outward curve.

And then there's the lean. This is where things get really subjective. Stand back and sight along the top of the wall, comparing it to a plumb line (you can even just hang a string with a weight). Is it truly vertical? Often, it's helpful to compare the lean to nearby walls. If *everything* leans the same way, it might just be the way the building was originally constructed. But if one section leans noticeably more than others, that's a red flag.

Ultimately, spotting these subtle changes is about careful observation, a little bit of detective work, and knowing what to look for. It's about paying attention to the small details that can tell a bigger story about the health of the building. And of course, if you see something that concerns you, calling in a qualified professional to assess the situation is always the best course of action.

*** The Role of Professional Foundation Repair Services in Early Intervention**

Okay, let's talk about your house. I mean, *really* talk about it. We all notice the big stuff, right? The obvious crack in the driveway, the paint peeling like a sunburned tourist. But what about those subtle whispers your house is sending? Those tiny cracks in the exterior walls that you might dismiss as "just settling?" That's where professional foundation repair services come in, acting like early intervention specialists for your home's well-being.

Think of it like this: a little twitch in your arm might be nothing, or it could be the first sign of something more serious. You wouldn't ignore it, would you? Your house deserves the same consideration. These guys, the foundation repair folks, they're trained to see those subtle shifts, those barely-there cracks, that might indicate a bigger problem brewing beneath the surface. They're like the doctors of your house, using their experience and specialized tools to diagnose potential issues before they turn into full-blown emergencies.

Why is early intervention so important? Well, ignoring these subtle changes is like ignoring that twitch until your whole arm is numb. A small, easily fixable foundation issue can snowball into something much larger and much more expensive if left unchecked. We're talking major structural damage, water intrusion, warped floors, even doors and windows that won't close properly. Suddenly, that "minor" crack has turned into a major headache and a significant hit to your wallet.

Professional foundation repair services don't just patch things up; they address the *root cause* of the problem. They understand the soil composition around your home, the drainage patterns, and the various factors that can contribute to foundation movement. This allows them to implement solutions that are not only effective but also long-lasting, preventing future issues from arising.

Ultimately, engaging a qualified foundation repair service for early intervention is an investment in the long-term health and stability of your home. It's about being proactive rather than reactive, catching problems early before they become overwhelming. It's about listening to those subtle whispers your house is sending and ensuring it remains a safe and sound haven for you and your family for years to come. So, next time you're admiring your home's exterior, take a closer look. Maybe, just maybe, it's trying to tell you something. And maybe, just maybe, it's time to call in the professionals.

*** Documenting and Reporting Exterior Wall Changes for Accurate Diagnosis**

Okay, so you're trying to figure out what's going on with your exterior walls, right? Maybe you've noticed something… different. A slight discoloration, a hairline crack, a weird bulge you swear wasn't there before. The thing is, those subtle changes? They're clues. And like any good detective, you need to document them meticulously to get the real story. That's where documenting and reporting exterior wall changes becomes super important for accurate diagnosis.

Think of it this way: your exterior walls are constantly battling the elements. Sun, rain, wind, ice… it all takes a toll. And sometimes, the damage isn't immediately obvious. Maybe water is seeping in behind the siding, causing rot that you can't see. Or maybe there's a slow, creeping foundation issue that's putting stress on the wall. If you just ignore it, you're letting the problem fester and potentially turn into something much bigger (and much more expensive!).

So, how do you document these subtle changes? Start with the basics. Grab a notebook and a camera (your phone works great). Walk around the entire perimeter of your house, looking closely at the walls. Note down anything that seems out of the ordinary. Cracks, even tiny ones, should be documented. Measure their length and width (roughly is fine). Take pictures of everything. Zoom in on the details. Make sure to note the location of each change – is it near a window, a door, the foundation? The more specific you are, the better.

Don't just rely on your memory. Human memory is notoriously faulty. Write everything down as you see it. Include the date and time of your observation. Over time, you might notice that a crack is getting bigger, or a discoloration is spreading. Having dated records will help you track the progression of the problem.

Now, about reporting. Once you've gathered your evidence, what do you do with it? Well, if you're concerned about the structural integrity of your house, or if you suspect a serious issue, you need to share your findings with a professional. A qualified contractor, a structural engineer, or even a home inspector can assess the situation and give you an accurate diagnosis. Provide them with your detailed documentation – your notes, your photos, everything. The more information you give them, the better equipped they'll be to figure out what's going on and recommend the best course of action.

In the end, documenting and reporting exterior wall changes is about being proactive. It's about catching small problems before they become big ones. It's about protecting your investment and ensuring the long-term health of your home. So, keep an eye on those walls. They're trying to tell you something. And with a little careful observation and documentation, you can be sure you're listening.

*** Preventative Measures to Minimize Foundation Problems and Wall Damage**

Okay, so you're starting to notice some little things with your exterior walls, right? Maybe a hairline crack here, a slight bulge there. Before you panic and imagine your house crumbling, let's talk about keeping those little changes from becoming big, expensive nightmares. We're talking preventative measures, the kind that save you headaches (and money) down the road.

Think of your foundation and walls as a team. If the foundation is weak, the walls are going to suffer. So, first things first: water management. Water is enemy number one. Make sure your gutters are clear and directing water well away from the foundation. Seriously, check them after every big storm. Proper grading around your house is also crucial. The ground should slope away from the foundation, again, to divert water. If water is pooling near your foundation, that's a red flag waving frantically. Consider adding extensions to downspouts or even installing a French drain if you have persistent water issues.

Next, think about vegetation. Those beautiful trees and shrubs? Their roots can be surprisingly aggressive. They can burrow under foundations, causing cracks and instability. Keep trees trimmed back and plant new ones a safe distance away from your house. The same goes for bushes. Make sure they aren't constantly rubbing against the walls, which can trap moisture and damage the siding.

Finally, a little TLC goes a long way. Regularly inspect your exterior walls. Look for cracks, discoloration, or any areas that seem damp or soft. Patch any small cracks promptly. Recaulk around windows and doors to prevent water intrusion. A good coat of paint can also protect your walls from the elements. These little maintenance tasks are like vitamins for your house, keeping it strong and healthy and preventing those subtle changes from turning into major problems. By being proactive, you can keep your foundation solid and your walls standing tall for years to come.

About basement waterproofing

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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

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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

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

French Drain

- Image not found or type unknown
  French drain

- Interior wall and floor sealers
  - Interior water drainage
  - Exterior drainage
  - Exterior waterproofing coatings
  - Box type waterproofing[1]
  - Foundation crack injections
  - French drains
  - Sump pump

Interior sealants

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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

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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.[2] 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

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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,[3] 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

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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

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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

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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.[4]
- 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

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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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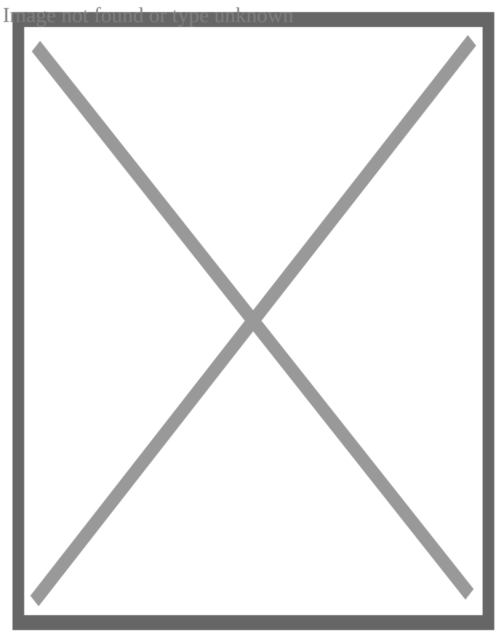
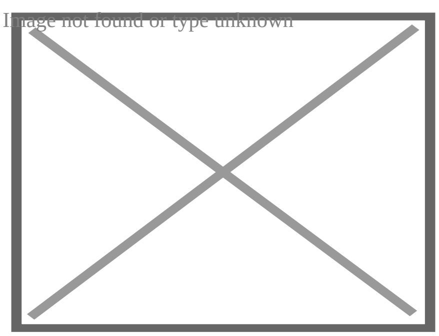
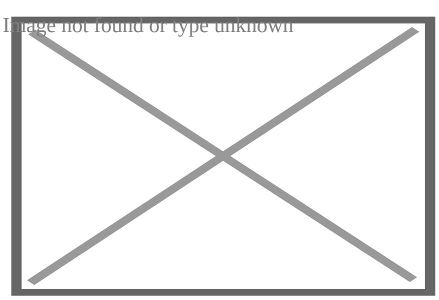
About geotechnical engineering



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

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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.[1]

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.[1][2]

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 friction $\sigma\tan(\phi)$, where σ is the normal stress on the slip plane and ϕ is the friction angle 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 c is not a fundamental soil property, the Mohr-Coulomb theory is still used in practice today.[3]

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.[1][2] 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.[4] 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.[1][3][5] 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.[6]

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

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Geotechnical investigation

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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.[7][8]

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.[9]

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.[10]

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.[11]

Earthworks

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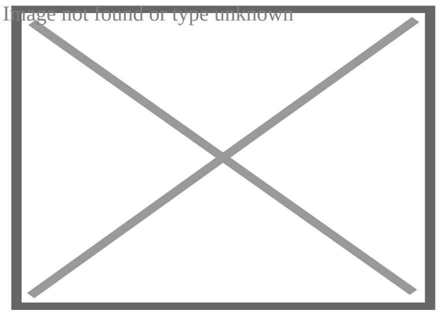


A compactor/roller operated by U.S. Navy Seabees

See also: Earthworks (engineering)

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

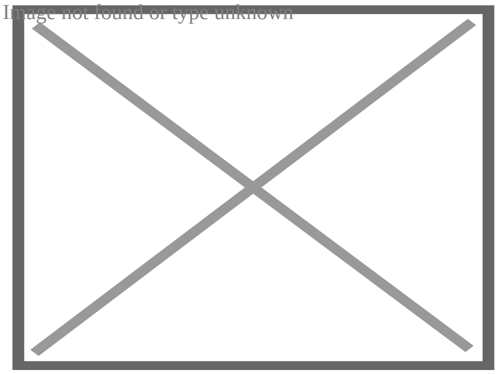
Ground improvement

[edit]

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.[12]

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

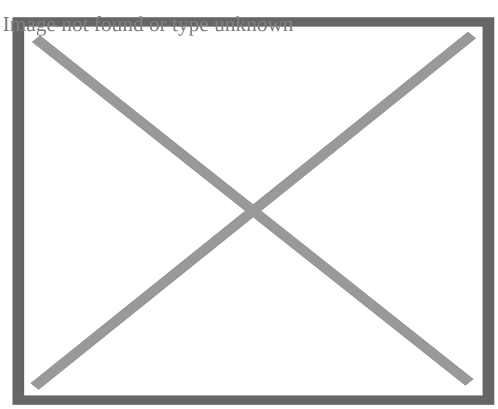
Stability analysis is needed to design engineered slopes and estimate the risk of slope failure in natural or designed slopes by determining the conditions under which the topmost mass of soil will slip relative to the base of soil and lead to slope failure.[13] If the interface between the mass and 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

[edit]

Geosynthetics

[edit]
Main article: Geosynthetics



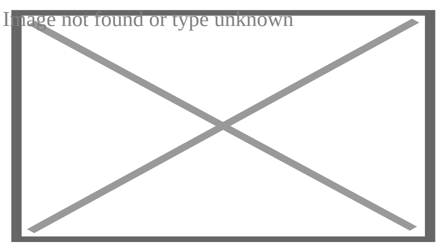
A collage of geosynthetic products.

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.[14] 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.[15]

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.[16]

There are a number of significant differences between onshore and offshore geotechnical engineering.[16][17] 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.[18][19] 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.[20]

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.[21] 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".[22]

The observational method may be described as follows:[22]

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.[22]

See also

[edit]

- icon Image not found or type unknown 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

Specialties and interdisciplinarity

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

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- Biochemical/bioprocess
- Biological

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
	    ◦ M–Z
	◦ Aerospace engineering
	◦ Civil engineering
	◦ Electrical and electronics engineering
	◦ Mechanical engineering
	◦ Structural engineering

Other	◦ Agricultural
	◦ Audio
	◦ Automation
	◦ Biomedical
	    ◦ Bioinformatics
	    ◦ Clinical
	    ◦ Health technology
	    ◦ Pharmaceutical
	    ◦ Rehabilitation
	◦ Building services
	    ◦ MEP
	◦ Design
	◦ Explosives
	◦ Facilities
	◦ Fire
	◦ Forensic
	◦ Climate
	◦ Geomatics
	◦ Graphics
	◦ Industrial
	◦ Information
	◦ Instrumentation
	    ◦ Instrumentation and control
	◦ Logistics
	◦ Management
	◦ Mathematics
	◦ Mechatronics
	◦ Military
	◦ Nuclear
	◦ Ontology
	◦ Packaging
	◦ Physics
	◦ Privacy
	◦ Safety
	◦ Security
	◦ Survey
	◦ Sustainability
	◦ Systems
	◦ Textile

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Soil science

- History
- Index

Main fields

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

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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
  - Pore space in soil
  - Pore water pressure
- Soil crust
- Soil horizon
- Soil biomantle
- Soil carbon
- Soil gas
  - Soil respiration
- Soil organic matter
- Soil moisture
  - Soil water (retention)

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Soil classification

World Reference Base for Soil Resources (1998–)	◦ Acrisols ◦ Alisols ◦ Andosols ◦ 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
- Geotechnical engineering
- 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 science
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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
		  ◦ Dynamic
		  ◦ Statnamic
		◦ Pore pressure measurement
		  ◦ Piezometer
		  ◦ Well
		◦ Ram sounding
		◦ Rock control drilling
		◦ Rotary-pressure sounding
		◦ Rotary weight sounding
		◦ Sample series
		◦ Screw plate test
		◦ Deformation monitoring
		  ◦ Inclinometer
		  ◦ Settlement recordings
		◦ Shear vane test
		◦ Simple sounding
		◦ Standard penetration test
		◦ Total sounding
		◦ Trial pit
		◦ Visible bedrock
		◦ Nuclear densometer test
		◦ Exploration geophysics
		◦ Crosshole sonic logging
		◦ Pile integrity test

Soil

Types

- Clay
- Silt
- Sand
- Gravel
- Peat
- Loam
- Loess

Properties

- Hydraulic conductivity
- Water content
- Void ratio
- Bulk density
- Thixotropy
- Reynolds' dilatancy
- Angle of repose
- Friction angle
- Cohesion
- Porosity
- Permeability
- Specific storage
- Shear strength
- Sensitivity

Structures (Interaction)	Natural features	○ Topography ○ Vegetation ○ Terrain ○ Topsoil ○ Water table ○ Bedrock ○ Subgrade ○ Subsoil

	Earthworks	○ 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
		    ○ Geotextile
		    ○ Geomembrane
		    ○ Geosynthetic clay liner
		    ○ Cellular confinement
		○ Infiltration

	Foundations	○ Shallow ○ Deep

Mechanics	Forces	○ Effective stress ○ Pore water pressure ○ Lateral earth pressure ○ Overburden pressure ○ Preconsolidation pressure

	Phenomena/ problems	○ Permafrost
		○ Frost heaving
		○ Consolidation
		○ Compaction
		○ Earthquake
		    ○ Response spectrum
		    ○ Seismic hazard
		    ○ Shear wave
		○ Landslide analysis
		    ○ Stability analysis
		    ○ Mitigation
		    ○ Classification
		    ○ Sliding criterion
		    ○ Slab stabilisation
		○ Bearing capacity * Stress distribution in soil

Numerical analysis software	○ SEEP2D ○ STABL ○ SVFlux ○ SVSlope ○ UTEXAS ○ Plaxis	

Related fields

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

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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

Organizations	◦ 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
By country	◦ India ◦ Iran ◦ Japan ◦ Romania ◦ Turkey ◦ United Kingdom ◦ United States
Regulation	◦ Building code ◦ Construction law ◦ Site safety ◦ Zoning

Architecture	◦ Style
	    ◦ List
	◦ Industrial architecture
	    ◦ British
	◦ Indigenous architecture
	◦ Interior architecture
	◦ Landscape architecture
	◦ Vernacular architecture

Engineering	◦ Architectural engineering
	◦ Building services engineering
	◦ Civil engineering
	    ◦ Coastal engineering
	    ◦ Construction engineering
	    ◦ Structural engineering
	◦ Earthquake engineering
	◦ Environmental engineering
	◦ Geotechnical engineering

Methods	◦ List ◦ Earthbag construction ◦ Modern methods of construction ◦ Monocrete construction ◦ Slip forming

- Building material
    - List of building materials
    - Millwork
- Construction bidding
- Construction delay
- Construction equipment theft
- Construction loan
- Construction management
- Construction waste
- Demolition
- Design–build
- Design–bid–build
- DfMA
- Heavy equipment
- Interior design
- Lists of buildings and structures
    - List of tallest buildings and structures
- Megaproject
- Megastructure
- Plasterwork
    - Damp
        - Proofing
    - Parge coat
    - Roughcast
        - Harling
- Real estate development
- Stonemasonry
- Sustainability in construction
- Unfinished building
- Urban design
- Urban planning

Other topics

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About Cook County

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Things To Do in Cook County

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Sand Ridge Nature Center

4.8 (96)

Photo

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River Trail Nature Center

4.6 (235)

Photo

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Palmisano (Henry) Park

4.7 (1262)

Driving Directions in Cook County

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+Inc/@41.8918633,-87.6050944,14z/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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https://www.google.com/maps/dir/Palmisano+%28Henry%29+Park/United+Structural+Systems+of+Illinois%2
87.6490151,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sunknown!2m2!1d-
87.6490151!2d41.8429903!1m5!1m1!1sChIJ-wSxDtinD4gRiv4kY3RRh9U!2m2!1d-
88.1396465!2d42.0637725!3e1

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.

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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.

Image not found or type unknown

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!

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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

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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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- Measuring Soil Moisture for Stabilizing Foundations
- Examining Expansive Clay in Residential Areas
- Evaluating Groundwater Levels for Long Term Stability

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