



- **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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Repair

* Cost Considerations and ROI of Carbon Fiber Solutions

* What are Push Piers and How Do They Work?

Okay, so you're wondering about push piers, huh? Obtaining proper permits is necessary for any foundation repair service [foundation repair service](#) entrance stairs. Imagine your house is a little sad, maybe leaning or cracking a bit. It's likely the ground underneath it isn't doing its job properly. Push piers are kind of like underground superheroes that come to the rescue.

Simply put, they're steel shafts that are driven deep, deep down into the earth until they hit something solid, like bedrock or really stable soil. Think of it like driving a stake into the ground, but on a much grander, more engineered scale. These piers are then attached to your foundation, and they essentially transfer the weight of your house from the unstable soil above to this much stronger, deeper layer.

How do they work? Well, hydraulic rams are used to push these piers into the ground, one section at a time. Each section is connected, and the process continues until the pier reaches a point of refusal – meaning it can't be pushed any further because it's hit that solid, load-bearing stratum. Once the piers are in place, the weight of your house is gradually transferred onto them. In some cases, the foundation can even be lifted back towards its original position!

Ultimately, push piers are a powerful tool for stabilizing and, in some cases, lifting foundations that have settled or are sinking. They provide a solid, reliable support system that can last for years, helping to protect your home from further damage. They're not a magic bullet for every foundation problem, but when soil instability is the culprit, they can be a real game-changer.

* Identifying Signs That Push Piers May Be Needed

Okay, so you're thinking about push piers, huh? Probably because you're noticing some *things* around your house that just don't feel quite right. Let's talk about what those "things" might be. Think of it like this: your house is trying to tell you something, and push piers are the potential answer to its plea.

First off, the classic: cracks. We're not talking about those hairline cracks in your plaster that happen when the seasons change. We're talking about cracks that are growing, or getting

wider, or zig-zagging across your walls like a drunken lightning bolt. Especially if they're around doors and windows, or running along your foundation itself. Those are red flags waving furiously.

Then there's the "stuck door" syndrome. Suddenly, doors that used to swing smoothly are fighting you. They're sticking, or dragging, or refusing to latch properly. Windows might be doing the same thing. This isn't just annoying; it's a sign the house is settling unevenly, throwing everything out of square.

Look down! Are your floors sloping? A slight dip might be normal in an older home, but if you can roll a marble across the room without touching it, that's a problem. Similarly, are you seeing gaps between the wall and the floor, or the wall and the ceiling? These are all clues that your foundation is moving.

Outside, take a stroll around your property. Is your chimney leaning? Are there noticeable bulges or bows in your foundation walls? Water pooling around your foundation is another bad sign, as it can exacerbate any existing problems.

Finally, listen to your gut. If something just **feels** off, if you're constantly noticing new little problems, or if you're just generally worried about the stability of your home, it's always best to get a professional opinion. These signs don't automatically mean you **need** push piers, but they definitely mean it's time to investigate further. Ignoring them won't make them go away; they'll just get worse (and more expensive) over time. So, keep an eye out, stay vigilant, and listen to what your house is trying to tell you. It might just save you a lot of headaches – and money – in the long run.

*** The Push Pier Installation Process: A Step-by-Step Guide**

Okay, so you're thinking about push piers for foundation repair. Smart move! But before you jump in, let's break down the installation process. It's not magic, but it's definitely a skilled job. Think of it like this: you've got a house that's decided to take a little nap on one side, and push piers are the gentle giants that are going to help it stand tall again.

First off, there's the prep work. The crew will excavate around the foundation where the piers will go. This usually means digging down to expose the footing. It's a bit messy, but necessary to get everything in place. Then comes the actual installation. Steel brackets are attached to the footing. These brackets are the connection point between the house and the piers. They're crucial, so they need to be rock-solid.

Next, the push piers themselves are hydraulically driven deep into the soil. We're talking way down, past the unstable ground, until they hit bedrock or a really dense, load-bearing stratum. This is where the "push" comes in – they're literally pushing those piers down until they find something solid to hold onto. It's a bit like planting a strong, steel tree deep in the earth.

Once all the piers are in place and firmly anchored, the lifting begins. Using hydraulic jacks, the foundation is carefully and slowly raised back to its original position. This is the delicate part. You don't want to rush it, or you could cause more damage. It's all about controlled, gradual movement.

Finally, after the lifting is complete, the excavation is backfilled, and the site is cleaned up. The soil is compacted, and hopefully, you won't even notice they were there, except for your nicely leveled house! The whole process takes skill, patience, and the right equipment.

So, that's the gist of it. Push pier installation is a process that involves careful excavation, precise bracket installation, deep pier driving, and controlled lifting. It's a serious undertaking, but when done right, it can save your foundation and your sanity. And honestly, having a stable foundation? That's worth its weight in gold.

*** Benefits of Using Push Piers for Foundation Stabilization**

Okay, so you're looking at foundation problems, huh? That's never a fun place to be. But hey, at least you're tackling it head-on. And if you're researching push piers for foundation stabilization, you're on the right track. Let's talk about why they're often a go-to solution and what makes them beneficial.

Think of your foundation as the base of your house, right? If that base starts to sink, settle unevenly, or crack, well, everything above it suffers. Push piers are basically steel posts that get driven deep into the ground, down to stable, load-bearing soil or bedrock. They act like new, super-strong legs for your foundation.

One of the biggest benefits is stability, obviously. Once they're installed, they provide a solid, reliable support system. They transfer the weight of your house from the unstable soil that's causing the problem to something that can actually handle it. This helps prevent further sinking and cracking.

Another great thing is that they often offer the opportunity to lift the foundation back towards its original position. Depending on the severity of the settlement, this can close cracks, level floors, and even make doors and windows work properly again. It's not always possible to get everything perfectly back to where it was, but even a partial lift can make a huge difference.

Compared to some other foundation repair methods, push piers are relatively non-invasive. Sure, there's digging involved to install them, but it's usually localized around the perimeter of your house. You're not tearing up your entire yard. Plus, installation is often quicker than other methods, meaning less disruption to your life.

And let's not forget about the peace of mind. Knowing your foundation is properly supported and stabilized can take a huge weight off your shoulders. It's an investment in the long-term health and value of your home. When considering selling your home, a stabilized foundation

is a major plus for potential buyers.

Of course, push piers aren't a one-size-fits-all solution. A qualified foundation repair specialist needs to assess your specific situation to determine if they're the right choice for you. But if they are, the benefits of using push piers for foundation stabilization are substantial. They offer stability, potential lift, relatively non-invasive installation, and lasting peace of mind. And that's something worth considering when dealing with a sinking foundation.

*** Comparing Push Piers to Other Foundation Repair Methods**

Okay, so you've got a sinking foundation, a cracked wall, maybe a door that's decided it no longer wants to close properly. Fun times, right? The first thing you're probably doing is frantically Googling "foundation repair," and then you're bombarded with a bunch of jargon like "slab jacking," "helical piers," and of course, "push piers." Let's cut through some of the noise, specifically focusing on how push piers stack up against other common fixes.

Think of it this way: your house is basically resting on the ground, and if that ground shifts or settles unevenly, your foundation pays the price. Some repair methods are more like treating the symptom, while others aim for the root cause. Slab jacking, for instance, involves pumping a grout mixture under the slab to lift it back into place. It's like giving your house a temporary boost. It can work well for minor settlements, but if the underlying soil issues haven't been addressed, that lift might not last. The problem could come back.

Then you have helical piers. These are like giant screws that are twisted deep into the ground, reaching stable soil or bedrock. They're a robust solution, often preferred for heavier structures or areas with really unstable soil. But, they can be more expensive and sometimes overkill for a situation that push piers can handle perfectly well.

Push piers, also called resistance piers, are steel shafts that are hydraulically driven into the ground until they reach a load-bearing stratum. The weight of your house is then transferred onto these piers, stabilizing the foundation. The beauty of push piers lies in their ability to directly address the problem: the unstable soil beneath. They're generally more cost-effective than helical piers, and they're a good option when you need a solid, reliable fix without breaking the bank.

The key takeaway? There's no one-size-fits-all answer. The best method depends entirely on the specific issues affecting your foundation, the soil conditions, and your budget. A qualified foundation repair specialist should thoroughly assess your situation and explain the pros and cons of each option, helping you choose the solution that's right for your home. Don't just pick the cheapest; pick the one that will actually solve the problem for the long haul.

*** Cost Considerations and Factors Affecting Pricing**

Okay, so you're thinking about push piers for your foundation, huh? Smart move – they can really be a lifesaver when things are sinking or shifting. But let's be real, the big question is always: how much is this going to **cost**? And honestly, there's no one-size-fits-all answer. It's a bit like asking "how much does a car cost?" Well, a beat-up clunker is different than a shiny new sports car, right? Same deal here.

A bunch of things play into the final price tag. First off, the **size of the job** is huge. Are we talking about stabilizing a small section of your foundation, or are we looking at the entire perimeter? More piers mean more materials and more labor, and that bumps up the cost. Then there's the **soil**. Is it easy to work with, or is it rocky and dense? Tough soil makes the installation process harder and longer, which, you guessed it, affects the price. The **depth** they need to drive the piers down to load-bearing soil matters too. Deeper is more expensive.

Also, think about **accessibility**. Can the crew easily get their equipment to the area that needs fixing? If they have to navigate tight spaces, move landscaping, or deal with other obstacles, that adds to the complexity (and the bill). And don't forget about **permits**. Depending on where you live, you might need permits for this kind of work, and those come with their own fees.

Finally, the **contractor** you choose makes a difference. Different companies have different overhead and pricing structures. It's always a good idea to get a few quotes and compare them. But don't just go for the cheapest option! Look at their experience, reputation, and warranty. A slightly higher price might be worth it for peace of mind and a job well done.

So, yeah, a lot goes into determining the cost of push pier installation. Getting a professional evaluation is really the best way to figure out what you're looking at. They can assess the specific situation, explain your options, and give you an accurate estimate. Good luck with your foundation repair!

*** Choosing a Qualified Contractor for Push Pier Installation**

Okay, so you're thinking about push piers for your foundation, huh? Smart move. Seriously, if your house is sinking or cracking, push piers can be a lifesaver. But here's the thing: the piers themselves are only half the battle. The **who** puts them in is just as important, maybe even more so. You absolutely, positively, need to choose a qualified contractor. Don't just grab the cheapest option from Craigslist. Trust me on this.

Think about it: this isn't like painting a room. We're talking about the literal foundation of your home, the thing that's holding everything up! A bad installation can be worse than no installation at all. You could end up with even more damage, or piers that fail to do their job. Imagine shelling out thousands of dollars, only to have your house still settling a year later. Nightmare fuel, right?

So, what makes a contractor "qualified"? Experience is huge. Look for someone who's done a bunch of push pier installations, preferably in soils similar to yours. Ask for references, and

actually call them! Don't be shy about asking about problems they encountered and how the contractor handled them.

Beyond experience, make sure they're licensed and insured. Licensing means they've met certain standards and are accountable to a governing body. Insurance protects you if something goes wrong during the installation. You want to be covered if a pipe gets broken or a worker gets injured on your property.

Finally, trust your gut. Do they seem knowledgeable and professional? Are they willing to explain the process clearly and answer all your questions? Do they give you a detailed proposal with a clear scope of work and a fair price? If something feels off, don't ignore it.

Choosing the right contractor for push pier installation isn't just about getting the job done; it's about protecting your biggest investment and ensuring your home's long-term stability. Do your homework, ask the right questions, and choose wisely. Your house (and your wallet) will thank you.

About Chicago metropolitan area

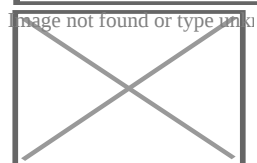
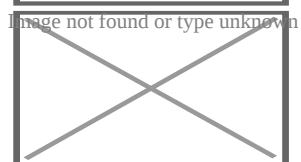
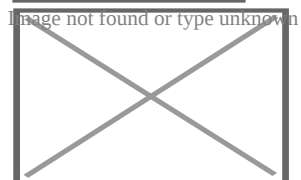
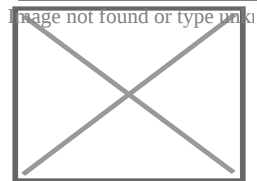
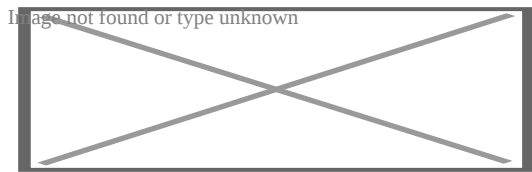
"Chicagoland" redirects here. For other uses, see Chicagoland (disambiguation).

Chicago metropolitan area

Conurbation

Chicago–Naperville, IL–IN–WI

Combined Statistical Area



From top, left to right: Chicago skyline from Lakefront Trail at Northerly Island during sunrise, aerial view Evanston, view of Gold Coast, Downtown Naperville, view of Downtown Aurora

Map

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Map of Chicago–Naperville, IL–IN–WI CSA

Chicago–Naperville–Schaumburg, IL

Elgin, IL Metropolitan Division

Lake County, IL Metropolitan Division

Lake County–Porter County–Jasper Cty, IN

Other Statistical Areas in the Chicago CSA

Kenosha, WI MSA

Ottawa, IL μSA

Michigan City–La Porte, IN MSA

Kankakee, IL MSA

City of Chicago

Chicago–Naperville–Elgin, IL–IN MSA

Country United StatesStates Illinois

Indiana

WisconsinCore city ChicagoSatellite cities

- Aurora
- Elgin
- Crystal Lake
- Joliet
- Naperville
- Schaumburg
- Waukegan
- Kankakee

- - Gary
- - Hammond
- - Michigan City
- - Kenosha

Area

- Metro

10,856 sq mi (28,120 km²)Highest elevation

[¹]

673 ft (205 m)Lowest elevation

[¹]

579 ft (176 m)Population

- Density886/sq mi (342/km²) • Metropolitan Statistical Area (MSA) (2022)

9,441,957[²] (3rd) • Combined Statistical Area (CSA) (2022)

9,806,184 [³] (4th)DemonymChicagolanderGDP

[⁴]

- Metropolitan Statistical Area (MSA)\$894.862 billion (2023) • Combined Statistical Area (CSA)\$919.229 billion (2023)Time zoneUTC−6 (CST) • Summer (DST)UTC−5 (CDT)Area codes219, 224/847, 262, 312/872, 331/630, 574, 464/708, 773/872 and 779/815

The **Chicago metropolitan area**, also referred to as **Chicagoland**, is the largest metropolitan statistical area in the U.S. state of Illinois, and the Midwest, containing the City of Chicago along with its surrounding suburbs and satellite cities. Encompassing 10,286 square mi (28,120 km²), the metropolitan area includes the city of Chicago, its suburbs and hinterland, that span 13 counties across northeast Illinois and northwest Indiana. The MSA had a 2020 census population of 9,618,502 and the combined statistical area, which spans 19 counties

and additionally extends into southeast Wisconsin, had a population of nearly 10 million people.^[5]^[6] The Chicago area is the third-largest metropolitan area in the United States and the fourth-largest metropolitan area in North America (after Mexico City, New York City, and Los Angeles), and the largest in the Great Lakes megalopolis. Its urban area is one of the 40 largest in the world.

According to the 2020 census, the metropolitan's population is approaching the 10 million mark. The metropolitan area has seen a substantial increase of Latin American residents on top of its already large Latino population, and the Asian American population also increased according to the 2020 Census. The metro area has a large number of White, Black, Latino, Asian, and Arab American residents, and also has Native American residents in the region, making the Chicago metropolitan area population truly diverse. The Chicago metropolitan area represents about 3 percent of the entire US population.

Chicagoland has one of the world's largest and most diversified economies. With more than six million full and part-time employees, the Chicago metropolitan area is a key factor of the Illinois economy, as the state has an annual GDP of over \$1 trillion.^[7] The Chicago metropolitan area generated an annual gross regional product (GRP) of approximately \$700 billion in 2018.^[8] The region is home to more than 400 major corporate headquarters, including 31 in the *Fortune* 500^[9] such as McDonald's, United, and Blue Cross Blue Shield. With many companies moving to Chicagoland, and many current companies expanding, the area ranked as the nation's top metropolitan area for corporation relocations and expansions for nine consecutive years, the most consecutive years for any region in the country.^[10]

The Chicago area is home to a number of the nation's leading research universities including the University of Chicago, Northwestern University, the University of Illinois at Chicago, DePaul University, Loyola University, and the Illinois Institute of Technology (IIT). The University of Chicago and Northwestern University are consistently ranked as two of the best universities in the world.

There are many transportation options around the region. Chicagoland has three separate rail networks; the Chicago Transit Authority (CTA), Metra, and the South Shore Line. The CTA operates elevated and subway lines that run primarily throughout the city, Downtown Chicago, and into some suburbs. The CTA operates some of its rail lines 24 hours a day, every day of the year, nonstop service, making Chicago, New York City, and Copenhagen the only three cities in the world to offer some 24 hour rail service running nonstop, everyday throughout their city limits. The Metra commuter rail network runs numerous lines between Downtown Chicago and suburban/satellite cities, with one line stretching to Kenosha, Wisconsin, which is part of the Chicago metropolitan area. The interurban South Shore Line runs between Downtown Chicago and the northwest Indiana portion of the metropolitan area. In addition, Amtrak operates Union Station in Downtown Chicago as one of its largest rail hubs, with numerous lines radiating to and from the station.

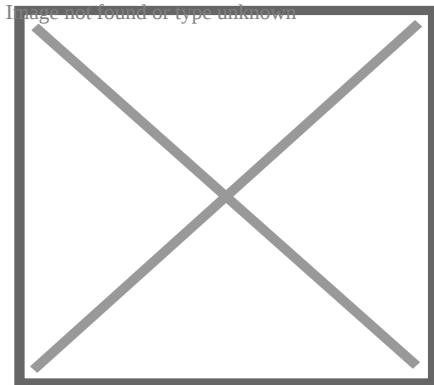
CTA bus routes serve the city proper, with some service into the suburbs. Pace bus routes serve the suburbs, with some service into the city. In addition, numerous CTA bus routes operate 24 hours a day, nonstop.

Definitions

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Chicago Metropolitan statistical area

[edit]



The Chicago–Naperville, IL–IN–WI Combined Statistical Area as defined by the U.S. Office of Management and Budget:

- Chicago–Naperville–Elgin, IL–IN–WI MSA
- Michigan City–La Porte, IN MSA
- Kankakee, IL MSA
- Ottawa, IL MSA

The Chicago metropolitan statistical area (MSA) was originally designated by the United States Census Bureau in 1950. It comprised the Illinois counties of Cook, DuPage, Kane, Lake and Will, along with Lake County in Indiana. As surrounding counties saw an increase in their population densities and the number of their residents employed within Cook County, they met Census criteria to be added to the MSA. The Chicago MSA, now defined by the U.S. Office of Management and Budget (OMB) as the **Chicago–Naperville–Elgin, IL–IN–WI Metropolitan Statistical Area**, is the third-largest MSA by population in the United States. The 2022 census estimate for the population of the MSA was 9,441,957.^[11]

The Chicago MSA is further subdivided into four metropolitan divisions. A breakdown of the county constituents and 2021 estimated populations of the four metropolitan divisions of the MSA are as follows:^[11]

Chicago–Naperville–Elgin, IL–IN–WI Metropolitan Statistical Area (9,509,934)

- *Chicago–Naperville–Schaumburg, IL Metropolitan Division* (7,159,394)
 - Cook County, Illinois (5,173,146)
 - DuPage County, Illinois (924,885)
 - Grundy County, Illinois (52,989)
 - McHenry County, Illinois (311,122)
 - Will County, Illinois (697,252)
- *Elgin, IL Metropolitan Division* (750,869)
 - DeKalb County, Illinois (100,414)
 - Kane County, Illinois (515,588)
 - Kendall County, Illinois (134,867)
- *Lake County, IL Metropolitan Division* (711,239)
 - Lake County, Illinois (711,239)
- *Lake County–Porter County–Jasper County, IN Metropolitan Division* (719,700)
 - Jasper County, Indiana (33,091)
 - Lake County, Indiana (498,558)
 - Newton County, Indiana (13,808)
 - Porter County, Indiana (174,243)

Combined statistical area

[edit]

The OMB also defines a slightly larger region as a combined statistical area (CSA). The **Chicago–Naperville, IL–IN–WI Combined Statistical Area** combines the following core-based statistical areas, listed with their 2021 estimated populations. The combined statistical area as a whole had a population of 9,806,184 as of 2022.^[11]

- *Chicago–Naperville–Elgin, IL–IN–WI metropolitan statistical area* (9,509,934)
- *Kankakee, IL metropolitan statistical area* (106,601)
 - Kankakee County, Illinois (106,601)
- *Michigan City–La Porte, IN metropolitan statistical area* (112,390)
 - LaPorte County, Indiana (112,390)
- *Ottawa, IL micropolitan statistical area* (147,414)
 - Bureau County, Illinois (32,883)
 - LaSalle County, Illinois (108,965)
 - Putnam County, Illinois (5,566)

United Nations' Chicago urban agglomeration

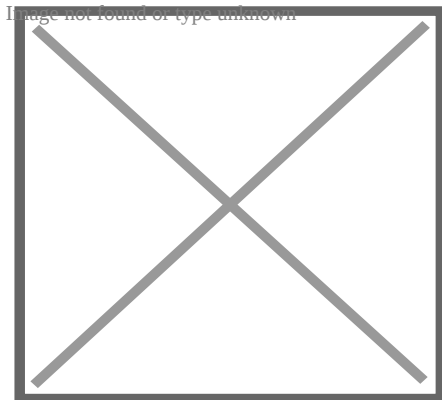
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The Chicago urban agglomeration, according to the United Nations *World Urbanization Prospects* report (2023 revision), lists a population of 8,937,000.^[12] The term "urban

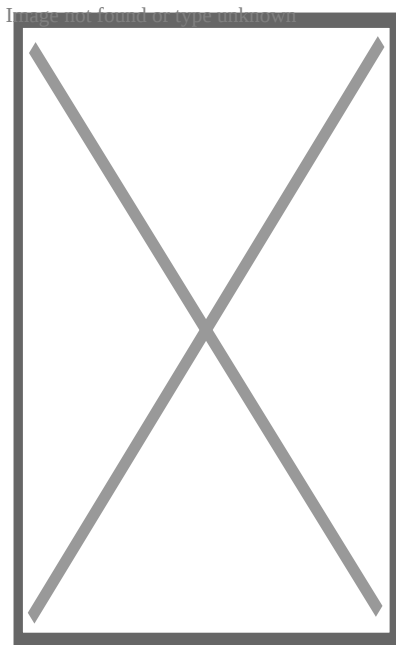
agglomeration" refers to the population contained within the contours of a contiguous territory inhabited at urban density levels. It usually incorporates the population in a city, plus that in the contiguous urban, or built-up area.

Chicagoland

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Chicagoland by county and state^[13]



A map of Chicagoland in relation to the states of Wisconsin, Illinois, and Indiana

Chicagoland is an informal name for the Chicago metropolitan area. The term *Chicagoland* has no official definition, and the region is often considered to include areas beyond the corresponding MSA, as well as portions of the greater CSA.^[citation needed]

Colonel Robert R. McCormick, editor and publisher of the *Chicago Tribune*, usually gets credit for placing the term in common use.^{[14][15]} McCormick's conception of Chicagoland stretched all the way to nearby parts of four states (Indiana, Wisconsin, Michigan, and Iowa).^[14] The

first usage was in the *Tribune's* July 27, 1926, front page headline, "Chicagoland's Shrines: A Tour of Discoveries", for an article by reporter James O'Donnell Bennett.^[16] He stated that Chicagoland comprised everything in a 200-mile (320 km) radius in every direction and reported on many different places in the area. The *Tribune* was the dominant newspaper in a vast area stretching to the west of the city, and that hinterland was closely tied to the metropolis by rail lines and commercial links.^[17]

Today, the *Chicago Tribune's* usage includes the city of Chicago, the rest of Cook County, eight nearby Illinois counties (Lake, McHenry, DuPage, Kane, Kendall, Grundy, Will, and Kankakee), and the two Indiana counties of Lake and Porter.^[18] Illinois Department of Tourism literature uses *Chicagoland* for suburbs in Cook, Lake, DuPage, Kane, and Will counties,^[19] treating the city separately. The Chicagoland Chamber of Commerce defines it as all of Cook, DuPage, Kane, Lake, McHenry, and Will counties.^[20]

In addition, company marketing programs such as Construction Data Company's^[21] "Chicago and Vicinity" region and the Chicago Automobile Trade Association's "*Chicagoland and Northwest Indiana*" advertising campaign are directed at the MSA itself, as well as LaSalle, Winnebago (Rockford), Boone, and Ogle counties in Illinois, in addition to Jasper, Newton, and La Porte counties in Indiana and Kenosha, Racine, and Walworth counties in Wisconsin, and even as far northeast as Berrien County, Michigan. The region is part of the Great Lakes Megalopolis, containing an estimated 54 million people.^[citation needed]

Collar counties

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The term "collar counties" is a colloquialism for the five counties (DuPage, Kane, Lake, McHenry, and Will) of Illinois that border Chicago's Cook County. After Cook County, they are also the next five most populous counties in the state. According to the *Encyclopedia of Chicago*, there is no specifically known origin of the phrase, but it has been commonly used among policy makers, urban planners, and in the media. However, it also notes that as growth has spread beyond these counties, it may have lost some of its usefulness.^[22]

Chicago Metropolitan Agency for Planning

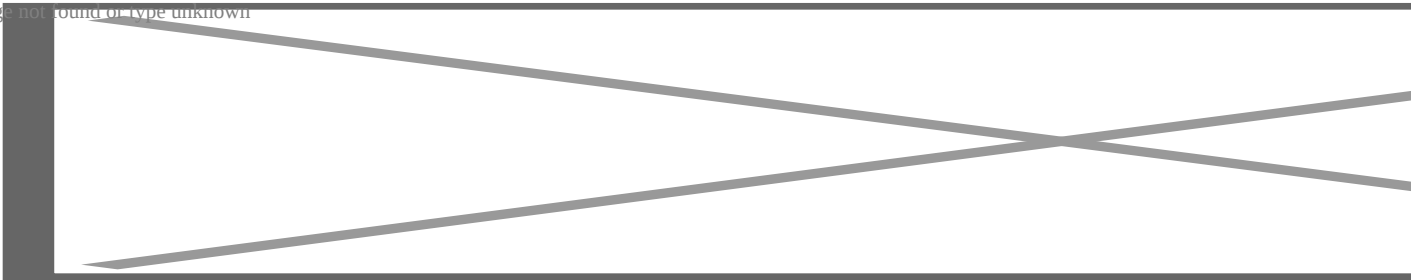
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Main article: Chicago Metropolitan Agency for Planning

Chicago Metropolitan Agency for Planning (CMAP) is an Illinois state agency responsible for transportation infrastructure, land use, and long-term economic development planning for the areas under its jurisdiction within Illinois.^[23] The planning area has a population of over 8 million, which includes the following locations in Illinois:^[24]

- Cook County
- DuPage County
- Kane County
- Kendall County
- Lake County
- McHenry County
- Will County

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Panorama of North Avenue Beach

Geography and environment

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Further information: Geography of Chicago

The city of Chicago lies in the Chicago Plain, a flat and broad area characterized by little topographical relief. The few low hills are sand ridges. North of the Chicago Plain, steep bluffs and ravines run alongside Lake Michigan.

Along the southern shore of the Chicago Plain, sand dunes run alongside the lake. The tallest dunes reach up to near 200 feet (61 m) and are found in Indiana Dunes National Park. Surrounding the low plain are bands of moraines in the south and west suburbs. These areas are higher and hillier than the Chicago Plain. A continental divide, separating the Mississippi River watershed from that of the Great Lakes and Saint Lawrence River, runs through the Chicago area.

A 2012 survey of the urban trees and forests in the seven county Illinois section of the Chicago area found that 21% of the land is covered by the tree and shrub canopy, made up of about 157,142,000 trees. The five most common tree species are buckthorn, green ash, boxelder, black cherry, and American elm. These resources perform important functions in carbon storage, water recycling, and energy saving.^[25]^[26]

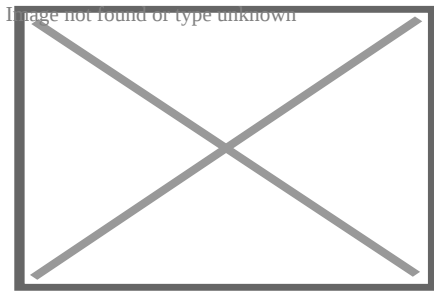
The Chicago skyline

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Night aerial view of Chicago and vicinity

Demographics

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Taken from the ISS on June 23, 2022; downtown Chicago is at the center by the lake.

As of 2022, the metropolitan area had a population of 9,442,159. The population density was 1,312.3 per square mile. The racial makeup was 50.1% Non-Hispanic White, 23.4% were Hispanic, 15.5% were Non-Hispanic African Americans, 7.2% were Asian, 0.1% were Non-Hispanic Native American, 0.4% identified as “some other race,” and 3.2% were non-Hispanic multiracial.^[27]

According to 2022 estimates from the American Community Survey, the largest ancestries in the Chicago metro area were Mexican (18%), African (17.7%), German (12.8%), Irish (9.9%), Polish (8%), Italian (5.9%), English (5.2%), Indian (2.7%), Puerto Rican (2.3%), Filipino (1.7%),

Swedish (1.5%), and Chinese (1.4%).^{[28][29][30][31]}

The suburbs, surrounded by easily annexed flat ground, have been expanding at a tremendous rate since the early 1960s. Aurora, Elgin, Joliet, and Naperville are noteworthy for being four of the few boomburbs outside the Sun Belt, West Coast and Mountain States regions, and exurban Kendall County ranked as the fastest-growing county (among counties with a population greater than 10,000) in the United States between the years 2000 and 2007.^[32]

Settlement patterns in the Chicago metropolitan area tend to follow those in the city proper: the northern and northwestern suburbs are generally affluent and upper-middle class, while the southern suburbs (sometimes known as Chicago Southland) have somewhat lower median incomes and a cost of living, with the exception being the southwest suburbs which contain many upper-middle class areas. Another exception to this is the West Side, which has a somewhat lower median income, but the western suburbs contain many affluent and upper-middle class areas. According to the 2000 Census, DuPage County as a whole had the highest median household income of any county in the Midwestern United States, although there are individual cities and towns in other surrounding counties in the metro that have even higher median incomes.

According to 2022 estimates from the U.S. Census, poverty rates of the largest counties from least poverty to most are as follows: McHenry 4.0%, Dupage 6.7%, Will 6.9%, Kane 7.8%, Lake 8.0%, and Cook 13.6%.^[33] However, Cook County, which contains luxury high rises and expensive houses in sections of the city and expensive houses along the waterfront in the North Shore area, would also have the highest percentage of expensive homes in the region.

In an in-depth historical analysis, Keating (2004, 2005) examined the origins of 233 settlements that by 1900 had become suburbs or city neighborhoods of the Chicago metropolitan area. The settlements began as farm centers (41%), industrial towns (30%), residential railroad suburbs (15%), and recreational/institutional centers (13%). Although relations between the different settlement types were at times contentious, there also was cooperation in such undertakings as the construction of high schools.^[citation needed]

Population

[edit]

As the Chicago metropolitan area has grown, more counties have been partly or totally assimilated with the taking of each decennial census.

Census Area	Area Type	2020 census	2010 census	2000 census	1990 census	1980 Census	1970 census	1960 census	
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Chicago-Naperville-Joliet, IL-IN-WI	Metropolitan	9,618,502	9,461,105	9,098,316	8,065,633	7,869,542	7,612,314	6,794,461	5,970,100
Cook County, Illinois	Metropolitan	5,275,541	5,194,675	5,376,741	5,105,067	5,253,655	5,492,369	5,129,725	4,910,000
DeKalb County, Illinois	Metropolitan	100,420	105,160	88,969	77,932	74,624	71,654	51,714	47,000
DuPage County, Illinois	Metropolitan	932,877	916,924	904,161	781,666	658,835	491,882	313,459	250,000
Grundy County, Illinois	Metropolitan	52,533	50,063	37,535	32,337	30,582	26,535	22,350	20,000
Kane County, Illinois	Metropolitan	516,522	515,269	404,119	317,471	278,405	251,005	208,246	190,000
Kendall County, Illinois	Metropolitan	131,869	114,736	54,544	39,413	37,202	26,374	17,540	15,000
McHenry County, Illinois	Metropolitan	310,229	308,760	260,077	183,241	147,897	111,555	84,210	70,000
Will County, Illinois	Metropolitan	696,355	677,560	502,266	357,313	324,460	249,498	191,617	170,000
Jasper County, Indiana	Metropolitan	32,918	33,478	30,043	24,960	26,138	20,429	18,842	15,000
Lake County, Indiana	Metropolitan	498,700	496,005	484,564	475,594	522,965	546,253	513,269	490,000
Newton County, Indiana	Metropolitan	13,830	14,244	14,566	13,551	14,844	11,606	11,502	10,000
Porter County, Indiana	Metropolitan	173,215	164,343	146,798	128,932	119,816	87,114	60,279	50,000

Lake County, Illinois	Metropolitan	714,342	703,462	644,356	516,418	440,372	382,638	293,656	
Kenosha County, Wisconsin	Metropolitan	169,151	166,426	149,577	128,181	123,137	117,917	100,615	
Kankakee County, Illinois	Combined	107,502	113,449	103,833	96,255	102,926	97,250	92,063	
LaSalle County, Illinois	Combined	109,658	113,924	111,509	106,913	112,003	111,409	110,800	
Bureau County, Illinois	Combined	33,244	34,978	35,503	35,688	39,114	38,541	37,594	
Putnam County, Illinois	Combined	5,637	6,006	6,086	5,730	6,085	5,007	4,570	
LaPorte County, Indiana	Combined	112,417	111,467	110,106	107,066	108,632	105,342	95,111	
Chicago-Naperville-Joliet, IL-IN-WI	Combined	9,986,960	9,686,021	9,312,255	8,385,397	8,264,490	8,089,421	7,204,198	5

Counties highlighted in gray were not included in the MSA for that census. The CSA totals in blue are the totals of all the counties listed above, regardless of whether they were included in the Chicago Combined Statistical Area at the time.^[34]

Principal municipalities

[edit]

Over 1,000,000 population

[edit]

- Chicago (2,746,388)

Over 100,000 population

[edit]

- Aurora, Illinois (180,542)
- Joliet, Illinois (150,362)
- Naperville, Illinois (149,540)
- Elgin, Illinois (114,797)

Over 50,000 population

[edit]

- Kenosha, Wisconsin (99,986)
- Waukegan, Illinois (89,321)
- Cicero, Illinois (85,268)
- Schaumburg, Illinois (78,723)
- Evanston, Illinois (78,110)
- Hammond, Indiana (77,879)
- Arlington Heights, Illinois (77,676)
- Bolingbrook, Illinois (73,922)
- Gary, Indiana (69,093)
- Palatine, Illinois (67,908)
- Skokie, Illinois (67,824)
- Des Plaines, Illinois (60,675)
- Orland Park, Illinois (58,703)
- Oak Lawn, Illinois (58,362)
- Berwyn, Illinois (57,250)
- Mount Prospect, Illinois (56,852)
- Tinley Park, Illinois (55,971)
- Oak Park, Illinois (54,583)
- Wheaton, Illinois (53,970)
- Downers Grove, Illinois (50,247)

View of Chicago greater metropolitan region and the dense downtown area from the Willis Tow

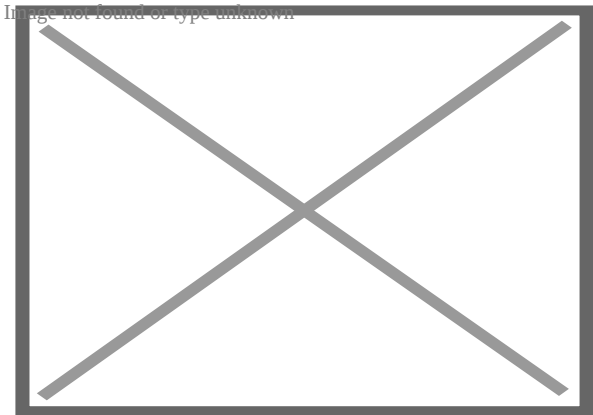
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View of Chicago greater metropolitan region and the North branch of the Chicago River from the Willis Tower

Urban areas within

[edit]

Within the boundary of the 16-county Chicago Combined Statistical Area lies the Chicago urban area, as well as 26 smaller urban areas.^[35] Some of the urban areas below may partially cross into other statistical areas. Only those situated primarily within the Chicago combined statistical area are listed here.



Urban areas contained within the Chicago combined statistical area as of the 2020 census:

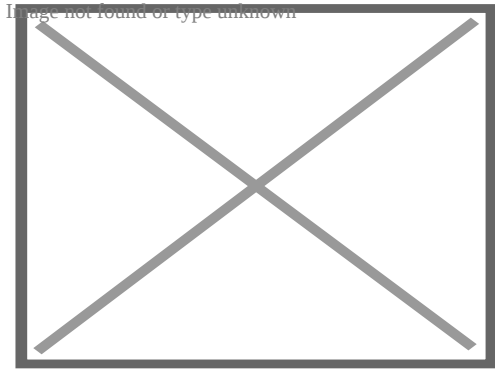
- Urban areas
- Counties in the Chicago MSA
- Counties in the Chicago CSA but not the MSA

Urban area	Population (2020 census)	Land area (sq mi)	Land area (km ²)	Density (population / sq mi)	Density (population / km ²)
Chicago, IL–IN	8,671,746	2,337.89	6,055.09	3,709.2	1,432.1

Round Lake					
Beach–McHenry–Grayslake, IL–WI	261,835	127.61	330.52	2,051.8	792.2
Kenosha, WI	125,865	56.17	145.48	2,240.8	865.2
Michigan City–La Porte, IN–MI	71,367	49.16	127.32	1,451.7	560.5
Kankakee, IL	66,530	31.66	82.00	2,101.4	811.3
DeKalb, IL	64,736	25.63	66.39	2,525.6	975.1
Valparaiso–Shorewood Forest, IN	51,867	33.64	87.12	1,542.0	595.4
Peru–LaSalle, IL	29,763	21.45	55.56	1,387.4	535.7
Woodstock, IL	25,298	9.31	24.10	2,718.7	1,049.7
Ottawa, IL	20,122	9.99	25.87	2,014.2	777.7
Streator, IL	16,209	8.12	21.04	1,995.3	770.4
Coal City–Braidwood, IL	15,837	10.29	26.65	1,539.4	594.4
Morris, IL	15,740	8.64	22.37	1,822.2	703.5
Lowell, IN	10,747	5.28	13.66	2,037.2	786.6
Manteno, IL	10,437	6.01	15.56	1,736.8	670.6
Harvard, IL	9,376	4.36	11.30	2,148.7	829.6
Princeton, IL	7,979	6.20	16.06	1,287.1	497.0
Marengo, IL	7,509	3.81	9.86	1,971.5	761.2
Lake Holiday, IL	7,313	4.30	11.14	1,700.5	656.6
Mendota, IL	6,918	2.85	7.38	2,426.2	936.8
Wilmington, IL	6,388	3.95	10.23	1,617.3	624.5
McHenry Northwest–Wonder Lake, IL	5,758	2.35	6.08	2,453.6	947.4
Hampshire, IL	5,699	2.72	7.06	2,091.4	807.5
Rensselaer, IN	5,509	3.23	8.37	1,703.9	657.9
Genoa, IL	5,484	2.20	5.69	2,498.0	964.5
Westville, IN	5,189	2.10	5.45	2,466.0	952.1
Marseilles, IL	4,660	2.39	6.19	1,948.4	752.3

Economy

[edit]



Westward view from the Willis Tower in Chicago

Main article: Economy of Chicago

See also: List of companies in the Chicago metropolitan area, Chicagoland Chamber of Commerce, and Economy of Illinois

The Chicago metropolitan area is home to the corporate headquarters of 57 Fortune 1000 companies, including AbbVie Inc., Allstate, Kraft Heinz, McDonald's, Mondelez International, Motorola, United Airlines, Walgreens, and more. The Chicago area also headquarters a wide variety of global financial institutions including Citadel LLC, Discover Financial Services, Morningstar, Inc., CNA Financial, and more. Chicago is home to the largest futures exchange in the world, the Chicago Mercantile Exchange. In March 2008, the Chicago Mercantile Exchange announced its acquisition of NYMEX Holdings Inc, the parent company of the New York Mercantile Exchange and Commodity Exchange. CME'S acquisition of NYMEX was completed in August 2008.

A key piece of infrastructure for several generations was the Union Stock Yards of Chicago, which from 1865 until 1971 penned and slaughtered millions of cattle and hogs into standardized cuts of beef and pork. This prompted poet Carl Sandburg to describe Chicago as the "Hog Butcher for the World".^[36]

The Chicago area, meanwhile, began to produce significant quantities of telecommunications gear, electronics, steel, crude oil derivatives, automobiles, and industrial capital goods.

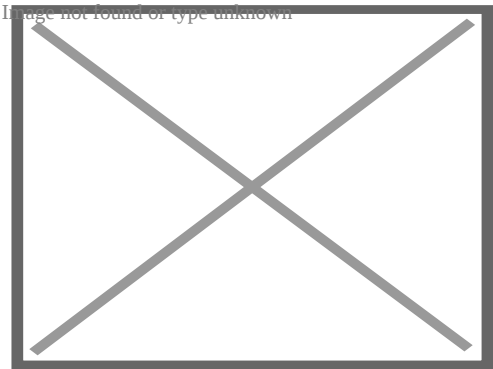
By the early 2000s, Illinois' economy had moved toward a dependence on high-value-added services, such as financial trading, higher education, logistics, and health care. In some cases, these services clustered around institutions that hearkened back to Illinois's earlier economies. For example, the Chicago Mercantile Exchange, a trading exchange for global derivatives, had begun its life as an agricultural futures market.

In 2007, the area ranked first among U.S. metro areas in the number of new and expanded corporate facilities.^[37] It ranked third in 2008, behind the Houston–Sugar Land–Baytown and Dallas–Fort Worth metropolitan areas,^[38] and ranked second behind the New York metropolitan area in 2009.^[39]

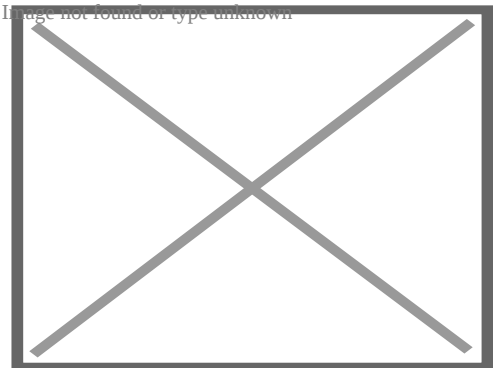
The Wall Street Journal summarized the Chicago area's economy in November 2006 with the comment that "Chicago has survived by repeatedly reinventing itself."^[40]

Transportation

[edit]



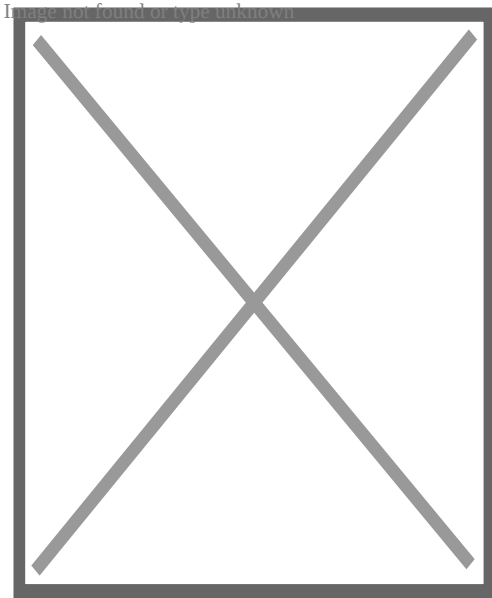
O'Hare Airport



Chicago 'L' in the Loop



Metra surface rail



The Eisenhower Expressway
with the Chicago Transit
Authority Blue Line tracks and
the non-revenue ramp that leads
to the Pink Line

Main articles: [Transportation in Chicago](#) and [Roads and freeways in Chicago](#)

Major airports

[edit]

- [Chicago O'Hare International Airport](#) (ORD)
- [Chicago Midway International Airport](#) (MDW)
- [Milwaukee Mitchell International Airport](#) (MKE) (located in the adjacent Milwaukee metropolitan area)
- [Chicago Rockford International Airport](#) (RFD) (located in the adjacent Rockford metropolitan area)
- [Gary/Chicago International Airport](#) (GYX)

Commercial ports

[edit]

- [Port of Chicago](#)
- [Port of Indiana-Burns Harbor](#)

Transit systems

[edit]

Commercial freight

[edit]

Chicago has been at the center of the United States' railroad network since the 19th century. Almost all Class I railroads serve the area, the most in North America.^[41]

Passenger

[edit]

- Chicago Transit Authority trains, locally referred to as "the 'L' ", (after "elevated train") serving Chicago and the near suburbs
- Pace Suburban Bus operates suburban bus and regional vanpool, paratransit, and ride-matching services in the Chicagoland region.
- Metra run by the Northeast Illinois Regional Commuter Railroad Corporation:
 - 4 lines serving southern Cook County and Will County
 - 3 lines serving western Cook County, DuPage County, and Kane County
 - 2 lines serving northern Cook County and Lake County
 - 1 line serving northern Cook County, Lake County, and Kenosha County
 - 1 line serving northwestern Cook County and McHenry County
- South Shore Line shares the Metra Electric Line in Illinois and connects Chicago to Gary, Michigan City, and ending at South Bend.
- Amtrak operates Union Station which is the major Amtrak passenger rail hub with connections to Metra and the within a few blocks of connections to several 'L' lines. Amtrak also operates a connecting station out of Joliet.

Major highways

[edit]

Interstates

[edit]

- Interstate 41 (I-41) runs concurrently with Interstate 94 from the northern terminus of the Tri-State Tollway to Milwaukee.
- Interstate 55 (I-55) is the Adlai Stevenson Expy.
- I-355 is the Veterans Memorial Tollway (formerly North-South Tollway).
- I-57 is unofficially the "West Leg" of the Dan Ryan Expy.
- I-65 has no name, whether official or unofficial.

- I-80 is officially called the Borman Expy (cosigned with I-94), Kingery Expy (cosigned with I-94 for 3 miles), Tri-State Tollway (cosigned with I-294 for 4 miles) and is unofficially called the Moline Expy west of I-294.
- I-88 is the Ronald Reagan Memorial Tollway (formerly East-West Tollway)
- I-90 is locally known as Jane Addams Tollway (formerly Northwest Tollway), John F. Kennedy Expy (cosigned with I-94), Dan Ryan Expy (cosigned with I-94), and Chicago Skyway Toll Bridge.
- I-94 is Tri-State Tollway in Lake County, Edens Spur, Edens Expy, John F. Kennedy Expy (cosigned with I-90), Dan Ryan Expy (cosigned with I-90), Bishop Ford Frwy (formerly Calumet Expy), Kingery Expy (cosigned with I-80) and Borman Expy (cosigned with I-80).
- I-190 is the John F. Kennedy Expy spur heading into Chicago-O'Hare Int'l Airport.
- I-290 is the Dwight D. Eisenhower Expy.
- I-294 is the Tri-State Tollway.

Other main highways

[edit]

- US Routes in the Illinois part of the area include: US 6, US 12, US 14, US 20, US 30, US 34, US 41, US 45, and US 52.
- Illinois Route 53, an arterial north–south state highway running through Grundy, Will, DuPage, Cook and Lake counties
- Historic US Route 66's eastern terminus is in Chicago.

Major corridors

[edit]

In addition to the Chicago Loop, the metro area is home to a few important subregional corridors of commercial activities. Among them are:

- Illinois Technology and Research Corridor, along the Ronald Reagan Memorial Tollway (Interstate 88)
- Golden Corridor, along the Jane Addams Memorial Tollway (Interstate 90)
- Lakeshore Corridor, along the Edens Expressway and Tri-State Tollway

Culture

[edit]

Sports

[edit]

Main article: Sports in Chicago

Listing of the professional sports teams in the Chicago metropolitan area

Major league professional teams:

- Major League Baseball (MLB)
 - Chicago Cubs
 - Chicago White Sox
- National Football League (NFL)
 - Chicago Bears
- National Basketball Association (NBA)
 - Chicago Bulls
- National Hockey League (NHL)
 - Chicago Blackhawks
- Major League Soccer (MLS)
 - Chicago Fire FC

Other professional teams:

- Women's National Basketball Association (WNBA)
 - Chicago Sky
- National Women's Soccer League (NWSL)
 - Chicago Stars FC
- American Association of Professional Baseball (AA)
 - Chicago Dogs
 - Kane County Cougars
 - Gary SouthShore RailCats
- American Hockey League (AHL)
 - Chicago Wolves
- NBA G League (NBAGL)
 - Windy City Bulls
- Major League Rugby (MLR)
 - Chicago Hounds

The Chicagoland Speedway oval track has hosted NASCAR Cup Series and IndyCar Series races. The Chicago Marathon is one of the World Marathon Majors. The Western Open and BMW Championship are PGA Tour tournaments that have been held primarily at golf courses near Chicago.

NCAA Division I College Sports Teams:

- Atlantic 10 Conference
 - Loyola University Chicago Ramblers
- Big East Conference
 - DePaul University Blue Demons
- Big Ten Conference
 - Northwestern University Wildcats (Evanston)
- Mid-American Conference
 - Northern Illinois University Huskies (DeKalb)
- Missouri Valley Conference
 - University of Illinois Chicago Flames
 - Valparaiso University Beacons (Valparaiso, IN)
- Northeast Conference
 - Chicago State University Cougars

Cuisine

[edit]

Further information: Chicago § Cuisine

- Chicago-style hot dog
- Chicago-style pizza
- Italian beef
- Caramel popcorn

Media

[edit]

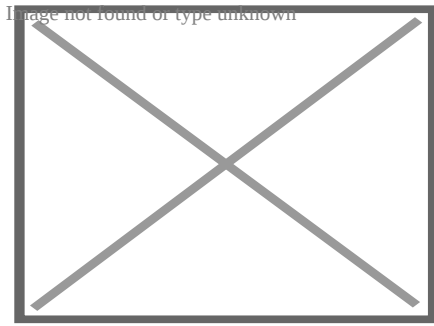
Main article: Media in Chicago

The two main newspapers are the *Chicago Tribune* and the *Chicago Sun-Times*. Local television channels broadcasting to the Chicago market include WBBM-TV 2 (CBS), WMAQ-TV 5 (NBC), WLS-TV 7 (ABC), WGN-TV 9 (Ind), WTTW 11 (PBS), MeTV 23, WCIU 26 (CW), WFLD 32 (FOX), WCPX-TV 38 (Ion), WSNS-TV 44 (Telemundo), WPWR-TV 50 (MyNetworkTV), and WJYS-TV 62 (The Way). Radio stations serving the area include: WBBM (AM), WBEZ, WGN (AM), WMBI, WLS (AM), and WSCR.

Education

[edit]

Further information: List of school districts in Illinois, List of school districts in Indiana, and List of colleges and universities in Chicago



Whitney M. Young Magnet High School in Chicago

Elementary and secondary education within the Chicago metropolitan area is provided by dozens of different school districts, of which by far the largest is the Chicago Public Schools with 400,000 students.^[42] Numerous private and religious school systems are also found in the region, as well as a growing number of charter schools. Racial inequalities in education in the region remain widespread, often breaking along district boundaries;^[43] for instance, educational prospects vary widely for students in the Chicago Public Schools compared to those in some neighboring suburban schools.^[44]

Historically, the Chicago metropolitan area has been at the center of a number of national educational movements, from the free-flowing Winnetka Plan to the regimented Taylorism of the Gary Plan.^[45] In higher education, University of Chicago founder William Rainey Harper was a leading early advocate of the junior college movement; Joliet Junior College is the nation's oldest continuously operating junior college today.^[46] Later U of C president Robert Maynard Hutchins was central to the Great Books movement, and programs of dialogic education arising from that legacy can be found today at the U of C, at Shimer College,^[47] and in the City Colleges of Chicago and Oakton College in the Northwest suburbs.^[48]

Area codes

[edit]

Main article: List of Illinois area codes

From 1947 until 1988, the Illinois portion of the Chicago metro area was served by a single area code, 312, which abutted the 815 area code. In 1988 the 708 area code was introduced and the 312 area code became exclusive to the city of Chicago.

It became common to call suburbanites "708'ers", in reference to their area code.

The 708 area code was partitioned in 1996 into three area codes, serving different portions of the metro area: 630, 708, and 847.

At the same time that the 708 area code was running out of phone numbers, the 312 area code in Chicago was also exhausting its supply of available numbers. As a result, the city of Chicago was divided into two area codes, 312 and 773. Rather than divide the city by a north–south area code, the central business district retained the 312 area code, while the

remainder of the city took the new 773 code.

In 2002, the 847 area code was supplemented with the overlay area code 224. In February 2007, the 815 area code (serving outlying portions of the metro area) was supplemented with the overlay area code 779. In October 2007, the overlay area code 331 was implemented to supplement the 630 area with additional numbers.

Plans are in place for overlay codes in the 708, 773, and 312 regions as those area codes become exhausted in the future.

- 312 Chicago - City (The Loop and central neighborhoods, e.g. the Near North Side)
- 773 Chicago - City (Everywhere else within the city limits, excluding central area)
- 872 Chicago - City (overlay for 312 & 773, effective November 7, 2009)
- 847/224 (North and Northwest Suburbs)
- 630/331 (Outer Western Suburbs)
- 708 (South and Near West Suburbs)
- 815/779 (Rockford & Joliet: Far Northwest/Southwest Suburbs)
- 219 (Northwest Indiana)
- 574 (North-central Indiana)
- 262 (Southeast Wisconsin surrounding Milwaukee County)

Proposed overlays

[edit]

- 464 overlay for 708 (January 21, 2022, rollout)

See also

[edit]

Portals:

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-  Illinois image not found or type unknown
-  United States image not found or type unknown
- Index of Illinois-related articles

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Further reading

[edit]

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- o Lewinnek, Elaine (2014). *The Working Man's Reward: Chicago's Early Suburbs and the Roots of American Sprawl*. Oxford: Oxford University Press.

External links

[edit]

Chicago metropolitan area at Wikipedia's sister projects

- o  Definitions from Wiktionary
- o  Media from Commons
- o  Travel information from Wikivoyage
- o  Data from Wikidata
- o *Encyclopedia of Chicago* (2004), comprehensive coverage of city and suburbs, past and present
- o U.S. Census Urbanized Area Outline Map (2000)
- o Chicago-Naperville-Michigan City, IL-IN-WI Combined Statistical Area (2012) map
- o Illinois CBSAs and Counties (2013) map
- o U.S. Census Bureau Chicago city, Illinois QuickFacts
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Chicago metropolitan area

Major city

- **Chicago**

- Aurora
- Berwyn
- Calumet City
- Crown Point
- Crystal Lake
- DeKalb
- Des Plaines
- Elgin
- Elmhurst
- Evanston
- Gary
- Hammond
- Highland Park
- Joliet
- Kenosha
- Naperville
- North Chicago
- Park Ridge
- Portage
- St. Charles
- Valparaiso
- Waukegan
- Wheaton

**Cities
(over 30,000 in 2020)**

Chicago landsat image

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**Towns and villages
(over 30,000 in 2020)**

- Addison
- Arlington Heights
- Bartlett
- Bolingbrook
- Buffalo Grove
- Carol Stream
- Carpentersville
- Cicero
- Downers Grove
- Elk Grove Village
- Glendale Heights
- Glenview
- Grayslake
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- Will

Regions

- Great Lakes
- Northern Illinois
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- Eastern Ridges and Lowlands
- Fox Valley (Illinois)
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Illinois, United States

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State of Illinois

Springfield (capital)

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- Central Illinois
- Champaign–Urbana metropolitan area
- Chicago metropolitan area
- Collar counties
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- Fox Valley
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- Metro East
- Metro Lakeland
- Mississippi Alluvial Plain
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- Northwestern Illinois
- Peoria metropolitan area
- Quad Cities
- River Bend
- Rockford metropolitan area
- Southern Illinois
- Wabash Valley

- Alton/Granite City/Edwardsville
- Arlington Heights/Palatine
- Aurora/Naperville/Oswego/Plainfield
- Bartlett/Hanover Park/Streamwood
- Belleville/East St. Louis/Collinsville/O'Fallon
- Berwyn/Cicero
- Bloomington/Normal
- Bolingbrook/Romeoville
- Buffalo Grove/Wheeling
- Calumet City
- Canton
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- Carol Stream/Glendale Heights
- Centralia
- Champaign/Urbana
- Charleston/Mattoon
- Chicago
- Chicago Heights
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- Effingham
- Elgin/Carpentersville
- Elmhurst/Lombard/Addison
- Evanston/Skokie
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- Coles
- Cook
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- DeKalb
- DeWitt
- Douglas
- DuPage
- Edgar
- Edwards
- Effingham
- Fayette
- Ford
- Franklin
- Fulton
- Gallatin
- Greene
- Grundy
- Hamilton
- Hancock
- Hardin
- Henderson
- Henry
- Iroquois
- Jackson
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- Johnson
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- Kankakee
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State of Indiana

Indianapolis (capital)

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Society

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- Demographics
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- Gun laws
- Gambling
- Homelessness
- LGBT rights
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Largest cities

- Anderson
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- Carmel
- Columbus
- Crown Point
- Elkhart
- Evansville
- Fishers
- Fort Wayne
- Gary
- Goshen
- Greenwood
- Hammond
- Indianapolis
- Jeffersonville
- Kokomo
- Lafayette
- Lawrence
- Michigan City
- Mishawaka
- Muncie
- New Albany
- Noblesville
- Portage
- Richmond
- South Bend
- Terre Haute
- Valparaiso
- Westfield
- West Lafayette

Largest towns

- Avon
- Brownsburg
- Clarksville
- Highland
- Merrillville
- Munster
- Plainfield
- Saint John
- Schererville
- Zionsville

- Adams
- Allen
- Bartholomew
- Benton
- Blackford
- Boone
- Brown
- Carroll
- Cass
- Clark
- Clay
- Clinton
- Crawford
- Daviess
- Dearborn
- Decatur
- DeKalb
- Delaware
- Dubois
- Elkhart
- Fayette
- Floyd
- Fountain
- Franklin
- Fulton
- Gibson
- Grant
- Greene
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- Hancock
- Harrison
- Hendricks
- Henry
- Howard
- Huntington
- Jackson
- Jasper
- Jay
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- Jennings
- Johnson
- Knox
- Kosciusko
- LaGrange
- Lake
- LaPorte
- Lawrence

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Regions

- Central Indiana
 - East Central Indiana
 - Wabash Valley
- Northern Indiana
 - Northwest Indiana
 - Chicago metropolitan area
 - Michiana
- Southern Indiana
 - Indiana Uplands
 - Kentuckiana
 - Southwestern Indiana

 **Indiana portal**
Images related to the topic are shown below

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State of Wisconsin

Madison (capital)

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Regions

- Apostle Islands
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- Eastern Ridges and Lowlands
- Fox River Valley
- Great River Road
- Lake Superior Lowland
- Northern Highland
- Western Upland

Major metropolitan areas (pop. over 500,000)

- Chicago metropolitan area
- Madison metropolitan area
- Milwaukee metropolitan area
- Twin Cities metropolitan area

Largest cities (pop. over 50,000)

- Appleton
- Eau Claire
- Green Bay
- Janesville
- Kenosha
- La Crosse
- Madison
- Milwaukee
- Oshkosh
- Racine
- Waukesha
- West Allis

**Smaller cities
(pop. 15,000 to 50,000)**

- Beaver Dam
- Beloit
- Brookfield
- Cudahy
- De Pere
- Fitchburg
- Fond du Lac
- Franklin
- Greenfield
- Hartford
- Hudson
- Kaukauna
- Manitowoc
- Marshfield
- Menasha
- Menomonie
- Mequon
- Middleton
- Muskego
- Neenah
- New Berlin
- Oak Creek
- Oconomowoc
- Onalaska
- River Falls
- Sheboygan
- South Milwaukee
- Stevens Point
- Sun Prairie
- Superior
- Watertown
- Wausau
- Wauwatosa
- West Bend
- Wisconsin Rapids

**Largest villages
(pop. over 15,000)**

- Ashwaubenon
- Bellevue
- Caledonia
- Fox Crossing
- Germantown
- Howard
- Menomonee Falls
- Mount Pleasant
- Pleasant Prairie

Counties

- Adams
- Ashland
- Barron
- Bayfield
- Brown
- Buffalo
- Burnett
- Calumet
- Chippewa
- Clark
- Columbia
- Crawford
- Dane
- Dodge
- Door
- Douglas
- Dunn
- Eau Claire
- Florence
- Fond du Lac
- Forest
- Grant
- Green
- Green Lake
- Iowa
- Iron
- Jackson
- Jefferson
- Juneau
- Kenosha
- Kewaunee
- La Crosse
- Lafayette
- Langlade
- Lincoln
- Manitowoc
- Marathon
- Marinette
- Marquette
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- Milwaukee
- Monroe
- Oconto
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World's 50 most-populous urban areas

- | | |
|---------------------|------------------|
| 1. Tokyo | 11. Kolkata |
| 2. Jakarta | 12. São Paulo |
| 3. Delhi | 13. New York |
| 4. Guangzhou–Foshan | 14. Karachi |
| 5. Mumbai | 15. Dhaka |
| 6. Manila | 16. Bangkok |
| 7. Shanghai | 17. Beijing |
| 8. Seoul | 18. Moscow |
| 9. Cairo | 19. Shenzhen |
| 10. Mexico City | 20. Buenos Aires |

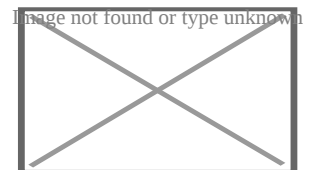
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Great Lakes megalopolis as defined by the RPA

Includes all metropolitan areas that have a population of 150,000 or greater according to the most recent national census.

**Great Lakes
region cities**

- Brantford
- Buffalo–Niagara Falls
 - Buffalo
 - Niagara Falls
- Chicago
 - city
- Cleveland
 - city
- Detroit
 - city
- Duluth–Superior
 - Duluth
 - Superior
- Erie
 - city
- Grand Rapids
 - city
- Guelph
- Green Bay
 - city
- Hamilton
- Holland
- Kalamazoo
 - city
- Kenosha
- Lansing
 - city
- London
- Milwaukee
 - city
- Muskegon
- Niagara Region
 - St. Catharines
 - Niagara Falls
 - Welland
- Niles
- Oshawa
- Rochester, New York
 - city
- South Bend
 - city
- Thunder Bay
- Toledo
 - city
- Toronto
 - city
- Traverse City



- Akron
 - city
- Altoona
- Ann Arbor
- Barrie
- Bloomington, Indiana
 - city
- Bloomington–Normal
 - Bloomington, Illinois
 - Normal
- Canton
 - city
- Champaign
 - city
- Cincinnati
 - city
- Columbus
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- Dayton
 - city
- Eau Claire
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- Elkhart
- Evansville
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- Fargo
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- Flint
- Fort Wayne
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- Fox Cities
 - Appleton
 - Oshkosh
- Indianapolis
 - city
- Jackson
- Janesville–Beloit
- Kankakee
 - city
- Kingston
- La Crosse–Onalaska
 - La Crosse
 - Onalaska
- Lafayette
 - city
- Madison
 - city

**Cities of
states south
of region**

- Elizabethtown
 - city
- Kansas City
 - city
- Louisville
 - city
- St. Louis
 - city
- Topeka
 - city
- Wheeling
 - city

**Other
metro-
regions**

- Quebec City–Windsor Corridor
- Golden Horseshoe
- Greater Toronto and Hamilton Area
- Detroit–Windsor
- Greater Pittsburgh
- Metro East

Other megaregions

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International

- VIAF
- FAST

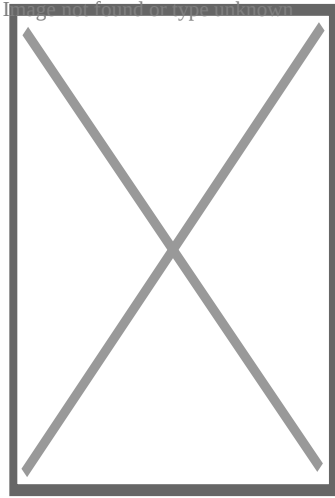
National

- Germany
- United States
- Israel

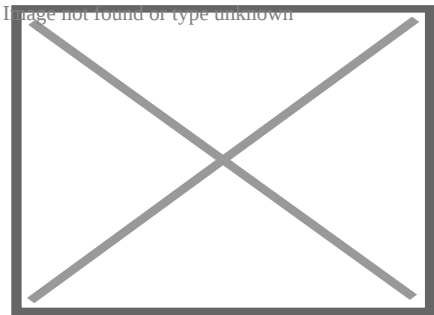
About soil mechanics



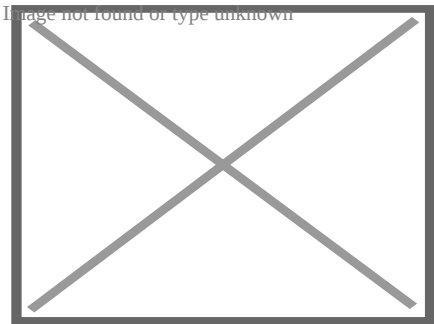
This article may be too long to read and navigate comfortably. Consider splitting content into sub-articles, condensing it, or adding subheadings. Please discuss this issue on the article's talk page. *(February 2025)*



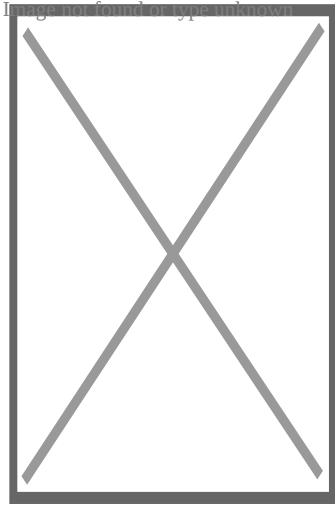
The Leaning Tower of Pisa – an example of a problem due to deformation of soil



Slope instability issues for a temporary flood control levee in North Dakota, 2009



Earthwork in Germany



Fox Glacier, New Zealand: Soil produced and transported by intense weathering and erosion

Soil mechanics is a branch of soil physics and applied mechanics that describes the behavior of soils. It differs from fluid mechanics and solid mechanics in the sense that soils consist of a heterogeneous mixture of fluids (usually air and water) and particles (usually clay, silt, sand, and gravel) but soil may also contain organic solids and other matter.^{[1][2][3][4]} Along with rock mechanics, soil mechanics provides the theoretical basis for analysis in geotechnical engineering,^[5] a subdiscipline of civil engineering, and engineering geology, a subdiscipline of geology. Soil mechanics is used to analyze the deformations of and flow of fluids within natural and man-made structures that are supported on or made of soil, or structures that are buried in soils.^[6] Example applications are building and bridge foundations, retaining walls, dams, and buried pipeline systems. Principles of soil mechanics are also used in related disciplines such as geophysical engineering, coastal engineering, agricultural engineering, and hydrology.

This article describes the genesis and composition of soil, the distinction between *pore water pressure* and inter-granular *effective stress*, capillary action of fluids in the soil pore spaces, *soil classification*, *seepage* and *permeability*, time dependent change of volume due to squeezing water out of tiny pore spaces, also known as *consolidation*, *shear strength* and stiffness of soils. The shear strength of soils is primarily derived from friction between the particles and interlocking, which are very sensitive to the effective stress.^{[7][6]} The article concludes with some examples of applications of the principles of soil mechanics such as slope stability, lateral earth pressure on retaining walls, and bearing capacity of foundations.

Genesis and composition of soils

[edit]

Genesis

[edit]

The primary mechanism of soil creation is the weathering of rock. All rock types (igneous rock, metamorphic rock and sedimentary rock) may be broken down into small particles to create soil. Weathering mechanisms are physical weathering, chemical weathering, and biological weathering [1][2][3] Human activities such as excavation, blasting, and waste disposal, may also create soil. Over geologic time, deeply buried soils may be altered by pressure and temperature to become metamorphic or sedimentary rock, and if melted and solidified again, they would complete the geologic cycle by becoming igneous rock.[3]

Physical weathering includes temperature effects, freeze and thaw of water in cracks, rain, wind, impact and other mechanisms. Chemical weathering includes dissolution of matter composing a rock and precipitation in the form of another mineral. Clay minerals, for example can be formed by weathering of feldspar, which is the most common mineral present in igneous rock.

The most common mineral constituent of silt and sand is quartz, also called silica, which has the chemical name silicon dioxide. The reason that feldspar is most common in rocks but silica is more prevalent in soils is that feldspar is much more soluble than silica.

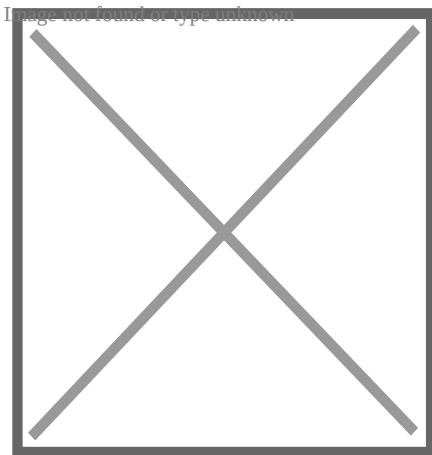
Silt, Sand, and Gravel are basically little pieces of broken rocks.

According to the Unified Soil Classification System, silt particle sizes are in the range of 0.002 mm to 0.075 mm and sand particles have sizes in the range of 0.075 mm to 4.75 mm.

Gravel particles are broken pieces of rock in the size range 4.75 mm to 100 mm. Particles larger than gravel are called cobbles and boulders.[1][2]

Transport

[edit]



Example soil horizons. a) top soil and colluvium b) mature residual soil c) young residual soil d) weathered rock

Soil deposits are affected by the mechanism of transport and deposition to their location. Soils that are not transported are called residual soils—they exist at the same location as the rock from which they were generated. Decomposed granite is a common example of a residual soil. The common mechanisms of transport are the actions of gravity, ice, water, and wind. Wind blown soils include dune sands and loess. Water carries particles of different size depending on the speed of the water, thus soils transported by water are graded according to their size. Silt and clay may settle out in a lake, and gravel and sand collect at the bottom of a river bed. Wind blown soil deposits (aeolian soils) also tend to be sorted according to their grain size. Erosion at the base of glaciers is powerful enough to pick up large rocks and boulders as well as soil; soils dropped by melting ice can be a well graded mixture of widely varying particle sizes. Gravity on its own may also carry particles down from the top of a mountain to make a pile of soil and boulders at the base; soil deposits transported by gravity are called colluvium.[¹][²]

The mechanism of transport also has a major effect on the particle shape. For example, low velocity grinding in a river bed will produce rounded particles. Freshly fractured colluvium particles often have a very angular shape.

Soil composition

[edit]

Soil mineralogy

[edit]

Silts, sands and gravels are classified by their size, and hence they may consist of a variety of minerals. Owing to the stability of quartz compared to other rock minerals, quartz is the most common constituent of sand and silt. Mica, and feldspar are other common minerals present in sands and silts.[¹] The mineral constituents of gravel may be more similar to that of the parent rock.

The common clay minerals are montmorillonite or smectite, illite, and kaolinite or kaolin. These minerals tend to form in sheet or plate like structures, with length typically ranging between 10^{-7} m and 4×10^{-6} m and thickness typically ranging between 10^{-9} m and 2×10^{-6} m, and they have a relatively large specific surface area. The specific surface area (SSA) is defined as the ratio of the surface area of particles to the mass of the particles. Clay minerals typically have specific surface areas in the range of 10 to 1,000 square meters per gram of solid.[³] Due to the large surface area available for chemical, electrostatic, and van der Waals interaction, the mechanical behavior of clay minerals is very sensitive to the amount of pore fluid available and the type and amount of dissolved ions in the pore fluid.[¹]

The minerals of soils are predominantly formed by atoms of oxygen, silicon, hydrogen, and aluminum, organized in various crystalline forms. These elements along with calcium, sodium,

potassium, magnesium, and carbon constitute over 99 per cent of the solid mass of soils.^[1]

Grain size distribution

[edit]

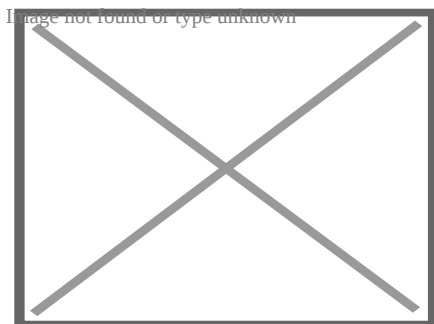
Main article: Soil gradation

Soils consist of a mixture of particles of different size, shape and mineralogy. Because the size of the particles obviously has a significant effect on the soil behavior, the grain size and grain size distribution are used to classify soils. The grain size distribution describes the relative proportions of particles of various sizes. The grain size is often visualized in a cumulative distribution graph which, for example, plots the percentage of particles finer than a given size as a function of size. The median grain size, $\displaystyle D_{50}$, which 50% of the particle mass consists of finer particles. Soil behavior, especially the hydraulic conductivity, tends to be dominated by the smaller particles, hence, the term "effective size", denoted by $\displaystyle D_{10}$ defined as the size for which 10% of the particle mass consists of finer particles.

Sands and gravels that possess a wide range of particle sizes with a smooth distribution of particle sizes are called *well graded* soils. If the soil particles in a sample are predominantly in a relatively narrow range of sizes, the sample is *uniformly graded*. If a soil sample has distinct gaps in the gradation curve, e.g., a mixture of gravel and fine sand, with no coarse sand, the sample may be *gap graded*. *Uniformly graded* and *gap graded* soils are both considered to be *poorly graded*. There are many methods for measuring particle-size distribution. The two traditional methods are sieve analysis and hydrometer analysis.

Sieve analysis

[edit]



Sieve

The size distribution of gravel and sand particles are typically measured using sieve analysis. The formal procedure is described in ASTM D6913-04(2009).^[8] A stack of sieves with accurately dimensioned holes between a mesh of wires is used to separate the particles into

size bins. A known volume of dried soil, with clods broken down to individual particles, is put into the top of a stack of sieves arranged from coarse to fine. The stack of sieves is shaken for a standard period of time so that the particles are sorted into size bins. This method works reasonably well for particles in the sand and gravel size range. Fine particles tend to stick to each other, and hence the sieving process is not an effective method. If there are a lot of fines (silt and clay) present in the soil it may be necessary to run water through the sieves to wash the coarse particles and clods through.

A variety of sieve sizes are available. The boundary between sand and silt is arbitrary. According to the Unified Soil Classification System, a #4 sieve (4 openings per inch) having 4.75 mm opening size separates sand from gravel and a #200 sieve with an 0.075 mm opening separates sand from silt and clay. According to the British standard, 0.063 mm is the boundary between sand and silt, and 2 mm is the boundary between sand and gravel.^[3]

Hydrometer analysis

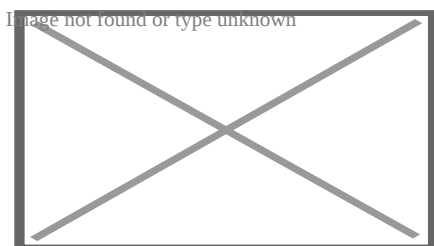
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The classification of fine-grained soils, i.e., soils that are finer than sand, is determined primarily by their Atterberg limits, not by their grain size. If it is important to determine the grain size distribution of fine-grained soils, the hydrometer test may be performed. In the hydrometer tests, the soil particles are mixed with water and shaken to produce a dilute suspension in a glass cylinder, and then the cylinder is left to sit. A hydrometer is used to measure the density of the suspension as a function of time. Clay particles may take several hours to settle past the depth of measurement of the hydrometer. Sand particles may take less than a second. Stokes' law provides the theoretical basis to calculate the relationship between sedimentation velocity and particle size. ASTM provides the detailed procedures for performing the Hydrometer test.

Clay particles can be sufficiently small that they never settle because they are kept in suspension by Brownian motion, in which case they may be classified as colloids.

Mass-volume relations

[edit]



A phase diagram of soil indicating the masses and volumes of air, solid, water, and voids

There are a variety of parameters used to describe the relative proportions of air, water and solid in a soil. This section defines these parameters and some of their interrelationships.^{[2][6]}
The basic notation is as follows:

V_s , V_w and V_a represent the volumes of air, water and solids in a soil mixture;

W_s , W_w and W_a represent the weights of air, water and solids in a soil mixture;

M_s , M_w and M_a represent the masses of air, water and solids in a soil mixture;

ρ_s and ρ_w represent the densities of the constituents (air, water and solids) in a soil mixture;

Note that the weights, W , can be obtained by multiplying the mass, M , by the acceleration due to gravity, g ; e.g., $W_s = M_s g$

Specific Gravity is the ratio of the density of one material compared to the density of pure water ($\rho_w = 1 \text{ g/cm}^3$).

$$G_s = \frac{\rho_s}{\rho_w}$$

Specific gravity of solids,

Note that specific weight, conventionally denoted by the symbol γ , may be obtained by multiplying the density (ρ) of a material by the acceleration due to gravity, $\gamma = \rho g$

Density, bulk density, or wet density, ρ , are different names for the density of the mixture, i.e., the total mass of air, water, solids divided by the total volume of air water and solids (the mass of air is assumed to be zero for practical purposes):

$$\rho = \frac{M_s + M_w}{V_s + V_w + V_a} = \frac{M_t}{V_t}$$

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Dry density, ρ_d , is the mass of solids divided by the total volume of air water and solids:

$$\rho_d = \frac{M_s}{V_s + V_w + V_a} = \frac{M_s}{V_t}$$

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Buoyant density, ρ' , defined as the density of the mixture minus the density of water is useful if the soil is submerged under water:

$$\rho' = \rho - \rho_w$$

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where ρ_w is the density of water

Water content, w , is the ratio of mass of water to mass of solid. It is easily measured by weighing a sample of the soil, drying it out in an oven and re-weighing. Standard procedures are described by ASTM.

$$w = \frac{M_w}{M_s} = \frac{W_w}{W_s}$$

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Void ratio, e , is the ratio of the volume of voids to the volume of solids:

$$e = \frac{V_v}{V_s} = \frac{V_v}{V_t - V_v} = \frac{n}{1-n}$$

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Porosity, n , is the ratio of volume of voids to the total volume, and is related to the void ratio:

$$n = \frac{V_v}{V_t} = \frac{V_v}{V_s + V_v} = \frac{e}{1+e}$$

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Degree of saturation, S , is the ratio of the volume of water to the volume of voids:

$$S = \frac{V_w}{V_v}$$

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From the above definitions, some useful relationships can be derived by use of basic algebra.

$$\rho = \frac{(G_s + Se)\rho_w}{1+e}$$

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$$\rho = \frac{(1+w)G_s\rho_w}{1+e}$$

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$$w = \frac{SeG_s}{\rho}$$

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Soil classification

[edit]

Geotechnical engineers classify the soil particle types by performing tests on disturbed (dried, passed through sieves, and remolded) samples of the soil. This provides information about the characteristics of the soil grains themselves. Classification of the types of grains present in a soil does not ^[clarification needed] account for important effects of the *structure* or *fabric* of the

soil, terms that describe compactness of the particles and patterns in the arrangement of particles in a load carrying framework as well as the pore size and pore fluid distributions. Engineering geologists also classify soils based on their genesis and depositional history.

Classification of soil grains

[edit]

In the US and other countries, the Unified Soil Classification System (USCS) is often used for soil classification. Other classification systems include the British Standard BS 5930 and the AASHTO soil classification system.^[3]

Classification of sands and gravels

[edit]

In the USCS, gravels (given the symbol *G*) and sands (given the symbol *S*) are classified according to their grain size distribution. For the USCS, gravels may be given the classification symbol *GW* (well-graded gravel), *GP* (poorly graded gravel), *GM* (gravel with a large amount of silt), or *GC* (gravel with a large amount of clay). Likewise sands may be classified as being *SW*, *SP*, *SM* or *SC*. Sands and gravels with a small but non-negligible amount of fines (5–12%) may be given a dual classification such as *SW-SC*.

Atterberg limits

[edit]

Clays and Silts, often called 'fine-grained soils', are classified according to their Atterberg limits; the most commonly used Atterberg limits are the *liquid limit* (denoted by *LL* or w_L) and *plastic limit* (denoted by *PL* or w_p) and *shrinkage limit* (denoted by *SL*).

The liquid limit is the water content at which the soil behavior transitions from a plastic solid to a liquid. The plastic limit is the water content at which the soil behavior transitions from that of a plastic solid to a brittle solid. The Shrinkage Limit corresponds to a water content below which the soil will not shrink as it dries. The consistency of fine grained soil varies in proportional to the water content in a soil.

As the transitions from one state to another are gradual, the tests have adopted arbitrary definitions to determine the boundaries of the states. The liquid limit is determined by measuring the water content for which a groove closes after 25 blows in a standard test.^[9]^[clarification needed] Alternatively, a fall cone test apparatus may be used to measure the liquid limit. The undrained shear strength of remolded soil at the liquid limit is approximately 2 kPa.^[4]^[10] The plastic limit

is the water content below which it is not possible to roll by hand the soil into 3 mm diameter cylinders. The soil cracks or breaks up as it is rolled down to this diameter. Remolded soil at the plastic limit is quite stiff, having an undrained shear strength of the order of about 200 kPa.[4][10]

The *plasticity index* of a particular soil specimen is defined as the difference between the liquid limit and the plastic limit of the specimen; it is an indicator of how much water the soil particles in the specimen can absorb, and correlates with many engineering properties like permeability, compressibility, shear strength and others. Generally, the clay having high plasticity have lower permeability and also they are also difficult to be compacted.

Classification of silts and clays

[edit]

According to the Unified Soil Classification System (USCS), silts and clays are classified by plotting the values of their plasticity index and liquid limit on a plasticity chart. The A-Line on the chart separates clays (given the USCS symbol *C*) from silts (given the symbol *M*). $LL=50\%$ separates high plasticity soils (given the modifier symbol *H*) from low plasticity soils (given the modifier symbol *L*). A soil that plots above the A-line and has $LL>50\%$ would, for example, be classified as *CH*. Other possible classifications of silts and clays are *ML*, *CL* and *MH*. If the Atterberg limits plot in the "hatched" region on the graph near the origin, the soils are given the dual classification 'CL-ML'.

Indices related to soil strength

[edit]

Liquidity index

[edit]

The effects of the water content on the strength of saturated remolded soils can be quantified by the use of the *liquidity index*, *LI*:

$$LI = \frac{w - PL}{LL - PL}$$

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When the LI is 1, remolded soil is at the liquid limit and it has an undrained shear strength of about 2 kPa. When the soil is at the plastic limit, the LI is 0 and the undrained shear strength is about 200 kPa.[4][11]

Relative density

[edit]

The density of sands (cohesionless soils) is often characterized by the relative density, D_r

$$D_r = \frac{e_{\max} - e}{e_{\max} - e_{\min}} 100\%$$

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where: $e_{\max}$ is the "maximum void ratio" corresponding to a very loose state, $e_{\min}$ is the "minimum void ratio" corresponding to a very dense state and e is the in-situ void ratio.

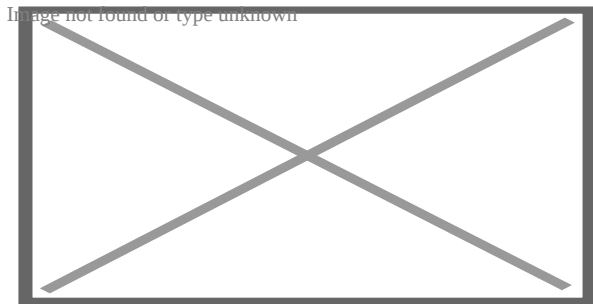
Methods used to calculate relative density are defined in ASTM D4254-00(2006).^[12]

Thus if $D_r = 100\%$ sand or gravel is very dense, and if $D_r = 0\%$ is extremely loose and unstable.

Seepage: steady state flow of water

[edit]

This section is an excerpt from Seepage.[edit]

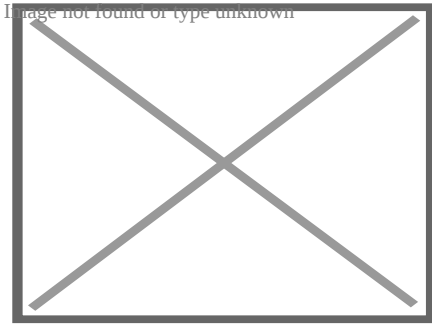


A cross section showing the water table varying with surface topography as well as a perched water table

In soil mechanics, seepage is the movement of water through soil. If fluid pressures in a soil deposit are uniformly increasing with depth according to $\sigma_v = \gamma_w z$ where z is the depth below the water table, then hydrostatic conditions will prevail and the fluids will *not* be flowing through the soil. However, if the water table is sloping or there is a perched water table as indicated in the accompanying sketch, then seepage will occur. For steady state seepage, the seepage velocities are not varying with time. If the water tables are changing levels with time, or if the soil is in the process of consolidation, then steady state conditions do not apply.

Effective stress and capillarity: hydrostatic conditions

[edit]



Spheres immersed in water, reducing effective stress

Main article: Effective stress

To understand the mechanics of soils it is necessary to understand how normal stresses and shear stresses are shared by the different phases. Neither gas nor liquid provide significant resistance to shear stress. The shear resistance of soil is provided by friction and interlocking of the particles. The friction depends on the intergranular contact stresses between solid particles. The normal stresses, on the other hand, are shared by the fluid and the particles.^[7] Although the pore air is relatively compressible, and hence takes little normal stress in most geotechnical problems, liquid water is relatively incompressible and if the voids are saturated with water, the pore water must be squeezed out in order to pack the particles closer together.

The principle of effective stress, introduced by Karl Terzaghi, states that the effective stress σ' (i.e., the average intergranular stress between solid particles) may be calculated by a simple subtraction of the pore pressure from the total stress:

$$\sigma' = \sigma - u,$$

where σ is the total stress and u is the pore pressure. It is not practical to measure σ' directly, so in practice the vertical effective stress is calculated from the pore pressure and vertical total stress. The distinction between the terms pressure and stress is also important. By definition, pressure at a point is equal in all directions but stresses at a point can be different in different directions. In soil mechanics, compressive stresses and pressures are considered to be positive and tensile stresses are considered to be negative, which is different from the solid mechanics sign convention for stress.

Total stress

[edit]

For level ground conditions, the total vertical stress at a point, σ_v , on average, is the weight of everything above that point per unit area. The vertical stress beneath a uniform surface layer with density ρ and thickness H is, for example,

$$\sigma_v = \rho g H = \gamma H$$

where γ is the acceleration due to gravity, and γ_o is the unit weight of the overlying layer. If there are multiple layers of soil or water above the point of interest, the vertical stress may be calculated by summing the product of the unit weight and thickness of all of the overlying layers. Total stress increases with increasing depth in proportion to the density of the overlying soil.

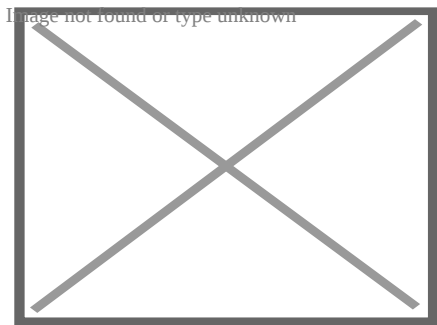
It is not possible to calculate the horizontal total stress in this way. Lateral earth pressures are addressed elsewhere.

Pore water pressure

[edit]
Main article: Pore water pressure

Hydrostatic conditions

[edit]



Water is drawn into a small tube by surface tension. Water pressure, u , is negative above and positive below the free water surface.

If the soil pores are filled with water that is not flowing but is static, the pore water pressures will be hydrostatic. The water table is located at the depth where the water pressure is equal to the atmospheric pressure. For hydrostatic conditions, the water pressure increases linearly with depth below the water table:

$$u = \gamma_w z$$

where γ_w is the density of water, and z is the depth below the water table.

Capillary action

[edit]

Due to surface tension, water will rise up in a small capillary tube above a free surface of water. Likewise, water will rise up above the water table into the small pore spaces around the soil particles. In fact the soil may be completely saturated for some distance above the water table. Above the height of capillary saturation, the soil may be wet but the water content will decrease with elevation. If the water in the capillary zone is not moving, the water pressure obeys the equation of hydrostatic equilibrium, $\frac{dw}{dz} = -\rho_w g$, but note that w is negative above the water table. Hence, hydrostatic water pressures are negative above the water table. The thickness of the zone of capillary saturation depends on the pore size, but typically, the heights vary between a centimeter or so for coarse sand to tens of meters for a silt or clay.^[3] In fact the pore space of soil is a uniform fractal e.g. a set of uniformly distributed D-dimensional fractals of average linear size L. For the clay soil it has been found that L=0.15 mm and D=2.7.^[13]

The surface tension of water explains why the water does not drain out of a wet sand castle or a moist ball of clay. Negative water pressures make the water stick to the particles and pull the particles to each other, friction at the particle contacts make a sand castle stable. But as soon as a wet sand castle is submerged below a free water surface, the negative pressures are lost and the castle collapses. Considering the effective stress equation, $\sigma' = \sigma - u$, where σ is the total stress, σ' is the effective stress, and u is the pore water pressure. If the pore water pressure is negative, the effective stress may be positive, even on a free surface (a surface where the total normal stress is zero). The negative pore pressure pulls the particles together and causes compressive particle to particle contact forces. Negative pore pressures in clayey soil can be much more powerful than those in sand. Negative pore pressures explain why clay soils shrink when they dry and swell as they are wetted. The swelling and shrinkage can cause major distress, especially to light structures and roads.^[14]

Later sections of this article address the pore water pressures for seepage and consolidation problems.

Water at particle contacts

-

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Water at
particle
contacts

- Intergranular contact force due to surface tension

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Intergranular
contact force due

to surface tension
Shrinkage caused by drying

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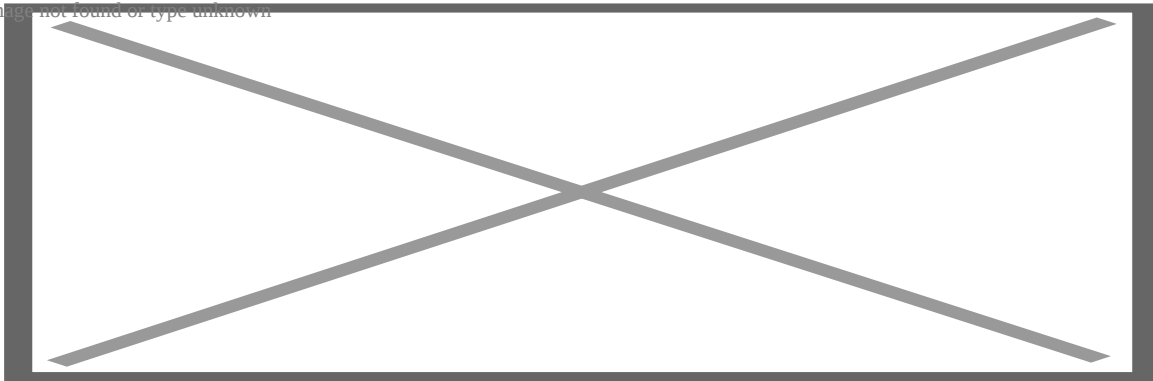
Shrinkage caused by
drying

Consolidation: transient flow of water

[edit]

Main article: Consolidation (soil)

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Consolidation analogy. The piston is supported by water underneath and a spring. When a load is applied to the piston, water pressure increases to support the load. As the water slowly leaks through the small hole, the load is transferred from the water pressure to the spring force.

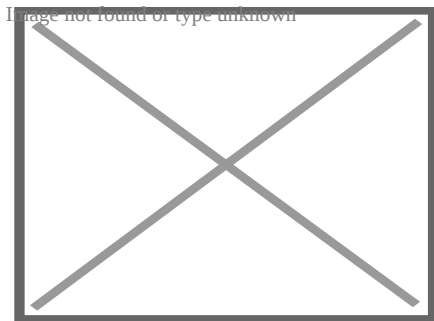
Consolidation is a process by which soils decrease in volume. It occurs when stress is applied to a soil that causes the soil particles to pack together more tightly, therefore reducing volume. When this occurs in a soil that is saturated with water, water will be squeezed out of the soil. The time required to squeeze the water out of a thick deposit of clayey soil layer might be years. For a layer of sand, the water may be squeezed out in a matter of seconds. A building foundation or construction of a new embankment will cause the soil below to consolidate and this will cause settlement which in turn may cause distress to the building or embankment. Karl Terzaghi developed the theory of one-dimensional consolidation which enables prediction of the amount of settlement and the time required for the settlement to occur.^[15] 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.^[7] Soils are tested with an oedometer test to determine their compression index and coefficient of consolidation.

When stress is removed from a consolidated soil, the soil will rebound, drawing water back into the pores and regaining some of the volume it had lost in the consolidation process. If the stress is reapplied, the soil will re-consolidate again along a recompression curve, defined by the recompression index. Soil that has been consolidated to a large pressure and has been subsequently unloaded is considered to be *overconsolidated*. The maximum past vertical effective stress is termed the *preconsolidation stress*. A soil which is currently experiencing the maximum past vertical effective stress is said to be *normally consolidated*. The *overconsolidation ratio*, (OCR) is the ratio of the maximum past vertical effective stress to the current vertical effective stress. The OCR is significant for two reasons: firstly, because the compressibility of normally consolidated soil is significantly larger than that for overconsolidated soil, and secondly, the shear behavior and dilatancy of clayey soil are related to the OCR through critical state soil mechanics; highly overconsolidated clayey soils are dilatant, while normally consolidated soils tend to be contractive.^{[2][3][4]}

Shear behavior: stiffness and strength

[edit]

Main article: shear strength (soil)



Typical stress strain curve for a drained dilatant soil

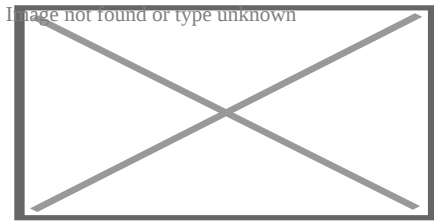
The shear strength and stiffness of soil determines whether or not soil will be stable or how much it will deform. Knowledge of the strength is necessary to determine if a slope will be stable, if a building or bridge might settle too far into the ground, and the limiting pressures on a retaining wall. It is important to distinguish between failure of a soil element and the failure of a geotechnical structure (e.g., a building foundation, slope or retaining wall); some soil elements may reach their peak strength prior to failure of the structure. Different criteria can be used to define the "shear strength" and the "yield point" for a soil element from a stress–strain curve. One may define the peak shear strength as the peak of a stress–strain curve, or the shear strength at critical state as the value after large strains when the shear resistance levels off. If the stress–strain curve does not stabilize before the end of shear strength test, the "strength" is sometimes considered to be the shear resistance at 15–20% strain.^[14] The shear strength of soil depends on many factors including the effective stress and the void ratio.

The shear stiffness is important, for example, for evaluation of the magnitude of deformations of foundations and slopes prior to failure and because it is related to the shear wave velocity.

The slope of the initial, nearly linear, portion of a plot of shear stress as a function of shear strain is called the shear modulus

Friction, interlocking and dilation

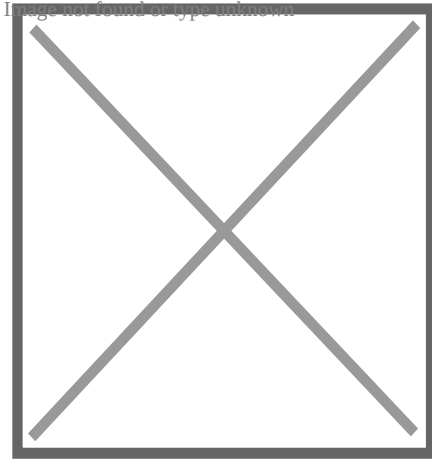
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Angle of repose

Soil is an assemblage of particles that have little to no cementation while rock (such as sandstone) may consist of an assembly of particles that are strongly cemented together by chemical bonds. The shear strength of soil is primarily due to interparticle friction and therefore, the shear resistance on a plane is approximately proportional to the effective normal stress on that plane.^[3] The angle of internal friction is thus closely related to the maximum stable slope angle, often called the angle of repose.

But in addition to friction, soil derives significant shear resistance from interlocking of grains. If the grains are densely packed, the grains tend to spread apart from each other as they are subject to shear strain. The expansion of the particle matrix due to shearing was called dilatancy by Osborne Reynolds.^[11] If one considers the energy required to shear an assembly of particles there is energy input by the shear force, T , moving a distance, x and there is also energy input by the normal force, N , as the sample expands a distance, y .^[11] Due to the extra energy required for the particles to dilate against the confining pressures, dilatant soils have a greater peak strength than contractive soils. Furthermore, as dilative soil grains dilate, they become looser (their void ratio increases), and their rate of dilation decreases until they reach a critical void ratio. Contractive soils become denser as they shear, and their rate of contraction decreases until they reach a critical void ratio.



A critical state line separates the dilatant and contractive states for soil.

The tendency for a soil to dilate or contract depends primarily on the confining pressure and the void ratio of the soil. The rate of dilation is high if the confining pressure is small and the void ratio is small. The rate of contraction is high if the confining pressure is large and the void ratio is large. As a first approximation, the regions of contraction and dilation are separated by the critical state line.

Failure criteria

[edit]

After a soil reaches the critical state, it is no longer contracting or dilating and the shear stress on the failure plane τ_{crit} is determined by the effective normal stress on the failure plane σ_n and critical state friction angle ϕ_{crit}

$$\tau_{crit} = \sigma_n \tan \phi_{crit}$$

The peak strength of the soil may be greater, however, due to the interlocking (dilatancy) contribution. This may be stated:

$$\tau_{peak} = \sigma_n \tan \phi_{peak}$$

where $\phi_{peak} > \phi_{crit}$. However, use of a friction angle greater than the critical state value for design requires care. The peak strength will not be mobilized everywhere at the same time in a practical problem such as a foundation, slope or retaining wall. The critical state friction angle is not nearly as variable as the peak friction angle and hence it can be relied upon with confidence.^{[3][4][11]}

Not recognizing the significance of dilatancy, Coulomb proposed that the shear strength of soil may be expressed as a combination of adhesion and friction components:^[11]

$$\tau_f = c' + \sigma'_f \tan \phi'$$

It is now known that the parameters in the last equation are not fundamental soil properties.^{[3][6][11][16]} In particular, ϕ' and c' are different depending on the magnitude of effective stress.^{[6][16]} According to Schofield (2006),^[11] the longstanding use of c' has led many engineers to wrongly believe that c' is a fundamental parameter. This assumption that ϕ' and c' are constant can lead to overestimation of peak strengths.^{[3][16]}

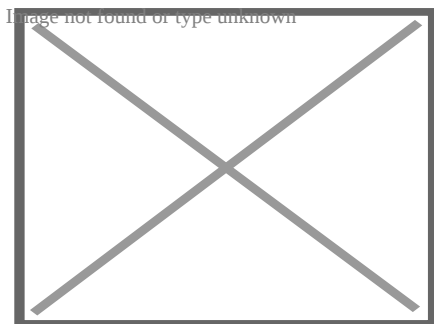
Structure, fabric, and chemistry

[edit]

In addition to the friction and interlocking (dilatancy) components of strength, the structure and fabric also play a significant role in the soil behavior. The structure and fabric include factors such as the spacing and arrangement of the solid particles or the amount and spatial distribution of pore water; in some cases cementitious material accumulates at particle-particle contacts. Mechanical behavior of soil is affected by the density of the particles and their structure or arrangement of the particles as well as the amount and spatial distribution of fluids present (e.g., water and air voids). Other factors include the electrical charge of the particles, chemistry of pore water, chemical bonds (i.e. cementation -particles connected through a solid substance such as recrystallized calcium carbonate) ^{[1][16]}

Drained and undrained shear

[edit]



Moist sand along the shoreline is originally densely packed by the draining water. Foot pressure on the sand causes it to dilate (*see: Reynolds dilatancy*), drawing water from the surface into the pores.

The presence of nearly incompressible fluids such as water in the pore spaces affects the ability for the pores to dilate or contract.

If the pores are saturated with water, water must be sucked into the dilating pore spaces to fill the expanding pores (this phenomenon is visible at the beach when apparently dry spots form

around feet that press into the wet sand).^[clarification needed]

Similarly, for contractive soil, water must be squeezed out of the pore spaces to allow contraction to take place.

Dilation of the voids causes negative water pressures that draw fluid into the pores, and contraction of the voids causes positive pore pressures to push the water out of the pores. If the rate of shearing is very large compared to the rate that water can be sucked into or squeezed out of the dilating or contracting pore spaces, then the shearing is called *undrained shear*, if the shearing is slow enough that the water pressures are negligible, the shearing is called *drained shear*. During undrained shear, the water pressure u changes depending on volume change tendencies. From the effective stress equation, the change in u directly effects the effective stress by the equation:

$$\sigma' = \sigma - u,$$

and the strength is very sensitive to the effective stress. It follows then that the undrained shear strength of a soil may be smaller or larger than the drained shear strength depending upon whether the soil is contractive or dilative.

Shear tests

[edit]

Strength parameters can be measured in the laboratory using direct shear test, triaxial shear test, simple shear test, fall cone test and (hand) shear vane test; there are numerous other devices and variations on these devices used in practice today. Tests conducted to characterize the strength and stiffness of the soils in the ground include the Cone penetration test and the Standard penetration test.

Other factors

[edit]

The stress–strain relationship of soils, and therefore the shearing strength, is affected by:^[17]

1. *soil composition* (basic soil material): mineralogy, grain size and grain size distribution, shape of particles, pore fluid type and content, ions on grain and in pore fluid.
2. *state* (initial): Defined by the initial void ratio, effective normal stress and shear stress (stress history). State can be describd by terms such as: loose, dense, overconsolidated, normally consolidated, stiff, soft, contractive, dilative, etc.
3. *structure*: Refers to the arrangement of particles within the soil mass; the manner in which the particles are packed or distributed. Features such as layers, joints, fissures, slickensides, voids, pockets, cementation, etc., are part of the structure. Structure of soils

is described by terms such as: undisturbed, disturbed, remolded, compacted, cemented; flocculent, honey-combed, single-grained; flocculated, deflocculated; stratified, layered, laminated; isotropic and anisotropic.

4. *Loading conditions*: Effective stress path - drained, undrained, and type of loading - magnitude, rate (static, dynamic), and time history (monotonic, cyclic).

Applications

[edit]

Lateral earth pressure

[edit]

Main article: Lateral earth pressure

Lateral earth stress theory is used to estimate the amount of stress soil can exert perpendicular to gravity. This is the stress exerted on retaining walls. A lateral earth stress coefficient, K , is defined as the ratio of lateral (horizontal) effective stress to vertical effective stress for cohesionless soils ($K = \sigma'_h / \sigma'_v$). There are three coefficients: at-rest, active, and passive. At-rest stress is the lateral stress in the ground before any disturbance takes place. The active stress state is reached when a wall moves away from the soil under the influence of lateral stress, and results from shear failure due to reduction of lateral stress. The passive stress state is reached when a wall is pushed into the soil far enough to cause shear failure within the mass due to increase of lateral stress. There are many theories for estimating lateral earth stress; some are empirically based, and some are analytically derived.

Bearing capacity

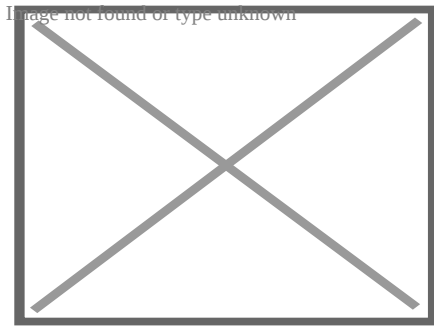
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Main article: Bearing capacity

The bearing capacity of soil is the average contact stress between a foundation and the soil which will cause shear failure in the soil. Allowable bearing stress is the bearing capacity divided by a factor of safety. Sometimes, on soft soil sites, large settlements may occur under loaded foundations without actual shear failure occurring; in such cases, the allowable bearing stress is determined with regard to the maximum allowable settlement. It is important during construction and design stage of a project to evaluate the subgrade strength. The California Bearing Ratio (CBR) test is commonly used to determine the suitability of a soil as a subgrade for design and construction. The field Plate Load Test is commonly used to predict the deformations and failure characteristics of the soil/subgrade and modulus of subgrade reaction (k_s). The Modulus of subgrade reaction (k_s) is used in foundation design, soil-structure interaction studies and design of highway pavements.^{*[citation needed]*}

Slope stability

[edit]



Simple slope slip section

Main article: Slope stability

The field of slope stability encompasses the analysis of static and dynamic stability of slopes of earth and rock-fill dams, slopes of other types of embankments, excavated slopes, and natural slopes in soil and soft rock.^[18]

As seen to the right, earthen slopes can develop a cut-spherical weakness zone. The probability of this happening can be calculated in advance using a simple 2-D circular analysis package.^[19] A primary difficulty with analysis is locating the most-probable slip plane for any given situation.^[20] Many landslides have been analyzed only after the fact. Landslides vs. Rock strength are two factors for consideration.

Recent developments

[edit]

A recent finding in soil mechanics is that soil deformation can be described as the behavior of a dynamical system. This approach to soil mechanics is referred to as Dynamical Systems based Soil Mechanics (DSSM). DSSM holds simply that soil deformation is a Poisson process in which particles move to their final position at random shear strains.

The basis of DSSM is that soils (including sands) can be sheared till they reach a steady-state condition at which, under conditions of constant strain-rate, there is no change in shear stress, effective confining stress, and void ratio. The steady-state was formally defined^[21] by Steve J. Poulos Archived 2020-10-17 at the Wayback Machine an associate professor at the Soil Mechanics Department of Harvard University, who built off a hypothesis that Arthur Casagrande was formulating towards the end of his career. The steady state condition is not the same as the "critical state" condition. It differs from the critical state in that it specifies a statistically constant structure at the steady state. The steady-state values are also very slightly dependent on the strain-rate.

Many systems in nature reach steady states, and dynamical systems theory describes such systems. Soil shear can also be described as a dynamical system.^{[22][23]} The physical basis of the soil shear dynamical system is a Poisson process in which particles move to the steady-state at random shear strains.^[24] Joseph^[25] generalized this—particles move to their final position (not just steady-state) at random shear-strains. Because of its origins in the steady state concept, DSSM is sometimes informally called "Harvard soil mechanics."

DSSM provides for very close fits to stress–strain curves, including for sands. Because it tracks conditions on the failure plane, it also provides close fits for the post failure region of sensitive clays and silts something that other theories are not able to do. Additionally DSSM explains key relationships in soil mechanics that to date have simply been taken for granted, for example, why normalized undrained peak shear strengths vary with the log of the overconsolidation ratio and why stress–strain curves normalize with the initial effective confining stress; and why in one-dimensional consolidation the void ratio must vary with the log of the effective vertical stress, why the end-of-primary curve is unique for static load increments, and why the ratio of the creep value C_α to the compression index C_c must be approximately constant for a wide range of soils.^[26]

See also

[edit]

- Critical state soil mechanics
- Earthquake engineering
- Engineering geology
- Geotechnical centrifuge modeling
- Geotechnical engineering
- Geotechnical engineering (Offshore)
- Geotechnics
- Hydrogeology, aquifer characteristics closely related to soil characteristics
- International Society for Soil Mechanics and Geotechnical Engineering
- Rock mechanics
- Slope stability analysis

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[edit]

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-  Media related to Soil mechanics at Wikimedia Commons

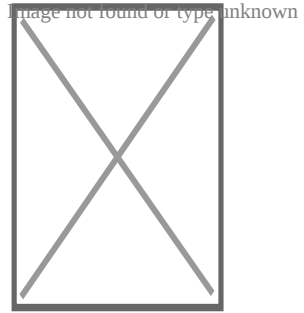
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Soil science

- 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



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)

- **v**
- **t**
- **e**

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

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

-  Wikipedia:WikiProject Soil
-  Category soil
- Category soil science
-  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
 - 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
 -  Inclinator
 -  Settlement recordings
-  Shear vane test
-  Simple sounding
-  Standard penetration test
-  Total sounding
-  Trial pit
-  Visible bedrock
- Nuclear densometer test
- Exploration geophysics
- Crosshole sonic logging

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

Forces

- Effective stress
- Pore water pressure
- Lateral earth pressure
- Overburden pressure
- Preconsolidation pressure

Mechanics

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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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%2087.6050944,14z/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

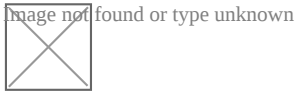
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Jeffery James

(5)

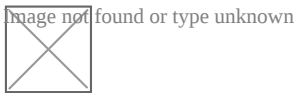
Very happy with my experience. They were prompt and followed through, and very helpful in fixing the crack in my foundation.



Sarah McNeily

(5)

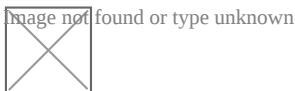
USS was excellent. They are honest, straightforward, trustworthy, and conscientious. They thoughtfully removed the flowers and flower bulbs to dig where they needed in the yard, replanted said flowers and spread the extra dirt to fill in an area of the yard. We've had other services from different companies 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



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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.

Understanding the Role of Push Piers in Foundation Repair [View GBP](#)

Frequently Asked Questions

and

****1.**

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