



- **Understanding Expansive Clay and Its Impact on Foundations**
Understanding Expansive Clay and Its Impact on Foundations **Examining Sandy Loam for Residential Support** **Identifying Areas Vulnerable to Soil Erosion** **Evaluating Soil Moisture Fluctuations Beneath Homes** **Approaches for Chemical Soil Stabilization** **Techniques for Addressing Soil Heave Issues** **Managing Settlement with Targeted Soil Compaction** **Recognizing Soil Drainage Limitations** **Investigating Soil Stress Testing in Residential Sites** **Incorporating Root Barriers to Prevent Shifts** **Examining Seasonal Swelling and Shrinking of Soil** **Employing Sustainable Methods for Long Term Soil Health**
- **Planning French Drains for Effective Water Control**
Planning French Drains for Effective Water Control **Setting Up Sump Pumps to Prevent Basement Flooding** **Extending Gutter Downspouts for Extra Protection** **Excavation Basics for Residential Construction Projects** **Coordinating Soil Compaction Methods on Site** **Limiting Erosion Through Proper Grading Techniques** **Evaluating Perimeter Drain Systems for Dry Foundations** **Installing Exterior Waterproof Barriers for Walls** **Adapting Site Plans to Local Rainfall Patterns** **Understanding Swale Placement for Controlled Water Flow** **Enhancing Overall Site Drainage with Gravel Trenches** **Minimizing Subsurface Water Accumulation Around Foundations**
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Explanation of the seasonal impact on soil expansion and contraction

Seasonal changes play a significant role in the expansion and contraction of soil, a phenomenon that can have widespread implications for agriculture, construction, and environmental management. High moisture levels can cause soil expansion, leading to foundation instability [home foundation repair service](#) structural failure. Understanding these seasonal impacts is crucial for mitigating potential problems and optimizing land use.

During the wet season, increased rainfall leads to higher soil moisture content. Clay-rich soils, in particular, are highly susceptible to swelling as they absorb water. This expansion can cause the ground to rise, leading to issues such as cracking in foundations, shifting of soil layers, and damage to infrastructure. Additionally, the expansion can affect plant root systems, influencing growth and stability.

Conversely, during the dry season, evaporation and reduced rainfall lead to a decrease in soil moisture. As the soil dries out, it contracts. This contraction can result in the formation of cracks and uneven ground surfaces. For agricultural lands, this can disrupt root systems and reduce the soil's ability to retain water and nutrients, impacting crop yields. In construction, shrinking soil can lead to settling and further structural damage to buildings and roads.

The cycle of swelling and shrinking is not only influenced by direct weather patterns but also by temperature fluctuations. Warmer temperatures during the dry season can accelerate evaporation, enhancing the rate of soil contraction. In contrast, cooler, wetter conditions during the wet season promote water retention and soil expansion.

To manage these seasonal impacts, several strategies can be employed. For agricultural purposes, incorporating organic matter into the soil can improve its structure and water retention capacity, reducing the extent of expansion and contraction. In construction, using soils with lower clay content or implementing proper drainage systems can mitigate the adverse effects of seasonal changes.

In summary, the seasonal swelling and shrinking of soil are natural processes driven by variations in moisture and temperature. By understanding and addressing these changes, we can better protect our infrastructure, enhance agricultural productivity, and maintain environmental stability.

Overview of common residential foundation types and their susceptibility to soil movement

Sure, here's a short essay on the topic:

When it comes to building homes, the foundation is critical. It's the base upon which everything else stands. There are several common types of residential foundations, each with its own characteristics and susceptibility to soil movement, particularly the seasonal swelling and shrinking of soil.

One of the most common types is the slab-on-grade foundation. This is essentially a thick concrete slab that sits directly on the ground. While it's cost-effective and simple to construct, it's highly susceptible to soil movement. When soil swells with moisture or shrinks during dry periods, the slab can crack or shift, leading to significant structural issues.

Another popular option is the crawl space foundation. This type elevates the home slightly off the ground, providing a small area beneath for ventilation and storage. Crawl spaces are somewhat less susceptible to soil movement than slab-on-grade foundations, but they are not immune. Poor drainage or excessive moisture can still cause the soil to shift, affecting the foundation's stability.

Basement foundations are another common type, especially in regions with cold climates. These foundations involve digging down to create a below-ground level that serves as additional living space. Basements are generally more resistant to soil movement due to their depth and the mass of soil above them acting as a buffer. However, they are not entirely immune, particularly if the soil around them experiences extreme swelling or shrinking.

Lastly, there's the pier and beam foundation, which uses a network of piers to support the home, leaving a gap between the ground and the living space. This type is less common in residential settings but offers good resistance to soil movement. The elevated structure means that minor soil shifts are less likely to impact the home's stability.

In conclusion, while all residential foundations are susceptible to some degree of soil movement, the extent varies. Homeowners should be aware of these susceptibilities and take appropriate measures, such as proper drainage and regular inspections, to mitigate potential issues arising from seasonal swelling and shrinking of soil.

Signs and symptoms of foundation damage due to seasonal soil changes

Seasonal changes in temperature and moisture levels can significantly impact the soil around a foundation, leading to swelling and shrinking that may cause structural damage. Recognizing the signs and symptoms of foundation damage due to these seasonal soil changes is crucial for homeowners. Here are some key indicators to watch for:

1. ****Cracks in Walls and Floors****: One of the most obvious signs of foundation issues is the appearance of cracks in interior and exterior walls, as well as in floors. These cracks may be horizontal, vertical, or diagonal and can vary in size. Seasonal soil changes often exacerbate these cracks, making them more noticeable during certain times of the year.

2. ****Uneven Floors****: If you notice that your floors are sloping or uneven, it could be a sign that the foundation is shifting due to soil movement. This can be particularly problematic in older homes where the foundation may already be compromised.
3. ****Sticking Doors and Windows****: Doors and windows that suddenly become difficult to open or close might indicate that the frame has shifted slightly. This can be a result of the foundation moving due to soil expansion or contraction.
4. ****Gaps Around Windows and Doors****: As the foundation shifts, gaps may appear around the frames of windows and doors. These gaps can allow drafts and pests into your home and are a clear sign that something is amiss beneath the surface.
5. ****Exterior Wall Cracks****: Similar to interior cracks, exterior wall cracks can also signal foundation problems. These cracks may be more pronounced after periods of heavy rain or drought, when soil swelling and shrinking are most active.
6. ****Bowing or Bulging Walls****: In severe cases, walls may start to bow or bulge outward. This is a serious sign of foundation distress and often indicates that the soil has moved significantly, putting pressure on the walls.
7. ****Foundation Settlement****: Uneven settling of the foundation can lead to a noticeable tilt in the structure. This is often accompanied by other symptoms like cracking and can be particularly pronounced after extreme weather events.
8. ****Water Intrusion****: Seasonal soil changes can also affect the integrity of basement walls and floors, leading to water intrusion. If you notice dampness, mold, or musty odors in your basement, it could be a sign that the foundation is compromised.

Addressing these signs promptly is essential to prevent further damage. Consulting with a professional foundation expert can help you determine the best course of action to stabilize your foundation and protect your home from the effects of seasonal soil changes.

Analysis of environmental factors contributing to soil swelling and shrinking

Examining the seasonal swelling and shrinking of soil involves understanding a variety of environmental factors that contribute to these phenomena. Soil is a dynamic medium influenced by numerous natural elements, each playing a crucial role in its behavior throughout the year.

One of the primary factors is moisture content. Soils with a high clay content are particularly susceptible to swelling and shrinking due to their ability to absorb and retain water. During the wet season, these soils soak up moisture like a sponge, expanding as the clay particles become hydrated. Conversely, in the dry season, as water evaporates, the soil contracts, leading to shrinkage. This cycle of expansion and contraction is a natural process but can be exacerbated by extreme weather conditions such as heavy rains or prolonged droughts.

Temperature fluctuations also play a significant role. Warmer temperatures can accelerate evaporation, leading to quicker soil drying and subsequent shrinking. In contrast, cooler temperatures may slow down evaporation, allowing soils to retain moisture longer and potentially leading to more pronounced swelling. The interaction between temperature and moisture is complex and can vary significantly depending on the specific climate and geographical location.

Another critical factor is the presence of organic matter in the soil. Organic matter can influence soil structure and its capacity to hold water. Soils rich in organic content tend to have better structure and may exhibit less dramatic swelling and shrinking compared to those with lower organic matter. Additionally, the type of vegetation covering the soil can impact these processes. Plants with deep root systems can help stabilize the soil, reducing the extent of swelling and shrinking by maintaining a more consistent moisture level throughout the soil profile.

Human activities also contribute to the seasonal changes in soil behavior. Agricultural practices, such as tilling and irrigation, can disrupt natural soil structures and moisture levels, leading to more pronounced swelling and shrinking. Urban development and construction can similarly alter soil conditions, often resulting in compaction and changes in drainage patterns that affect soil moisture dynamics.

In conclusion, the analysis of environmental factors contributing to soil swelling and shrinking is a multifaceted study. It requires consideration of moisture content, temperature variations, organic matter, vegetation, and human activities. Understanding these factors is essential for managing soil health and predicting its behavior in various seasonal conditions, ultimately aiding in the sustainable use of land resources.

Discussion on the importance of regular foundation inspections and maintenance

Certainly!

Discussing the importance of regular foundation inspections and maintenance is crucial, especially when examining the seasonal swelling and shrinking of soil. Soil dynamics play a significant role in the structural integrity of buildings, and understanding these changes can help mitigate potential damage.

Firstly, seasonal changes can cause significant fluctuations in soil moisture levels. During wet seasons, soil absorbs water and expands, while in dry seasons, it loses moisture and contracts. This natural phenomenon, known as soil swelling and shrinking, can exert considerable pressure on a building's foundation. If left unchecked, these movements can lead to cracks, uneven settling, and structural instability.

Regular foundation inspections allow homeowners and professionals to identify early signs of distress. By monitoring the condition of the foundation throughout the year, one can detect subtle shifts or cracks before they escalate into major issues. This proactive

approach not only prolongs the lifespan of the structure but also saves on costly repairs down the line.

Maintenance is equally important. Techniques such as installing proper drainage systems, maintaining consistent moisture levels around the foundation, and using materials that accommodate soil movement can significantly reduce the impact of seasonal changes. Additionally, repairing cracks promptly and ensuring that the soil around the foundation is compacted correctly can prevent further damage.

In conclusion, regular foundation inspections and maintenance are vital in managing the effects of seasonal soil swelling and shrinking. By staying vigilant and implementing preventative measures, we can ensure the stability and longevity of our structures, providing a safe and secure environment for occupants.

Presentation of repair techniques and solutions for addressing foundation issues caused by soil movement

Certainly! Here's a short essay on the presentation of repair techniques and solutions for addressing foundation issues caused by soil movement, specifically focusing on the seasonal swelling and shrinking of soil:

When it comes to safeguarding homes and buildings from the detrimental effects of soil movement, understanding and implementing effective repair techniques is paramount. Seasonal swelling and shrinking of soil, often driven by changes in moisture content, can lead to significant foundation issues. These issues manifest as cracks, uneven floors, and misaligned doors and windows, which not only compromise structural integrity but also affect the aesthetic appeal of the property.

To address these challenges, a multifaceted approach to repair and mitigation is essential. One of the primary techniques involves the use of helical piers. These steel piers are driven deep into the stable soil layers beneath the foundation, providing robust support that counteracts the effects of soil movement. By transferring the load of the structure to more stable soil, helical piers effectively stabilize the foundation, preventing further damage.

Another effective solution is the installation of push piers. Similar to helical piers, push piers are driven into the ground until they reach load-bearing strata. However, push piers are installed by hydraulically pushing them through the unstable soil, ensuring minimal disruption to the surrounding area. This method is particularly beneficial in urban settings where space is at a premium.

For less severe cases, mudjacking, also known as slab jacking, can be an efficient solution. This technique involves pumping a slurry mixture beneath the sunken concrete, raising it to its original position. While mudjacking is a cost-effective option, it is important to note that it may not provide the same level of long-term stability as pier systems.

In addition to these structural solutions, proactive maintenance practices play a crucial role in mitigating soil movement issues. Proper landscaping and drainage systems are vital in managing moisture levels around the foundation. Ensuring that water is directed away from the structure can significantly reduce the risk of soil expansion and contraction.

Furthermore, the use of moisture barriers and sealants can help protect the foundation from excessive moisture infiltration. These barriers act as a shield, preventing water from seeping into the soil and causing it to swell.

In conclusion, addressing foundation issues caused by seasonal swelling and shrinking of soil requires a comprehensive approach that combines structural repairs with proactive maintenance. By employing techniques such as helical piers, push piers, and mudjacking, alongside effective drainage and moisture management strategies, homeowners can ensure the longevity and stability of their properties.



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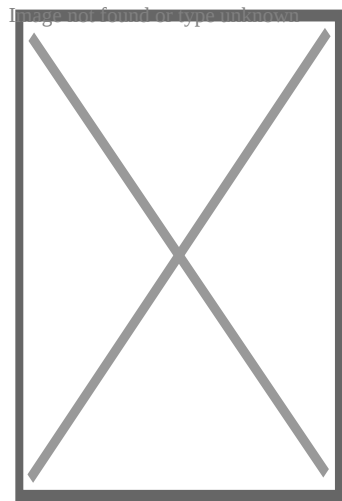
Residential Foundation Repair Services

Strong Foundations, Strong Homes

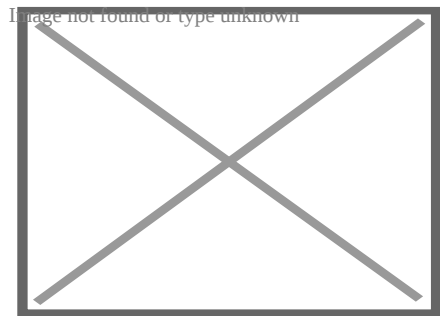


About soil mechanics

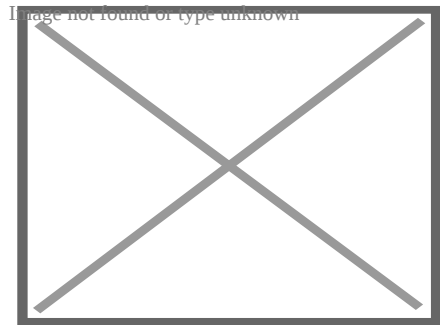
 This article **may be too long to read and navigate comfortably**. Consider splitting content into sub-articles, condensing it, or adding subheadings. Please discuss this issue on the article's talk page. *(February 2025)*



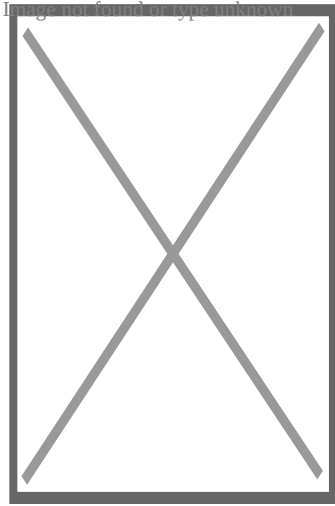
The Leaning Tower of Pisa – an example of a problem due to deformation of soil



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.

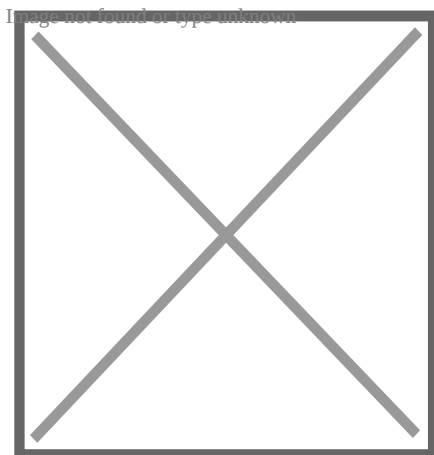
Silt, Sand, and Gravel are basically little pieces of broken rocks.

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

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Soil mineralogy

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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

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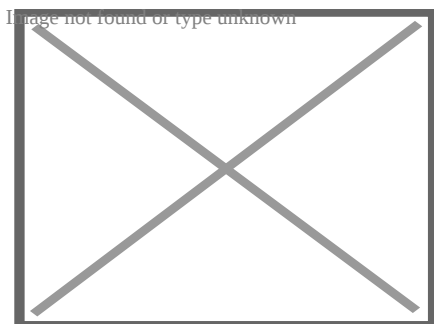
Main article: Soil gradation

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, 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 d_{10} 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

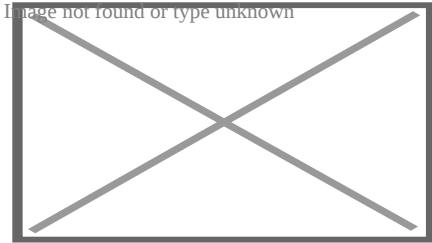
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The classification of fine-grained soils, i.e., soils that are finer than sand, is determined primarily by their Atterberg limits, not by their grain size. If it is important to determine the grain size distribution of fine-grained soils, the hydrometer 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 and V_v represent the volumes of air, water and solids in a soil mixture;

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

M_s and M_w 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, 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):

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

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

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

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

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

where ρ 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.

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

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

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

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

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

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

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

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

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

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

$$w = \frac{Se}{G_s}$$

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

{\displaystyle LL}

), *plastic limit* (denoted by *PL* or

{\displaystyle PL}

), 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

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

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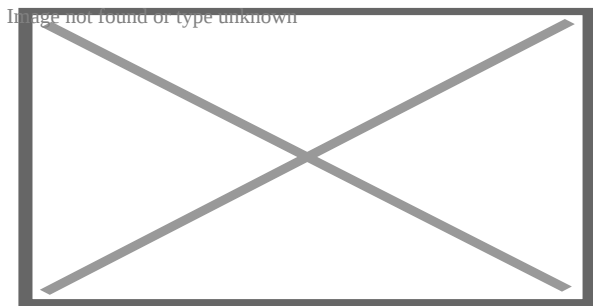
where: $e_{\max}$ is the "maximum void ratio" corresponding to a very loose state, $e_{\min}$ is the "minimum void ratio" corresponding to a very dense state and e is the *in situ* void ratio. Methods used to calculate relative density are defined in ASTM D4254-00(2006).^[12]

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

Seepage: steady state flow of water

[edit]

This section is an excerpt from Seepage.[edit]



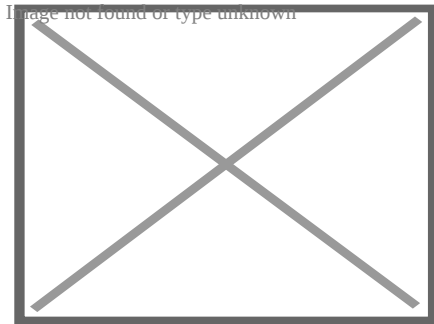
A cross section showing the water table varying with surface topography as well as a perched water table

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 $\frac{dP}{dz} = \gamma_w$ where z is the depth w 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 g is the acceleration due to gravity, and γ 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.

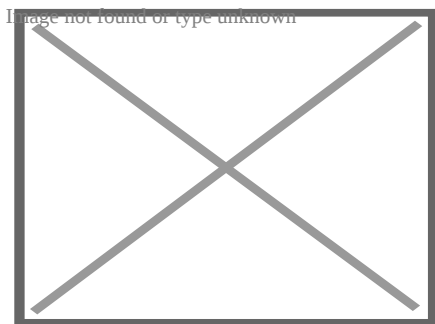
Pore water pressure

[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:

$$u = \rho_w g z_w$$

where ρ_w is the density of water, and z_w 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, $\frac{dp}{dz} = \rho_w g$, but note that z 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, $\sigma' = \sigma - u$, if the 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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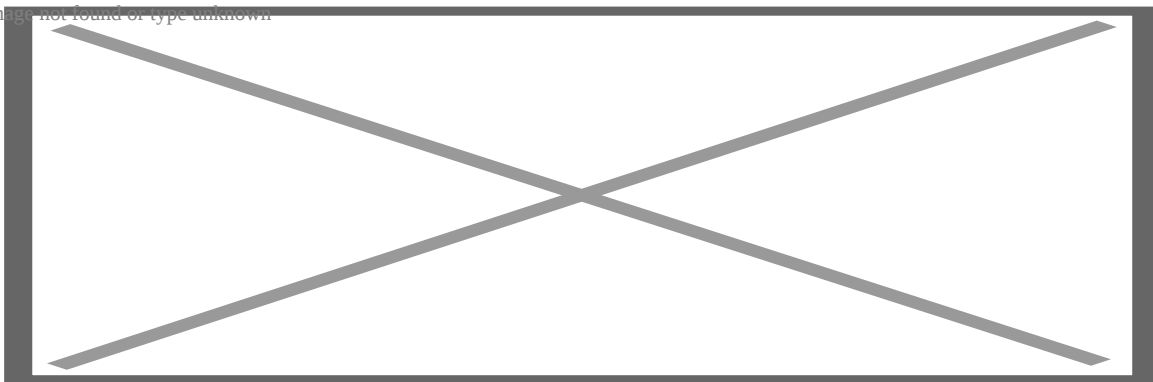
Shrinkage caused by
drying

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

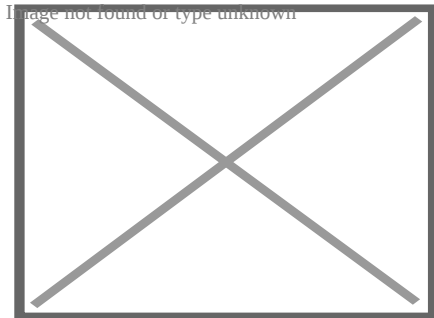
Terzaghi developed the theory of one-dimensional consolidation which enables prediction of the amount of settlement and the time required for the settlement to occur.^[15] Afterwards, Maurice Biot fully developed the three-dimensional soil consolidation theory, extending the one-dimensional model previously 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

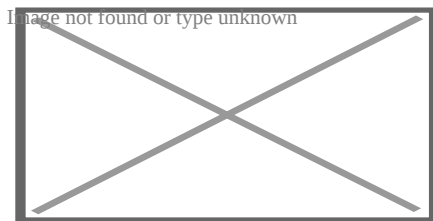
The shear strength and stiffness of soil determines whether or not soil will be stable or how much it will deform. Knowledge of the strength is necessary to determine if a slope will be stable, if a building or bridge might settle too far into the ground, and the limiting pressures on a retaining wall. 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

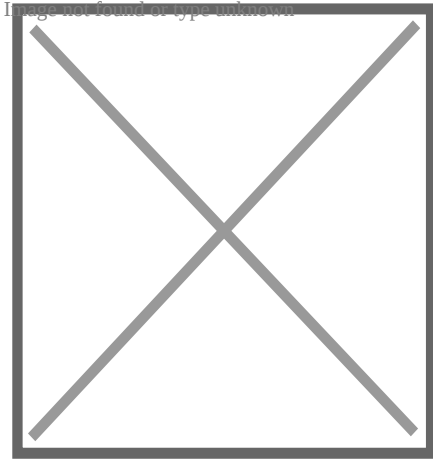
[edit]



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]

$$\tau = c' + \sigma' \tan \phi'$$

It is now known that the ϕ' and c' 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]}

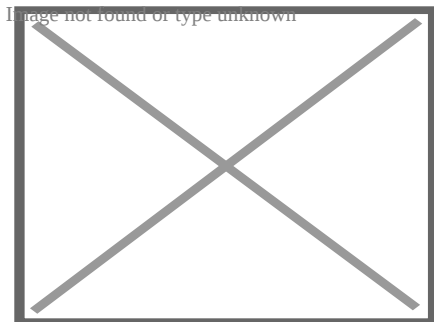
Structure, fabric, and chemistry

[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 described 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

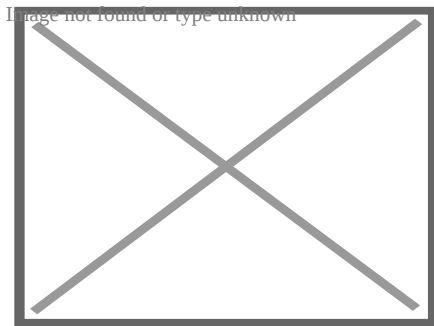
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Main article: Bearing capacity

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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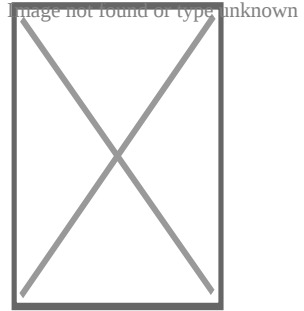
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 - Pedodiversity
 - Soil formation
- Soil erosion
- Soil contamination
- Soil retrogression and degradation
- Soil compaction
 - Soil compaction (agriculture)
- Soil sealing
- Soil salinity
 - Alkali soil
- Soil pH
 - Soil acidification
- Soil health
- Soil life
- Soil biodiversity
- Soil quality
- Soil value
- Soil fertility
- Soil resilience
- Soil color
- Soil texture
- Soil structure
 - Pore space in soil
 - Pore water pressure
- Soil crust
- Soil horizon
- Soil biomantle
- Soil carbon
- Soil gas
 - Soil respiration
- Soil organic matter
- Soil moisture
 - Soil water (retention)

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Soil classification

World Reference Base for Soil Resources (1998–)

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

USDA soil taxonomy

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

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
 -  Inclinometer
 -  Settlement recordings
-  Shear vane test
-  Simple sounding
-  Standard penetration test
-  Total sounding
-  Trial pit
-  Visible bedrock
- Nuclear densometer test
- Exploration geophysics
- Crosshole sonic logging

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

Authority control databases: National  [BnF](#) [JSTOR](#) [NLA](#) [OL](#) [Open Library](#) [UDL](#) [Wikidata](#) [Wikisource](#) [Wikiversity](#) [Wikivoyage](#) [WorldCat](#)

- Germany
- United States
- France
- Japan
- Czech Republic
- Israel

About Hoffman Estates, Illinois

Hoffman Estates is located in Illinois

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Hoffman Estates

Estates

Hoffman Estates is located in the United States

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Hoffman Estates

Estates

Hoffman Estates, Illinois

Village

Hoffman Estates scenery

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Hoffman Estates scenery

Flag of Hoffman Estates, Illinois

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Flag

Official seal of Hoffman Estates, Illinois

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Seal

Motto:

"Growing to Greatness"

Location of Hoffman Estates in Cook County, Illinois

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Location of Hoffman Estates in Cook County, Illinois

Hoffman Estates is located in Chicago metropolitan area

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Hoffman Estates
Estates

Coordinates: 42°03′50″N 88°08′49″W﻿ / ﻿42.06389°N 88.14694°W﻿ / 42.06389; -88.14694Country United StatesState IllinoisCounties CookTownships Schaumburg, Palatine, Hanover, BarringtonIncorporated 1959 (village)Government

• MayorWilliam D. McLeod^[*citation needed*] • Village ManagerEric J. Palm^[*citation needed*]Area

^[1]

• Total

21.25 sq mi (55.03 km²) • Land21.07 sq mi (54.56 km²) • Water0.18 sq mi (0.47 km²)
0.86%Elevation

^[2]

824 ft (251 m)Population

(2020)

• Total

52,530 • Density2,493.71/sq mi (962.82/km²)Zip Code

60169, 60010, 60192

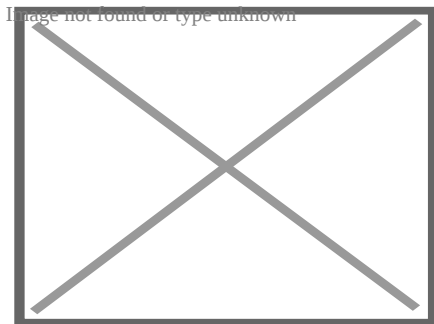
Area code(s)847 / 224FIPS code17-35411GNIS feature ID2398519^[2]Websitewww.hoffmanestates.org

Hoffman Estates is a village in Cook County, Illinois, United States. It is a suburb of Chicago. Per the 2020 census, the population was 52,530.^[3]

The village previously served as the headquarters for Sears and is one of the American headquarters for Mori Seiki. Now Arena, home of the Windy City Bulls of the NBA G League is part of the village. Between 2006 and 2009, the village hosted the Heartland International Tattoo, one of the largest music and dance festivals of its kind in the Midwest.

History

[edit]



Sunderlage Farm Smokehouse^[4](National Register of Historic Places) in Hoffman Estates

Prior to the 1940s, German settlers moved into the area west of Roselle Road and north of Golf Road, then known as Wildcat Grove. The area was sparsely populated until farmers purchased land in the area in the 1940s.

In 1954, Sam and Jack Hoffman, owners of a father-son owned construction company, bought 160 acres of land in the area.^[5] The pair constructed homes and began the development of the region which now bears their name. As residents moved in, they voted to incorporate the area, and the Village of Hoffman Estates was incorporated on September 23, 1959.^{[6][5][7]} In 1973, six former town officials, including mayors Edward F. Pinger (1959?1965) and Roy L. Jenkins (1965?1969) were indicted on bribery and tax charges.^[8]

Once the Northwest Tollway opened, Schaumburg Township became more attractive to Chicago commuters. In the early 1960s, land annexations north of the tollway and in other neighboring regions more than doubled Hoffman Estates' land area.^[9]

The opening of the Woodfield Mall in Schaumburg to the east in 1971 made the area a major business center. An attempt to change the name of the village to East Barrington, among other names, was made in the early 1980s but failed upon a residential vote.^[10]

In the 1990s, the Prairie Stone Business Park began development. This 750-acre (3.0 km²) planned multi-purpose business park^[11] is bounded by Illinois Route 59 on the east, Interstate 90 on the south, Illinois Route 72 on the north, and Beverly Road on the west. The business

park came to fruition in 1993 when Sears, Roebuck and Company relocated from the Sears Tower in Chicago to a sprawling headquarters in the northwest part of Prairie Stone.^{[12][11]} That was followed in by Indramat and Quest International, which in 1995 also opened facilities in the park.^{[13][14][15]} Throughout the 1990s, a health and wellness center and child care facility were developed, as well as other smaller office buildings, and a branch of Northern Illinois University. Development of the business park is still ongoing, and recent additions in the 2000s include the 11,000-seat Now Arena; office buildings for Serta, WT Engineering, I-CAR, and Mary Kay; a Cabela's outdoor outfitters store; a 295-room Marriott hotel; and the 400,000-square-foot (37,000 m²) Poplar Creek Crossing Retail Center, which is anchored by Target and numerous other big-box retailers. Future development will include further office buildings and retail development, Sun Island Hotel and Water Park, an amphitheater, and restaurants.

In 2011, the Village of Hoffman Estates took over ownership of the Now Arena.^[16] On June 23, 2020, the Village of Hoffman Estates approved an \$11.5 million deal to rename the Sears Centre Arena to the "NOW Arena".^[17]

In the fall of 2016, papers and artifacts from President Barack Obama's administration began to arrive in town, where they are being stored in a building on Golf Road. The site is their temporary home while construction takes place on the Barack Obama Presidential Center in Jackson Park, Chicago, and is not open to the public.^[18]

In January 2020, the Centers for Disease Control and Prevention (CDC) confirmed the second U.S. case of COVID-19 in a Hoffman Estates resident. The patient, a woman in her 60s returning from Wuhan, China, was treated at St. Alexius Medical Center.^[19] Her husband was later infected in the first case of human-to-human transmission of the SARS-CoV-2 virus in the United States.^[20]

Geography

[edit]

According to the 2021 census gazetteer files, Hoffman Estates has a total area of 21.25 square miles (55.04 km²), of which 21.07 square miles (54.57 km²) (or 99.15%) is land and 0.18 square miles (0.47 km²) (or 0.85%) is water.^[21]

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Places adjacent to Hoffman Estates, Illinois

Barrington Hills

South Barrington

Inverness

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Elgin / East Dundee

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Hoffman Estates, Illinois

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Schaumburg

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Elgin

Streamwood

Schaumburg

Demographics

[edit]

Historical population

Census	Pop.	Note	%±
1960	8,296	—	
1970	22,238		168.1%
1980	37,272		67.6%
1990	46,363		24.4%
2000	49,495		6.8%
2010	51,895		4.8%
2020	52,530		1.2%
U.S. Decennial Census ^[22]			
2010 ^[23] 2020 ^[24]			

Hoffman Estates village, Illinois – Racial and ethnic composition

Note: the US Census treats Hispanic/Latino as an ethnic category. This table excludes Latinos from the racial categories and assigns them to a separate category. Hispanics/Latinos may be of any race.

Race / Ethnicity (NH = Non-Hispanic)	Pop 2000 ^[25]	Pop 2010 ^[23]	Pop 2020 ^[24]	% 2000	% 2010	% 2020
White alone (NH)	33,789	29,357	26,014	68.27%	56.57%	49.52%
Black or African American alone (NH)	2,141	2,393	2,472	4.33%	4.61%	4.71%
Native American or Alaska Native alone (NH)	54	60	69	0.11%	0.12%	0.13%
Asian alone (NH)	7,429	11,701	13,733	15.01%	22.55%	26.14%
Pacific Islander alone (NH)	10	4	2	0.02%	0.01%	0.00%
Other race alone (NH)	73	70	183	0.15%	0.13%	0.35%
Mixed race or Multiracial (NH)	801	1,013	1,579	1.62%	1.95%	3.01%
Hispanic or Latino (any race)	5,198	7,297	8,478	10.50%	14.06%	16.14%
Total	49,495	51,895	52,350	100.00%	100.00%	100.00%

As of the 2020 census^[26] there were 52,530 people, 18,110 households, and 14,048 families residing in the village. The population density was 2,472.58 inhabitants per square mile (954.67/km²). There were 19,160 housing units at an average density of 901.86 per square mile (348.21/km²). The racial makeup of the village was 52.08% White, 26.26% Asian, 4.87% African American, 0.60% Native American, 0.02% Pacific Islander, 7.51% from other races, and 8.68% from two or more races. Hispanic or Latino of any race were 16.14% of the population.

There were 18,110 households, out of which 36.3% had children under the age of 18 living with them, 61.71% were married couples living together, 11.97% had a female householder with no husband present, and 22.43% were non-families. 18.07% of all households were made up of individuals, and 5.43% had someone living alone who was 65 years of age or older. The average household size was 3.16 and the average family size was 2.77.

The village's age distribution consisted of 23.1% under the age of 18, 7.3% from 18 to 24, 27.7% from 25 to 44, 28.3% from 45 to 64, and 13.5% who were 65 years of age or older. The median age was 38.2 years. For every 100 females, there were 97.6 males. For every 100 females age 18 and over, there were 96.4 males.

The median income for a household in the village was \$92,423, and the median income for a family was \$103,641. Males had a median income of \$56,210 versus \$42,288 for females. The per capita income for the village was \$40,016. About 3.3% of families and 4.3% of the population were below the poverty line, including 4.9% of those under age 18 and 3.5% of those age 65 or over.

Economy

[edit]

Employers

[edit]

Many Japanese companies have their U.S. headquarters in Hoffman Estates and Schaumburg^[27] but the largest employers in Hoffman Estates as of 2023^[28] are:

No.	Employer	No. of employees
1	St. Alexius Medical Center	2,500
2	Siemens Medical Systems	400
3	Claire's ^[29]	400
4	Village of Hoffman Estates	370
5	FANUC America ^[30]	350
6	Vistex	350

7	Leopardo Companies, Inc.	300
8	Wells Fargo	300
9	The Salvation Army	270
10	Tate & Lyle	220

Education

[edit]

The village is served by several public school districts. The majority of residents who live in Schaumburg Township attend:

- Township High School District 211 (9–12)^[31]
- Community Consolidated School District 54 (K–8)^[32]

North Hoffman Estates (north of I-90) residents are served by:

- Township High School District 211
- Community Consolidated School District 15 (K–8)^[33] (East of Huntington Blvd)
- Barrington School District 220 (K–12) (Unit District) (West of Huntington Blvd).^[34]

Residents west of Barrington Road primarily attend Unit School District, Elgin Area U46.

High schools

[edit]

Schools located in the Hoffman Estates village limits:

- Hoffman Estates High School
- James B. Conant High School

Other high schools in the same township high school district:

- Schaumburg High School
- William Fremd High School
- Palatine High School

Community college

[edit]

Most of the village is served by Harper College Community College District 512.

Miscellaneous education

[edit]

The Xilin Northwest Chinese School (simplified Chinese: 馨林西北汉语学校; traditional Chinese: 馨林西北漢語學校; pinyin: *Xīnlín Xīběi Zhōngwén Xuéxiào*) holds its classes at Conant High School in Hoffman Estates.^[35] It serves grades preschool through 12.^[36] The school predominately serves mainland Chinese families. In 2003 the school held its classes in Palatine High School in Palatine. In 2000 the school had served around 300 students. This figure increased almost by 100%, to almost 600 students. This made it one of the largest of the Chinese schools in the Chicago area.^[37]

Library

[edit]

-  [Chicago portal](#)
-  [Illinois portal](#)
- [Barrington Area Library](#)
- [Schaumburg Township District Library](#)
- [Gail Borden Public Library District](#)
- [Palatine Township Library](#)

Sister city

[edit]

Hoffman Estates has one sister city:^[38]

- [Angoulême, Charente, Nouvelle-Aquitaine, France](#)

Transportation

[edit]

Pace provides bus service on multiple routes connecting Hoffman Estates to Elgin, Rosemont, and other destinations.^[39]

Notable people

[edit]

- Tammy Duckworth, U.S. Senator from Illinois (2016–present)^[40]
- Rob Valentino (b. 1985), former soccer player who is an assistant coach for Atlanta United^[41]
- William Beckett, lead singer of the band The Academy Is...

Notes

[edit]

- ¹ ^ "2020 U.S. Gazetteer Files". *United States Census Bureau*. Retrieved March 15, 2022.
- ² ^ **a b** U.S. Geological Survey Geographic Names Information System: Hoffman Estates, Illinois
- ³ ^ "Hoffman Estates village, Illinois". *United States Census Bureau*. Retrieved April 15, 2022.
- ⁴ ^ "The Sunderlage Smokehouse: Hoffman Eestates' National Register Landmark". *History of Schaumburg Township: A Blog of the Schaumburg Township District Library*. February 21, 2010. Retrieved March 3, 2017.
- ⁵ ^ **a b** Collins, Catherine (August 24, 1986). "Hoffman Estates Plans a Revamp of Future Image". *Chicago Tribune*.
- ⁶ ^ "Hoffman Estates, IL". *The Encyclopedia of Chicago*. Retrieved March 8, 2020.
- ⁷ ^ "HR0614 96th General Assembly". *State of Illinois*.
- ⁸ ^ Davis, Robert (October 27, 1973). "U.S. indicts builder, seven ex-officials in suburb bribe". *Chicago Tribune*.
- ⁹ ^ "History of Hoffman Estates". *Village of Hoffman Estates*. Retrieved March 8, 2020.
- ¹⁰ ^ "Name history of Hoffman Estates". *Falcon Living*. Retrieved November 26, 2017.
- ¹¹ ^ **a b** Sulski, Jim (May 11, 2000). "Versatile Network Brings Workers to Prairie Stone Business Park". *Chicago Tribune*.
- ¹² ^ Bernstein, David (May 16, 2020). "The Sears Headquarters Deal Cost Taxpayers \$500 Million. 30 Years Later, There's Little to Show for It". *ProPublica*.
- ¹³ ^ Russis, Martha (December 28, 1994). "PRAIRIE STONE GETS ELECTRONIC FIRM FOR TENANT". *Chicago Tribune*.
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- ¹⁵ ^ "Village of Hoffman Estates: History of Hoffman Estates". *Hoffmanestates.com*. Archived from the original on May 11, 2012. Retrieved April 30, 2012.
- ¹⁶ ^ Manson, Ken (December 23, 2009). "Suburb takes over Sears Centre". *Chicago Tribune*.
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20. ^ Hauck, Grace (January 30, 2020). "Chicago man is first US case of person-to-person coronavirus spread". *USA Today*. Chicago. Retrieved February 13, 2020.
21. ^ "Gazetteer Files". *Census.gov*. Retrieved June 29, 2022.
22. ^ "Decennial Census of Population and Housing by Decades". *US Census Bureau*.
23. ^ **a b** "P2 Hispanic or Latino, and Not Hispanic or Latino by Race – 2010: DEC Redistricting Data (PL 94-171) – Hoffman Estates village, Illinois". *United States Census Bureau*.
24. ^ **a b** "P2 Hispanic or Latino, and Not Hispanic or Latino by Race – 2020: DEC Redistricting Data (PL 94-171) –Hoffman Estates village, Illinois". *United States Census Bureau*.
25. ^ "P004: Hispanic or Latino, and Not Hispanic or Latino by Race – 2000: DEC Summary File 1 – Hoffman Estates village, Illinois". *United States Census Bureau*.
26. ^ "Explore Census Data". *data.census.gov*. Retrieved June 28, 2022.
27. ^ Selvam, Ashok. "Asian population booming in suburbs". *Daily Herald* (Arlington Heights, Illinois). March 6, 2011. Retrieved on June 19, 2013.
28. ^ "Village of Hoffman Estates Comprehensive Annual Financial Report". June 25, 2024.
29. ^ "FAQ Archived July 13, 2014, at the Wayback Machine." Claire's. Retrieved on December 25, 2011. "Claire's Stores, Inc. has its investor relations and customer service located in Pembroke Pines , Florida . The buying, marketing and distribution offices are located in Hoffman Estates, a suburb of Chicago . Please visit Contact Us if you would like to send correspondence to our corporate headquarters."
30. ^ "Village of Hoffman Estates Top Employers". *Hoffmanestates.org*. March 21, 2012. Archived from the original on April 22, 2012. Retrieved April 30, 2012.
31. ^ "d211.org". *d211.org*. Archived from the original on May 4, 2012. Retrieved April 30, 2012.
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36. ^ "About Us." Northwest Xilin Chinese School. Retrieved on February 24, 2014.
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41. ^ "Rob Valentino Biography". ESPN. Retrieved March 31, 2024.

External links

[edit]

- Village of Hoffman Estates official website

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Places adjacent to Hoffman Estates, Illinois



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Hoffman Estates, Illinois

Education

Schools

- Community Consolidated School District 54
- Community Consolidated School District 15
- Barrington School District 220
- Township High School District 211
 - Hoffman Estates High School
 - James B. Conant High School
- Elgin Area School District U46

- Other education
 - Harper College (in Palatine)
 - Schaumburg Township District Library
 - Barrington Area Library

Other

- Landmarks
 - Now Arena
 - Sunderlage Farm Smokehouse

This list is incomplete.

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Municipalities and communities of Cook County, Illinois, United States

County seat: **Chicago**

- Cities
- Berwyn
 - Blue Island
 - Burbank
 - Calumet City
 - Chicago‡
 - Chicago Heights
 - Country Club Hills
 - Countryside
 - Des Plaines
 - Elgin‡
 - Elmhurst‡
 - Evanston
 - Harvey
 - Hickory Hills
 - Hometown
 - Markham
 - Northlake
 - Oak Forest
 - Palos Heights
 - Palos Hills
 - Park Ridge
 - Prospect Heights
 - Rolling Meadows

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Map of Illinois highlighting Cook County

Towns

- Cicero

- Alsip
- Arlington Heights‡
- Barrington‡
- Barrington Hills‡
- Bartlett‡
- Bedford Park
- Bellwood
- Bensenville‡
- Berkeley
- Bridgeview
- Broadview
- Brookfield
- Buffalo Grove‡
- Burnham
- Burr Ridge‡
- Calumet Park
- Chicago Ridge
- Crestwood
- Deer Park‡
- Deerfield‡
- Dixmoor
- Dolton
- East Dundee‡
- East Hazel Crest
- Elk Grove Village‡
- Elmwood Park
- Evergreen Park
- Flossmoor
- Ford Heights
- Forest Park
- Forest View
- Frankfort‡
- Franklin Park
- Glencoe
- Glenview
- Glenwood
- Golf
- Hanover Park‡
- Harwood Heights
- Hazel Crest
- Hillside
- Hinsdale‡
- Hodgkins
- Hoffman Estates
- Homer Glen‡
- Homewood
- Indian Head Park
- Inverness

Townships

- Barrington
- Berwyn
- Bloom
- Bremen
- Calumet
- Cicero
- Elk Grove
- Hanover
- Lemont
- Leyden
- Lyons
- Maine
- New Trier
- Niles
- Northfield
- Norwood Park
- Oak Park
- Orland
- Palatine
- Palos
- Proviso
- Rich
- River Forest
- Riverside
- Schaumburg
- Stickney
- Thornton
- Wheeling
- Worth

Former: Evanston • Hyde Park • Jefferson • Lake • Lake View • North Chicago • Rogers Park • South Chicago • West Chicago

Unincorporated communities

- Central Stickney
- Hines
- Indian Hill
- La Grange Highlands
- Nottingham Park
- Sag Bridge
- Sutton

- Other Communities

- Orchard Place
 - Techny

Footnotes

‡This populated place also has portions in an adjacent county or counties

- Illinois portal
- United States portal

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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
- Gurnee
- Hanover Park
- Hoffman Estates
- Lombard
- Merrillville
- Mount Prospect
- Mundelein
- Niles
- Northbrook
- Oak Lawn
- Oak Park
- Orland Park
- Oswego
- Palatine
- Plainfield
- Romeoville
- Schaumburg
- Skokie
- Streamwood
- Tinley Park
- Wheeling
- Wonder Lake
- Woodridge

Counties

- Cook
- DeKalb
- DuPage
- Grundy
- Jasper
- Kane
- Kankakee
- Kendall
- Kenosha
- Lake, IL
- Lake, IN
- McHenry
- Newton
- Porter
- Will

Regions

- Great Lakes
- Northern Illinois
- Northern Indiana

Sub-regions

- Chicago Southland
- Eastern Ridges and Lowlands
- Fox Valley (Illinois)
- Golden Corridor
- Illinois Technology and Research Corridor
- North Shore (Chicago)
- Northwest Indiana

Illinois, United States

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State of Illinois

Springfield (capital)

Topics

- Index
- Abortion
- African Americans
- Buildings and structures
- Census areas
- Climate change
- Crime
- Communications
- Culture
- Delegations
- Earthquakes
- Economy
- Education
- Energy
- Environment
- Geography
- Government
- Health
- History
- Homelessness
- Languages
- Law
- Military
- Music
- People
- Politics
- Portal
- Protected areas
- Science and technology
- Sister cities
- Society
- Sports
- Symbols
- Tourism
- Transportation
- Windmills

Regions

- American Bottom
- Bloomington–Normal metropolitan area
- Central Illinois
- Champaign–Urbana metropolitan area
- Chicago metropolitan area
- Collar counties
- Corn Belt
- Driftless Area
- Forgottonia
- Fox Valley
- Illinois–Indiana–Kentucky tri-state area
- Metro East
- Metro Lakeland
- Mississippi Alluvial Plain
- North Shore
- Northern Illinois
- 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
- Carbondale
- Carol Stream/Glendale Heights
- Centralia
- Champaign/Urbana
- Charleston/Mattoon
- Chicago
- Chicago Heights
- Crystal Lake/Algonquin
- Danville
- Decatur
- DeKalb/Sycamore
- Des Plaines/Mount Prospect/Park Ridge
- Dixon
- Downers Grove/Woodridge
- Effingham
- Elgin/Carpentersville
- Elmhurst/Lombard/Addison
- Evanston/Skokie
- Freeport
- Galesburg
- Glenview/Northbrook
- Harrisburg
- Jacksonville
- Joliet
- Kankakee/Bradley/Bourbonnais
- Lincoln
- Macomb
- Marion/Herrin
- Moline/East Moline/Rock Island
- Mount Vernon
- Mundelein
- Oak Lawn
- Oak Park
- Orland Park/Tinley Park
- Ottawa/Streator/LaSalle/Peru
- Peoria/Pekin/East Peoria/Morton/Washington
- Pontiac

Municipalities

- Adams
- Alexander
- Bond
- Boone
- Brown
- Bureau
- Calhoun
- Carroll
- Cass
- Champaign
- Christian
- Clark
- Clay
- Clinton
- Coles
- Cook
- Crawford
- Cumberland
- DeKalb
- DeWitt
- Douglas
- DuPage
- Edgar
- Edwards
- Effingham
- Fayette
- Ford
- Franklin
- Fulton
- Gallatin
- Greene
- Grundy
- Hamilton
- Hancock
- Hardin
- Henderson
- Henry
- Iroquois
- Jackson
- Jasper
- Jefferson
- Jersey
- Jo Daviess
- Johnson
- Kane
- Kankakee
- Kendall
- Knox

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International

- VIAF
- WorldCat

National

- Germany
- United States
- Israel

Geographic

- MusicBrainz area

About Cook County

Photo



Photo



Photo



Photo



Things To Do in Cook County

Photo



Sand Ridge Nature Center

4.8 (96)

Photo

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River Trail Nature Center

4.6 (235)

Photo

Image not found or type unknown

Palmisano (Henry) Park

4.7 (1262)

Driving Directions in Cook County

Driving Directions From Palmisano (Henry) Park to

Driving Directions From Lake Katherine Nature Center and Botanic Gardens to

Driving Directions From Navy Pier to

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

<https://www.google.com/maps/dir/Lake+Katherine+Nature+Center+and+Botanic+Gardens%2C-87.8010774,14z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1sunknown!2m2!1d-87.8010774!2d41.6776048!1m5!1m1!1sChIJ-wSxDtinD4gRiv4kY3RRh9U!2m2!1d-88.1396465!2d42.0637725!3e2>

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

Reviews for



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Jeffery James

(5)

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



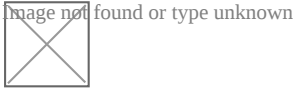
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Sarah McNeily

(5)

USS was excellent. They are honest, straightforward, trustworthy, and conscientious. They thoughtfully removed the flowers and flower bulbs to dig where they needed in the yard, replanted said flowers and spread the extra dirt

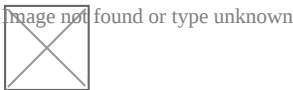
to fill in an area of the yard. We've had other services from different companies and our yard was really a mess after. They kept the job site meticulously clean. The crew was on time and friendly. I'd recommend them any day! Thanks to Jessie and crew.



Jim de Leon

(5)

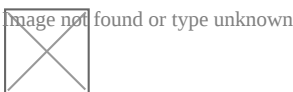
It was a pleasure to work with Rick and his crew. From the beginning, Rick listened to my concerns and what I wished to accomplish. Out of the 6 contractors that quoted the project, Rick seemed the MOST willing to accommodate my wishes. His pricing was definitely more than fair as well. I had 10 push piers installed to stabilize and lift an addition of my house. The project commenced at the date that Rick had disclosed initially and it was completed within the same time period expected (based on Rick's original assessment). The crew was well informed, courteous, and hard working. They were not loud (even while equipment was being utilized) and were well spoken. My neighbors were very impressed on how polite they were when they entered / exited my property (saying hello or good morning each day when they crossed paths). You can tell they care about the customer concerns. They ensured that the property would be put back as clean as possible by placing MANY sheets of plywood down prior to excavating. They compacted the dirt back in the holes extremely well to avoid large stock piles of soils. All the while, the main office was calling me to discuss updates and expectations of completion. They provided waivers of lien, certificates of insurance, properly acquired permits, and JULIE locates. From a construction background, I can tell you that I did not see any flaws in the way they operated and this an extremely professional company. The pictures attached show the push piers added to the foundation (pictures 1, 2 & 3), the amount of excavation (picture 4), and the restoration after dirt was placed back in the pits and compacted (pictures 5, 6 & 7). Please notice that they also sealed two large cracks and steel plated these cracks from expanding further (which you can see under my sliding glass door). I, as well as my wife, are extremely happy that we chose United Structural Systems for our contractor. I would happily tell any of my friends and family to use this contractor should the opportunity arise!



Chris Abplanalp

(5)

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



Dave Kari

(5)

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

Examining Seasonal Swelling and Shrinking of Soil [View GBP](#)

Check our other pages :

- [Setting Up Sump Pumps to Prevent Basement Flooding](#)
- [Recognizing Soil Drainage Limitations](#)
- [Employing Sustainable Methods for Long Term Soil Health](#)
- [Incorporating Root Barriers to Prevent Shifts](#)
- [Approaches for Chemical Soil Stabilization](#)

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home foundation repair service

Foundation Repair Service

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