

162

Helpsheet



*World Leaders in Computer Controlled Testing
Systems for Geotechnical Engineers and Geologists*

GDS Instruments Ltd Nomenclature and Glossary of terms

1. Introduction

GDS uses many acronyms to represent the names of different pieces of hardware and software. This helpsheet serves to provide a list of all known GDS acronyms.

2. Terms

A

AASHTO Soil Classification

A soil classification system usually used for highway design and construction.

Active earth pressure

The horizontal stress exerted by a mass of soil on a retaining wall as the wall moves away from the soil.

See the link to [Retaining Walls](#) for equations and calculations.

Active (Rankine) zone

The area behind a retaining structure that is above the failure plane.

Activity

The ratio of plasticity index to percent by weight of clay. This property is correlated with the type of clay.

Adhesion

The shear resistance between soil and a structure (e.g. steel, concrete or timber piles; along a retaining wall)

Air-voids ratio

The ratio of the volume of air to the total volume of a mass of soil.

Allowable bearing capacity

The bearing pressure that can be allowed on a foundation soil, usually to limit settlements. See the link to [Bearing Capacity](#) for equations and calculations.

Alluvial soils

Soils deposited in a valley or slightly graded area by transporting sediments through a mountain river or streams.

American Association of State Highway Transportation Officials' Classification System (AASHTO)

A system of soil classification based on grain size, liquid limit and plasticity of soils.

Angle of internal friction

For a given soil, the angle on the graph of the shear stress and normal effective stresses at which shear failure occurs. See the link to [angle of internal friction](#) for various relationships.

Angle of repose

The maximum angle, just before failure, of a slope composed of granular material .

Angle of shearing resistance

The ratio of effective shear and normal stresses mobilized at any state prior to failure.

Angle of slip plane

The angle referred to horizontal of a plane or other surface along which a discontinuous slip or rupture may occur.

Angle of wall friction

The angle of friction between soil and the surface of a retaining wall or bottom side of a foundation.

Angular distortion

The ratio between the relative deflection between two points in a foundation and the distance between them.

Anisotropic

A mass of soil having different properties in different directions. Primarily refers to permeability or stress-strain characteristics.

Aquifer

A stratum of soil with relatively high permeability; a water-bearing stratum of rock or soil.

Artesian

A condition that exists when the water table piezometric surface lies above the ground level.

At-rest earth pressure

The horizontal stress developed in a mass of soil loaded in conditions of zero horizontal strain. The retaining wall neither moves away or towards the soil. See the link to [Retaining Walls](#) for equations and calculations.

Atterberg Limits

The water contents of a soil mass corresponding to the transition between a solid, semi-solid, plastic solid or liquid. Laboratory test used to distinguish the plasticity of clay and silt particles.

Axial strain

Direct strain measured along an axis of a triaxial test sample.

Axial stress

Total or effective stress (Both confining and vertical stresses combined) acting along an axis of a triaxial test sample.

B

[Bearing capacity](#)

The ability of the underlying soil to support the foundation loads without shear failure.

Bearing capacity factors

Empirically derived factors used in a bearing capacity equation that usually correlates with the angle of internal friction of the soil. See [Bearing Capacity Factors](#) for various tables and relationships.

Bearing pressure

The total stress transferred from the structure to the foundation, then to the soil below the foundation. See the link to [Bearing Capacity](#) for equations and calculations.

Bedrock

Strong rock underlying surface deposits of soil and weathered rock.

Bentonite

Sodium montmorillonite.

Borrow

A site that is used to supply soils for earthwork construction (i.e. gravel pit).

Boulders

Soil particles over 12 inches (305 mm) in size.

Boussinesq equation

An equation used to determine the increase in vertical pressure at a particular depth that is caused by an application of a point load at a given surface. See [Boussinesq Theory](#) for equations and calculations.

Braced excavation

The use of bracing to laterally support the side-walls of temporary trenches or cuts.

British Soil Classification System

A system of soil classification based on size, consistency and structure.

Bulk density

Soil density. The total mass of water and soil particles contained in a unit volume of soil. (pcf).

Bulk unit weight

The total weight of water and soil particles contained in a unit volume of soil.

Buoyant Density

Also, submerged density. Difference between the total density and the density of water.
Buoyant density = Soil density - Density of water.

C

Caisson

A component of a particular foundation system.

California Bearing Ratio (CBR)

A laboratory test that is used to determine the suitability of a soil for use as a subbase in a pavement section.

Capillary rise

The height to which water will rise above the water table due to negative pore water pressure or capillary action of the soil. See [Capillary](#) information in the settlement analysis and stress analysis section for equations and calculations.

Capillary stresses

Pore water pressures less than atmospheric values produced by surface tension of pore water acting on the meniscus formed in void spaces between soil particles.

Circular Footing

Isolated/ spread footing that is circular shaped. Usually a shallow footing. See the link to [Bearing Capacity](#) for equations and calculations.

Clay

Soil particles which are finer (smaller) than 0.002 mm in size.

Coarse-grained soils

Soils with more than 50% by weight of grains retained on the #200 sieve (0.075mm).

Cobbles

Soil particles between 3 inches (76 mm) and 12 inches (305 mm) in size.

Coefficient of active earth pressure

The ratio of the minimum horizontal effective stress of a soil to the vertical effective stress at a single point in a soil mass retained by a retaining wall as the wall moves away from the soil. See the link to [Retaining Walls](#) for equations and calculations.

Coefficient of compressibility

The ratio of void ratio difference to the effective pressure difference of two different loadings during primary consolidation.

Coefficient of consolidation

The rate of change of volume during primary consolidation. Units: ft²/day, m²/s.

Coefficient of curvature

Also curvature coefficient. A measure of the shape parameter obtained from a grain size distribution curve.

$$C_D = (D_{30})^2 / D_{10} D_{60}$$

Coefficient of earth pressure at rest

The ratio of horizontal effective stress of a soil to the vertical effective stress at a specific point in a soil mass behind a retaining wall when the wall does not move (loaded in conditions of zero horizontal strain). See the link to [Retaining Walls](#) for equations and calculations.

Coefficient of friction

The ratio between the tangential force required to cause a body, such as a foundation surface or a retaining wall, to slide along a plane and the normal force between the body and the plane.

Coefficient of passive earth pressure

The ratio of the maximum horizontal effective stress of a soil to the vertical effective stress at a specific point in a soil mass behind a retaining wall as the wall moves toward the soil. See the link to [Retaining Walls](#) for equations and calculations.

Coefficient of permeability

See hydraulic conductivity.

Coefficient of secondary consolidation

The change in volumetric strain per a logarithmic cycle of time after primary consolidation is complete.

Coefficient of uniformity

Also uniformity coefficient. A measure of the slope of a grain size distribution curve, and therefore the uniformity of the soil.

$$C_u = D_{60}/D_{10}.$$

Cofferdam

A temporary structure used to enclose a construction area, and prevent soil or water from entering the construction area.

Cohesionless soils

Granular soils (sand and gravel type) with values of cohesion close to zero.

Cohesive soils

Clay type soils with angles of internal friction close to zero. Cohesion is the force that holds together molecules or like particles within a substance.

Colluvial soils

Soils deposited at the base of foot-hills via gravity or erosion.

Compaction

Volume change in soils which air is expelled from the voids, but with the water content remaining constant. Compaction may occur due to vibration, and self-weight. In construction, compaction is achieved by rolling, tamping or vibrating fill soils. See link relating to [Compaction](#) for additional information, equations and calculations.

Compression index

(Also, compressibility index) The logarithmic slope of the primary consolidation curve. The slope of the normal compression line and critical state line of the Casagrande Method of consolidation curves.

Compression Test

The compression test is performed in the laboratory using a relatively undisturbed ring sample. The sample is loaded with expected building pressures to estimate the amount of compression the soil undergoes. The sample is then inundated with water in order to measure additional compression or swelling.

Cone resistance

The resistance force divided by the end area of the cone tip, measured during the cone penetration test.

Cone penetration test

A penetration test in which a cone that has a 60° point is pushed into the ground at a continuous rate. Resistance is measured by correlating the depth penetrated with the force applied.

Confined aquifer

An aquifer that is contained between two stratifications of low permeability soil or rock.

Confined Compression Test

See Consolidation Test

Consistency

Water content of clay relative to the Atterberg limits.

Consistency index

A measure of the relationship between the current water content and the consistency limits.

Consistency limits

See Atterberg limits.

Consolidation

Volume change due to dissipation of excess pore pressure from static loads.

Consolidation (settlement)

The settlement of a foundation due to squeezing out of water from the pores as the soil comes to equilibrium with the applied loads.

Consolidation test

A laboratory test in which results are used to predict consolidation of a soil under applied structural loads. Also known as confined compression tests and oedometer tests.

Continuous footing

Also see "Strip footing." A horizontally long footing supporting a wall. Usually a shallow footing. See the link to [Bearing Capacity](#) for publications equations and calculations.

Coulomb earth pressure theory

An earth pressure theory that includes friction between the soil and retaining structure, and assumes that failure occurs along a flat plane behind the retaining structure at an angle that is in part derived from the angle of internal friction. See the link to [Retaining Walls](#) for equations and calculations.

Coulomb's equation

Named after Charles Augustin Coulomb, (1736-1806) An equation relating the shear strength of soil to the normal effective stress on the failure plane.

Counterfort walls

Type of retaining wall that depends on tension ribs between the stem and the heel in order to resist flexure and overturning.

Creep

Time dependent deformations which occurs in soil at constant effective stress without changes in volume and pore water pressure.

Critical circle

In a slope stability analyses, the slip circle that corresponds to the lowest factor of safety.

Critical ground slope angle

The angle of the ground slope that corresponds to a factor of safety of 1.0 relative to the slope stability.

critical height

The height of a slope that corresponds to a factor of safety of 1.0 relative to slope failure.

Critical hydraulic gradient

The hydraulic gradient at which effective stresses becomes zero. Upward seepage.

Curvature coefficient

See coefficient of curvature.

Cyclic stress ratio

A numerical rating of the potential for liquefaction in sands.

D**Darcy's law**

(After H.P.G. Darcy, 1856) The formula used for laminar flow of water through porous saturated soils. Velocity of flow = hydraulic conductivity X hydraulic gradient.

Degree of consolidation

The proportion of consolidation that has occurred after a given elapsed time.

Degree of saturation

The proportion of the volume of water to the total volume of voids of a given mass of soil.

Density

The ratio of the total mass to the total volume of a unit of soil. Usually expressed as a unit weight where weight is interchanged with mass.

Units: lbf/ft³, kg/m³.

Density index

Also, relative density. The density of a granular soil relative to the minimum and maximum densities achieved for that particular soil.

Density of soil grains

The average density of the mineral or rock of which the soil particles are composed.

Density of water

The density of water will vary with temperature and pressure. Values used for soils analysis are 62.4 lbf/ft³, 9.81 kN/m³ or 1000 kg/m³. A value of 64.0 lbf/ft³ is the value for sea water.

Depth factor

One of the terms in the bearing capacity equation that relates to depth of the foundation. The ratio between the depth of a slip circle below the top of a slope and the height of the slope. See the link to [Bearing Capacity](#) for publications, equations and calculations.

Desiccation

The process of shrinkage or consolidation of the fine-grained soil produced by increase of effective stresses in the grain skeleton accompanying the development of capillary stresses in the pore water.

Deviator stress

The difference between the axial and radial stresses of a triaxial test sample.

Dewater

Removal of water from a job site. Usually by pumping from excavations.

Differential settlement

The vertical displacement due to settlement of one point in a foundation with respect to another point of the foundation. See [Settlement analysis](#) information for further reading.

Direct shear test

Laboratory test used to determine the relationship of shear strength to consolidation stress. Strength characteristics that are estimated from this test includes cohesion and angle of internal friction.

Direct strain

The ratio of the change in length to the original length of a soil mass.

Downdrag

Negative skin friction. Forces induced on deep foundations resulting from downward movement of adjacent soil relative to the foundation element.

Drained loading

Loading which is slow enough for the water to drain from the soil as the total stresses increase. Pore pressure will not change, and volume will with loading.

Drawdown

The magnitude of the lowering of a water table, usually near a well being pumped.

Dredging

Removing soils from a sea, river or lake bed in order to deepen the waterway for water travel.

Dry density

The ratio of the mass of the solids (soil grains) to the total unit volume of soil. Units: lbf/ft³, kg/m³.

Dry unit weight

The weight of solids (soil grains) to the total unit volume of soil. Units lb/ft³, kN/m³. See [unit weight](#) page for various tables and relationships.

Dynamic compaction

The use of high-energy impact to densify loose granular soils.

E

Earth pressure

The force per unit area exerted by soil on a retaining wall. See the link to [Retaining Walls](#) for additional information, equations and calculations.

Earth pressure coefficients

Coefficients used in determining earth pressure. Components may include angle of internal friction, friction between the soil and wall face, angle of the wall face, and angle of the sloping backfill.

Effective stress

The portion of the total stress that is supported through grain-to-grain contact of the soil. The stress in a soil mass that is effective in causing volume changes and in mobilizing the shear strength arising from friction. The difference between the total stress and the pore water pressure. Effective stress = Total stress - Pore water pressure. See [Effective stress](#) information in the settlement analysis and stress analysis section for equations and calculations.

Efficiency of a pile

Also, pile efficiency. For a given pile in a group of piles, the ratio of the average ultimate load in the group to the individual ultimate load on the given pile.

Elastic deformation

Deformation caused in a soil due to a change in loading, and the soil recovers completely when the load is removed.

Embankment

Usually referred to a 'built-up' section of soil (engineered fill) as for roads or dams.

Engineering properties

Engineering parameters of a soil such as permeability, shear strength and consolidation. Different from index properties. See the [Laboratory Testing](#) link for additional information concerning engineering properties of the soil.

Engineered fill

Soils used as fill, such as retaining wall backfill, foundation support, dams, slopes, etc.. that are to be placed in accordance to engineered specifications. These specifications may delineate soil grain-size, plasticity, moisture, compaction, angularity, and many other index properties depending on the application.

Eolian Soil

Soil deposits that have been transported by wind.

Equipotential

For a flow net, lines connecting points of equal total head. Equipotential lines are usually drawn so that the interval, or equipotential drop, is constant. Equipotentials intersect flow lines and impermeable boundaries at right angles.

Equivalent fluid pressure

Horizontal pressures of soil, or a combination of soil and water, which increase linearly with depth and are equivalent to those that would be produced by a heavy fluid of a selected unit weight.

Excess pore pressure

That increment of pore water pressures greater than hydro-static values, produced by consolidation stresses in compressible materials or by shear strain; excess pore pressure is dissipated during consolidation.

Exit gradient

The hydraulic gradient near an exposed surface through which seepage is moving.

Expansive Clays

Also, Reactive Clays. Clays that are sensitive to water, causing them to swell or expand.

F**Factor of safety**

The ratio of a limiting value of a quantity to the design value of that quantity. See [Factor of Safety](#) for typical values with relation to geotechnical design.

Failure envelope

For a given soil, the graph of the shear stress and normal effective stresses at which shear failure occurs.

Fault

A shear fracture in a rock mass along which movement has taken place.

Field density test

Also In-place density test. Field testing that determines density of compacted fill to verify that it meets specifications. Types of tests may include sand cone, rubber balloon or nuclear densiometer.

Fine-grained soils

Silt and clay soils. Soils containing particles smaller than No. 200 sieve or 0.075 mm in size according to the Unified Soil Classification System.

Fines content (fraction)

Soil grains smaller than No. 200 sieve (0.075 mm), e.g. Clay and Silt.

Fissured clay

A clay having an internal network of narrow cracks or separations, in which the width and depth tends to increase upon drying.

Fissures

Small cracks.

Flow line

The path water will follow traveling from high head to low head in a seepage flow analysis.

Flow net

A graphical analysis of seepage flow in a mass of soil to estimate flow quantities and pore pressures.

Flow quantity

The total volume of water flowing in a seepage analysis.

Flow rate

The ratio of total volume of water flowing to a particular unit of time.

Flow slide

Shear failure in which a soil mass moves over a relatively long distance in a fluid-like manner, occurring rapidly on flat slopes in loose, saturated, uniform sands, or in highly sensitive clays.

Flow velocity

The velocity of water flow through a soil.

Footing

An enlargement at the base of a foundation that is designed to transmit forces to the soil.

Foundation

A component of an engineered structure that transmits the structure's forces into the soil or rock that supports it. See the link to [Foundations](#) or [Bearing Capacity](#) for foundation types, applications, equations and calculations.

Founding depth

The depth below the ground surface where the base of a foundation is located.

Friction angle

See angle of internal friction.

Friction pile

A pile that derives the majority of its load bearing ability from the skin friction between the soil and the pile. See the link to [Bearing Capacity](#) for publications, equations and calculations.

Frost jacking

A pile forced upward due to freezing ground moving upward or repeated freeze-thaw events.

G**Geotextiles**

A synthetic fabric used to stabilize soils, retain soils, prevent the mixing of dissimilar

soils, provide a filtering function, pavement support, subgrade reinforcement, drainage, erosion control and silt containment. See [Geosynthetics](#) for additional information and publications.

Grading curve

See grain size distribution curve.

Grain size distribution

See particle size distribution.

Grain size distribution curve

A curve drawn on a log scale to represent the distribution of particle sizes in a soil.

Gravity walls

Retaining walls which depend upon their self weight to provide stability against overturning and sliding; usually made of a high bulk structure. See the link to [Retaining Walls](#) for equations and calculations.

H

Historical maximum stress

See Pre-consolidation load.

Homogenous earth dam

An earth dam whose embankment is formed of one soil type without a systematic zoning of fill materials.

Homogenous soils

A mass of soil where the soil is of one characteristic having the same engineering and index properties.

Horizontal strain

Strain measured in a horizontal direction.

Horizontal stress

Total or effective stress acting in a horizontal direction.

Hveem's Resistance Value Test

Laboratory test that evaluates the resistance of a re-molded soil sample to be used in a pavement section.

Hydraulic conductivity

Also, coefficient of permeability. The constant average discharge velocity of water passing through soil when the hydraulic gradient is equal to 1.0. Clays are considered relatively impervious, while sands and gravels are considered pervious.

Hydraulic gradient

Between two points in a hydraulic flow: the difference in total head (piezometric levels) divided by the length of the flow path (distance between the two points).

Hydrometer test

Laboratory test used to determine the amount and distribution of finer particles of a soil sample. Fine soils are classified as silts and clays. (Soils that pass the No. 200 sieve, or 0.075 mm).

Hydrostatic pore pressure

Pore water pressures exerted under conditions of no groundwater flow where the magnitude of pore pressures increase linearly with depth below the ground surface.

I

Igneous

Rocks that were once molten. Could be intrusive (ex. granite), or extrusive (ex. basalt).

Illite

A type of clay structure where potassium ions hold together a silica(x2) and aluminum molecule.

Immediate settlement

The settlement of a foundation occurring immediately upon loading. See [Immediate settlement](#) information in the settlement analysis and stress analysis section for information, publications, equations and calculations.

Index properties

Attributes of a soil such as moisture content, void ratio, specific gravity, Atterberg limits and grain size distribution. Different from index properties. See the [Laboratory Testing](#) link for additional information concerning index properties of the soil.

In-place density test

See field density test.

In-situ

Undisturbed, existing field conditions.

Instrumentation

Geotechnical instruments used to monitor conditions such as deformations, pressures, loads, etc.. within the ground.

Isolated footing

Also, spread or pad footing. A footing designed to support a structural load from a single column. Usually a shallow foundation, and square or circular in shape. See the link to [Foundations](#) or [Bearing Capacity](#) for foundation types, applications, equations and calculations.

Isotropic

A soil mass having essentially the same properties in all directions. Primarily refers to permeability and stress-strain characteristics.

J

K

Kaolinite

A repeated silica and aluminum molecule clay structure. White mineral. Very little volume change when drying.

L

Leaching

The removal of salts and soluble substances as water flows through a soil medium. Leachate is the leached liquid from the soil, rich in minerals.

Liquefaction

The sudden, large decrease of shear strength of cohesionless soil caused by collapse of the soil structure, produced by small shear strains associated with sudden but temporary increase of pore water pressure. Usually a problem in submerged poorly graded sands within the upper 50 feet of subgrade in earthquake prone environments. See the link to [Earthquake Engineering](#) for liquefaction equations and calculations.

Liquid limit

The water content above which the soil will flow like a liquid, but below which it will have a plastic consistency.

Liquidity index

A measure of the relationship between the current water content of a soil and its consistency limits.

Log-spiral earth pressure theory

An earth pressure theory that assumes that the failure surface is curved behind a retaining structure. See the link to [Retaining Walls](#) for publications, equations and calculations.

Long-term conditions

Conditions in the ground where full consolidation has taken place and the soils are fully-drained.

M

Machine foundation

A foundation that receives regular or irregular vibratory loads that are generated from rotating or impact machinery.

Mat foundation

Sometimes called a raft foundation. A structural slab utilized as a footing, which usually

encompasses the entire building footprint. Mat foundations are advantageous on compressible soils because the building loads are distributed over a large area. Mats may also provide additional resistance to uplift. See the link to [Foundations](#) or [Bearing Capacity](#) for foundation types, applications, equations and calculations.

Maximum dry density

A soil property obtained in the laboratory from a Proctor test. Density of soil at 100% compaction.

Mean normal stress

The mean value of the three orthogonal stresses.

Metamorphic

Igneous or sedimentary rock that has changed by heat and/or pressure. Examples include quartz to quartzite, shale to slate, and limestone to marble.

Micropile

Piles with relatively small diameters.

Modified Proctor

Laboratory test used to determine maximum dry density and optimum moisture content of soils. Test results are used to estimate relative compaction in the field. Soils are compacted in the laboratory in five layers with a 10 pound hammer falling 18 inches.

Modulus of subgrade reaction

Also, subgrade modulus. The ratio between the bearing pressure of a foundation and the corresponding settlement at a given point. The slope of the line in the loading range encountered by the soil in a plate bearing value test. See the link to [Modulus of subgrade reaction](#) for typical values relating to soil characteristics.

Mohr's circle

A circle constructed in the triaxial test using the measured stresses (principal stresses) in order to determine the stresses on the failure plane.

Moisture content

See Water content. The ratio between the mass of water and the mass of soil solids.
 $w = (\text{wet weight} - \text{dry weight}) / \text{dry weight}$.

Montmorillonite

A clay structure that has a strong attraction to water. May swell 20x its original volume when saturated. A repeating molecule structure of 2 silica atoms and one aluminum.

N

N-Value

Also, standard penetration resistance. The number of blows required to drive a split-spoon sampler during a standard penetration test a distance of 12 inches (0.305 m) after the initial penetration of 6 inches (0.15 m).

Negative skin friction

Forces induced on deep foundations resulting from downward movement of adjacent soil relative to the foundation element.

Nominal bearing pressure

Allowable bearing pressure for spread foundations on various soil types, derived from experience which provides safety against shear failure or excessive settlements.

Normal compression line

The relationship between void ratio and the normal effective stress for soil loaded beyond the current yield stress in an isotropic compression.

Normal force

Force acting normal to the plane of reference. Units: lb, N.

Normalization

Analysis of soil test data to compensate for different states of samples.

Normally consolidated soil

Soil having a current state which lies on the normal compression line.

O**Oedometer Test**

See Consolidation Test

One-dimensional compression

Compression taking place with zero radial and horizontal strain.

One-dimensional modulus

The ratio of the change in vertical effective stress to the change in vertical strain, when there is zero horizontal strain.

Open layer

A layer or stratum of soil from which porewater may drain both upward and downward into overlying and underlying permeable layers, thus enabling two-way drainage.

Optimum moisture content

The water content at which the maximum dry density of a soil is obtained using a specific effort of compaction. Optimum moisture of a specific soil is determined through a Proctor test.

Organic soils

Earth comprised of organic material, peat, muskeg.

Overburden Soil

Overlying soil of a desirable soil stratum.

Overburden pressure

(Also overburden stress) The total or effective stress at a given depth due to the weight of overlying soil or rock.

Overconsolidated soil

A clayey soil carrying a higher load in the past. Soil having a current state which lies inside the normal compression line

Overconsolidation ratio

The ratio of maximum past pressure (preconsolidation pressure) to the current effective stress.

Overturning

[Overturning](#) failure is a result of excessive lateral earth pressures with relation to retaining wall resistance thereby causing the retaining wall system to topple or rotate (overturn).

P

Pad footing

"See Isolated Footing."

Particle size characteristics

Used in particle size analyses and grading specifications: stated as the maximum particle size of a specified percentage (smallest) of the total content of a soil graded by mass.

D_{10} = maximum size of the smallest 10% of the particle content (also referred to as effective size)

D_{60} = maximum size of the smallest 60% of the particle content

Particle size distribution

Soil particle sizes that are determined from a representative sample of soil that is passed through a set of sieves of consecutively smaller openings.

Passive earth pressure

The maximum horizontal stress exerted by a mass of soil on a retaining surface as the surface moves toward the soil. See the link to [Retaining Walls](#) for publications, equations and calculations.

Peak shear strength

The maximum shear strength of a soil at a given normal effective stress and water content.

Permeability

A measure of continuous voids in a soil. The property which allows the flow of water through a soil. See also coefficient of permeability. See the link to [Permeability](#) for typical values relating to soil type.

pH value

A measure of acidity or alkalinity of groundwater or soil water extract based on the hydrogen ion content.

Pier

A deep foundation component that is usually cast-in-place, instead of driven, drilled or jettted as a pile.

Piezometer

An instrument used to measure in-situ pore water pressures.

Piezometric surface

An imaginary surface corresponding to the hydrostatic water level of a confined body of groundwater.

Pile

A slender member of a deep foundation system that is driven (hammered), drilled or jetted into the ground. Piles are usually constructed of timber, steel or pre-stressed reinforced concrete. See the link to [Foundations](#) or [Bearing Capacity](#) for foundation types, applications, equations and calculations.

Pile Driving Analyzer

A method to compute average pile force and velocity by using wave equation analysis with electronic measurements.

Pile efficiency

See efficiency of a pile.

Pile spacing

The distance from center to center of piles.

Piping

The movement of soil particles as a result of unbalanced seepage forces produced by percolating water. Piping leads to the development of boils or erosion channels.

Plane strain

A two-dimensional state of stress, where the out-of-plane strain (i.e. the strain normal to the plane being considered) is zero. An example of a plane strain situation would be on a cross-section through a long structure being loaded in the x-y plane, such as an embankment dam.

Plastic deformation

The distortion of soil resulting in a permanent and irrecoverable change in shape or volume.

Plastic limit

The moisture content in which a soil will have a plastic consistency.

Plastic strain

Deformation of soil that is not recovered upon unloading.

Plasticity

The property of a soil which allows it to deform continuously, usually a mass of clay size particles.

Plasticity index

The difference between the liquid limit and plastic limit of a soil mass.

Plate bearing value

A field test that is performed on compacted soil that provides an indication of shear strength pavement components.

Point-bearing capacity

Also, tip resistance or point capacity. The bearing capacity at the bottom tip of one member of a deep foundation system. See the link to [Foundations](#) or [Bearing Capacity](#) for foundation types, applications, equations and calculations.

Point-bearing pile

A pile that derives the majority of its loadbearing ability from the support of the soil layer beneath the tip of the pile.

Poisson's ratio

(After Simeon Poisson 1781-1840) The ratio of the change in strain perpendicular to the direction of loading to the change in strain caused in the same direction.

Pore air pressure

The pressure of air within the void space of a partially saturated soil.

Pore pressure

Also, hydrostatic pressure. The pressure exerted by the fluid within the pores or voids in a porous material; in saturated soil the pore pressure is the pore water pressure. See [Pore pressure](#) information in the settlement analysis and stress analysis section for equations and calculations.

Pore pressure coefficient

The ratio of the change in pore pressure to the change in deviator stress.

Pore pressure coefficient

The ratio of the change in pore pressure to the change in isotropic stress in undrained loading.

Pore pressure ratio

At a given depth of soil, the ratio of the porewater pressure to the vertical overburden pressure.

Pore space

See porosity.

Pore water pressure

See pore pressure.

Porosity

Also, pore space. The ratio of the volume of voids to the total volume. Expressed in %, or unitless.

Pre-consolidation load

The maximum load ever imposed on a particular soil mass in its geological history.

Preconsolidation pressure

The maximum past pressure of a soil.

Pressure head

The height of a column of water required to develop a given pressure at a given point.

Pressure in tension crack

The horizontal pressure exerted in a slope or against a retaining wall due to hydrostatic water pressure in tension cracks.

Primary consolidation

The long-term consolidation of a clay from the loss of water from the voids due to a high pressure.

Principal strains

The strains occurring in the directions of the principal axes of strain.

Principal stresses

Normal stresses acting in the direction of principal axes of stress.

Proctor test

Laboratory test used to determine maximum dry density and optimum moisture content of soils. Test results are used to determine relative density in the field using in-place density tests. Standard effort or Modified effort may be used in the lab. See the [Laboratory Testing](#) link for additional information concerning the Proctor test.

Q**Quick sand**

The effective stresses within a mass of sand is zero.

R**R - Value**

The R-Value, or resistance value, of a soil is measured in a stabilometer test, and is usually estimated for pavement design. The R-value is the ability of a soil medium to resist lateral spreading due to an applied vertical load, such as tire loads. A range of values are established from 0 to 100, where 0 is the resistance of water and 100 is the resistance of steel. See the link to [R-Values](#) for typical values relating to soil type.

Radial stress

In a triaxial sample, the total or effective stress acting perpendicular to the longitudinal axis.

Radius of influence

The outer radius from a well that has a depression of water pressure or water table produced by pumping of a well.

Raft Foundation

See mat foundation. A structural slab utilized as a footing, which usually encompasses the entire building footprint. Raft foundations are advantageous on compressible soils

because the building loads are distributed over a large area. Rafts may also provide additional resistance to uplift. See the link to [Foundations](#) or [Bearing Capacity](#) for foundation types, applications, equations and calculations.

Rankine earth pressure theory

Earth pressure analysis that disregards friction between the wall and soil, and assumes that failure occurs along a flat plane behind the retaining structure at an angle that is derived from the angle of internal friction. See the link to [Retaining Walls](#) for publications, equations and calculations.

Reactive clays

"See Expansive Clays."

Recompression index

The logarithmic slope recompression (reloading) line.

Relative deflection

The deflection in a foundation due to settlement.

Relative compaction

A minimum density specification usually designated as a percentage of the maximum dry density.

Relative density

Also, density index. The density of a granular soil relative to the minimum and maximum densities achieved for that particular soil.

Remolded Swell Test

Using the same equipment as the compression test, the soil sample is remolded and compacted in order to achieve similar earthwork conditions for the project's soils. The amount of swell can be measured after inundating the soil sample with water after the applied loads have stabilized.

Residual soils

Soils that have been formed in place.

Resistance value

See R-Value.

Response spectrum

Information regarding frequency-dependent energy distribution of an earthquake derived from the Fourier analysis.

Resultant force

The single force or pressure that will produce the same effect as several forces or pressures acting along a plane. Used for easier calculations, such as analyzing earth pressures.

Retaining wall

Walls, usually constructed of concrete or rock, that provides lateral stability of the earth, thus preventing the soil from sloughing or slope failure. See the link to [Retaining Walls](#) for publications, equations and calculations.

S

Sand

Particles that pass through a #4 sieve (4.75 mm), and retained on a #200 sieve (0.075 mm).

Sand cone test

Apparatus used for measuring density of soil in the field.

Saturated density

Density of soil when the voids are filled with water.

Secondary compression index

The logarithmic slope of the secondary compression line.

Secondary consolidation

The considerably decreased rate of consolidation following the completion of primary consolidation. See [consolidation](#) information in the settlement analysis and stress analysis section for information, publications, equations and calculations.

Sedimentary

Soils formed by the deposition of fine-grained soil in water.

Seepage

The flow of water through soil. See [seepage](#) for information and publications.

Seepage force

The force transmitted to a mass of soil due to the seepage of groundwater.

Seepage pressure

The seepage force per unit volume.

Seepage velocity

The average velocity at which groundwater flows through the pores of a soil. The ratio of the volume flow rate to the average area of voids in a soil cross-section.

Sensitivity

A measure of the change in ultimate strength of clays between undisturbed and disturbed samples.

Settlement

The downward movement of soil, or the downward movement of a foundation. See [settlement](#) information in the settlement analysis and stress analysis section for information, publications, equations and calculations.

Shallow Foundation

Refers to a foundation system that has a shallow founding depth relative to the foundation width. These foundations usually include spread footings, continuous footings and mats. See the link to [Foundations](#) or [Bearing Capacity](#) for foundation types, applications, equations and calculations.

Shape factors

Factors used in a general bearing capacity equation which provides an adjustment relating to the footing geometry.

Shear modulus

The ratio of the change in shear stress to the resulting change in shear strain.

Shear strain

The angular distortion or change in shape of a mass of soil.

Shear strength

The maximum shear stress which a soil can sustain under a given set of conditions. For clay, shear strength = cohesion. For sand, shear strength = the product of effective stress and the tangent of the angle of internal friction. See the [Laboratory Testing](#) link for additional information concerning properties of the soil.

Shear stress

The force per unit area acting tangentially to a given plane or surface.

Sheet pile

Steel section panels that are driven into the ground to provide lateral support.

Shrinkage index

The difference between the plastic and shrinkage limits.

Shrinkage limit

The water content corresponding to the transition between a brittle solid and a semi-solid. The water content below which further reduction in water content causes no further reduction in volume.

Sieve analysis test

Soil particle sizes that are determined from a representative sample of soil that is passed through a set of sieves of consecutively smaller openings. See the [Laboratory Testing](#) link for additional information concerning properties of the soil.

Site investigation

Process of methodically observing, soil sampling and field testing in such a manner that is based on proposed development and existing site conditions.

Skin-friction capacity

Also, skin resistance or side resistance. The bearing capacity for the shaft of one member of a deep foundation system. See the link to [Bearing Capacity](#) for equations and calculations.

Skin friction stress

The shear stress on the shaft of a pile, caisson or cone penetrometer.

Skin resistance

See skin-friction capacity.

Sliding

[Sliding](#) failure is a result of excessive lateral earth pressures with relation to retaining wall

resistance thereby causing the retaining wall system to move away (slide) from the soil it retains.

Slurry

A thick mixture of soil and water.

Soil classification

Standardized classification schemes that delineates soil characteristics that are important in determining soil behavior. See the [Laboratory Testing](#) link for additional information concerning properties of the soil.

Soil Nailing

Slope stabilization method that involves installing and usually grouting closely spaced rebar in the soil or rock face.

Soil suction

See capillary rise.

Specific gravity

The ratio of the density of a body or a substance to the mass of an equal volume of water. Unitless.

Spread footing

Also, isolated footing. A footing designed to support a structural load from a single column. Usually a shallow foundation, and square or circular in shape. See the link to [Foundations](#) or [Bearing Capacity](#) for foundation types, applications, equations and calculations.

SPT

See Standard Penetration Test.

Square Footing

Isolated/ spread footing shaped as a square. Usually a shallow footing.

Standard Penetration Resistance

See N-value.

Standard Penetration Test (SPT)

A field test that measures resistance of the soil to the penetration of a standard split-spoon sampler that is driven 12 inches (0.3 m) with a 140-pound (63.5 kg) hammer dropped from a height of 30 inches (0.76 m). The N-value is derived from this test.

Standard Proctor

See Proctor test.

Steady state pore pressure

The pore water pressure at equilibrium when all excess pore pressures have fully dissipated.

Stiffness

Susceptibility to distortion or volume change under an applied load.

Strain

A measure of the change in size or shape of a mass of soil relative to its original size or shape.

Stress

The intensity of force per unit area; normal stress is applied perpendicularly to a surface or plane, shear stress is applied tangentially to a surface or plane. See [stress](#) information in the settlement analysis and stress analysis section for information, publications, equations and calculations.

Stress history

The past history of loading and unloading of a soil mass.

Strip footing

Also see "Continuous footing." A horizontally long footing supporting a wall. Usually a shallow footing. See the link to [Foundations](#) or [Bearing Capacity](#) for foundation types, applications, equations and calculations.

Subgrade modulus

See Modulus of subgrade reaction.

Submerged Density

Also, buoyant density. Difference between the total density and the density of water. Submerged density = Soil density - Density of water.

Surcharge

An additional force applied at the exposed upper surface of a restrained soil. See the [Retaining wall](#) link for additional information, equations and calculations concerning surcharges.

Suspension

A thin mixture of soil and water, whereas the soil particles are floating within the water.

Swell

Increase in soil volume; volumetric expansion of particular soils due to changes in water content.

Swelling index

The slope of the swelling (unloading) line.

T

Tailings

Crushed rocks from mines after ore extraction.

Tension crack

Cracks appearing at the surface of a soil mass, often adjacent to a retaining wall or top of a failing slope.

Tension crack depth

The depth of a tension crack from the ground surface to a depth at which the horizontal effective stress is zero.

Tension pile

Piles that are designed to resist upward forces.

Time factor

A dimensionless quantity dependent on the degree of consolidation that is used in primary consolidation analyses.

Tip resistance

See point-bearing capacity.

Tolerable vibration

The level of vibration magnitude that a structure is designed. Structure vibrations range from unnoticeable to persons to structural danger.

Total head

The height of the free water surface above a given datum.

Total stress

The stress acting on or within a soil mass due to surcharges, overlying weight, etc. Total stress = effective stress + pore water pressure. See [stress](#) information in the settlement analysis and stress analysis section for information, publications, equations and calculations.

Transport soil

Soils that have formed, then moved to another place via wind, water, glacier, etc...

Triaxial shear strain

A strain parameter used in the interpretation of triaxial stress test results.

Triaxial stress test

Laboratory tests such as the *consolidated-drained (CD) test*, *consolidated-undrained (CU) test* and *unconsolidated-undrained (UU) test* that are used to determine the soils' strength characteristics such as [cohesion](#) and [angle of internal friction](#).

U

Ultimate bearing capacity

The bearing stress which would cause shear failure in the soil below a foundation; dependent upon the shear strength of the soil, applied loads and on the shape and depth of the foundation. See the link to [Bearing Capacity](#) for equations and calculations.

Unconfined Compressive Strength Test

Laboratory test similar to the unconsolidated-undrained test performed on plastic soils, usually clay. From this test, the *undrained shear strength* is calculated as 1/2 of the unconfined compressive strength. [Cohesion](#) is considered to be equal to the undrained shear strength.

Undrained shear strength

(Also undrained strength) The shear strength of a saturated soil at a given water content (or voids ratio, or specific volume) under loading conditions where no drainage of pore

water can take place. The undrained shear strength of soil is independent of applied stresses and therefore can be measured at any level of stress, provided the void ratio remains constant. The undrained Mohr-Coulomb envelope will be horizontal.

Unified Soil Classification System

Known as USCS. A system of soil classification based on grain size, liquid limit and plasticity of soils.

Uniformity Coefficient

See coefficient of uniformity.

Unit weight

The ratio of the total weight of soil to the total volume of a unit of soil. Units: lb/ft³, kN/m³. See the [soil unit weight](#) link for unit weight relationships with soil type and density. .

Unit weight of water

The weight of a unit volume of water;
62.4 lb/ft³, 9.81 kN/m³.

USCS

See the Unified Soil Classification System.

V

Vane shear test

A field test used to measure the shear strength of a soil that is low-strength, homogeneous and cohesive.

Varved clays

Clays that are layered with fine and coarse varieties.

Vertical stress

The total or effective stress acting vertically in a soil mass at a given depth caused by the soil's own weight. See [stress](#) information in the settlement analysis and stress analysis section for information, publications, equations and calculations.

Vibrodensification

The compaction (densification) of cohesionless soils by imparting wave energy to the soil mass so as to rearrange soil particles resulting in less voids in the overall mass. Such as using a vibratory roller.

Vibroflot

A crane suspended cylindrical penetrator with an opened water jet at the tip and acts in conjunction with vibrations to dig a hole.

Vibroflotation

A method to densify granular soils using a vibroflot to dig a hole and then backfilled with sand or gravel that is dumped in from the surface and densified.

Visual Classification

A field test that is used to estimate soil characteristics such as the range of particle sizes and plasticity.

Void ratio

The ratio of the volume of voids to the volume of solids (soil grains). Unitless

Volume of solids

Volume of soil grains in a total soil volume.

Volume of voids

Volume of air space in a total soil volume.

Volume of water

Volume of water in a total soil volume.

Volumetric strain

The ratio of the change in soil volume to the original soil volume.

W**Water content**

See Moisture content. The ratio between the mass of water and the mass of soil solids.

$w = (\text{wet weight} - \text{dry weight}) / \text{dry weight}$.

Water table

The level in a body of soil at which the hydrostatic water pressure is zero.

Weight of soil grains

The dry weight of soil grains in a mass of soil.

Weight of water

The weight of water contained in the void space of a body of soil.

X**Y****Yield point**

The point at which the soil loading behavior changes from elastic to inelastic.

Yield stress

The stress at which yielding takes place in soils. The stress at which the swelling-recompression line joins the normal compression line.

Z

Zero air voids curve

The curve created by plotting dry densities of soils corresponding to saturation at each water content.

Zoned earth dam

An earth dam embankment zoned by the systematic distribution of soil types according to their strength and permeability characteristics, usually with a centrally impervious core and shells of coarser materials.