

Definition of Terms Fluid Mechanics & Hydraulics

Soil Properties

Void Ratio - The ratio of the volume of void space to the volume of solid substance.

Porosity - The ratio of the volume of voids to the volume of the soil sample or specimen. It is simply the open space between the soil grains.

Degree of Saturation - The ratio of the volume of water in the void spaces to the volume of the voids. It is simply the measure of the void volume that is filled by water, expressed as a percentage ranging from 0 to 100.

Moisture Content - The ratio of weight of water to the weight of solids in a given volume of soil.

Unit Weight - the weight of soil per unit volume

Dry Unit Weight - the weight per unit volume of soil, excluding water

Saturated Unit Weight - the bulk unit weight of a soil when it is 100 percent saturated.

Bulk unit weight - known as total, wet or moist unit weight. It is the total weight divided by the total volume

Critical hydraulic gradient - the hydraulic gradient that brings a soil (essentially, Coarse-grained soils) to static liquefaction

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.

Dry density - The ratio of the mass of the solids (soil grains) to the total unit volume of soil.

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

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

Atterberg Limits

Consistency - used to describe the degree of firmness of soil

Cohesion - the attraction of one water molecule to another resulting from hydrogen bonding (water-water bond).

Adhesion - It involves the attraction of a water molecule to a non-water molecule (water-solid bond).

Stickiness - The capacity of soil to adhere to other objects. It is estimated at moisture content that displays maximum adherence between thumb and forefinger.

Rupture Resistance - a field measure of the ability of the soil to withstand an applied stress or pressure as applied using the thumb and forefinger.

Atterberg's Limit - the limits of water content used to define soil behavior

Liquid Limit - The moisture content in percent required to close a distance of 12.7mm along the bottom of the groove after 25 blows.

-defined as the moisture content at which soil begins to behave as a liquid material and begins to flow

Cup Method To Determine Liquid Limit -the device used in this method consists of a brass cup and a hard rubber. The brass cup is dropped onto the base by a cam operated by a crank.

Plastic Limit - The moisture content at which the transition from Semi-Solid to Plastic state.

Shrinkage Limit - The moisture content at which the transition from Solid to Semi-Solid takes place defined as the moisture content at which no further volume change occurs with further reduction in moisture content.



Liquidity Index - ratio which signifies the relative consistency of a cohesive in the natural state

Plasticity - Degree a soil can be molded or reworked causing permanent deformation without rupturing.

Consistency Index

- The ratio of the difference between the liquid limit and water content to the difference between the liquid limit and the plasticity index.

Plasticity index - difference between the liquid limit and plastic limit of a soil.

Shrinkage index - The difference between the plastic and shrinkage limits

Residual Soil - Soils formed by the weathered products at their place of origin

Lacustrine Soil - Soils formed by deposition of quiet lakes

Alluvial Soil - Soils transported by running water and deposited along streams

Glacial Soil - Soils formed by the transportation and deposition of glaciers

Marine Soil - Soils deformed by deposition in the seas

Gravel Soil - Soil with occasional particles of quartz, feldspar and other minerals

Aelian Soil - Soils transported and deposited by wind:

Skempton - defined the ratio of the plasticity index to the percent of clay size fraction, by weight as Activity

Soil Classification

Sieve Analysis - used to determine the grain size distribution of coarse-grained soil.

Hydrometer Analysis - used to determine the grain size distribution of the soils passing the No. 200 sieve.

Effective Size - this diameter in the particle size distribution curve corresponding to 10% finer. It is used to measure the hydraulic conductivity and drainage through the soil
- the grain size corresponding to 10 percent passing on a grain-size distribution curve.

Particle-Size Distribution Curve - used to determine the following four) parameters for a give soil:

Coefficient of Uniformity - defined as the ratio between the grain diameter (in millimeters) corresponding to 60 percent passing on the curve (D60) divided by the diameter of the 10 percent (D10) passing.

Coefficient Gradation - is defined as the ratio between the square of the grain diameter (in millimeter) corresponding to 30 percent passing on the curve (D30) divided by the product of the grain diameter of the 60 percent (D60) passing and the grain diameter of the 10 percent (D10) passing.

Coefficient of curvature - Also curvature coefficient. A measure of the shape parameter obtained from a grain size distribution curve.
 $CD=(D30)^2/D10D60.$

Poorly Graded - A type of soil in the particle size distribution curve in which most of the soil grains are the same size

AASHTO System - was originally proposed by the a Highway Research Board's Committee on Classification of Materials for Subgrades and Granular Type Road. According to the present form of the system, soil can be classified according to eight major groups, A-1 through A-8, based on the grain size distribution, liquid limit and plasticity indices.

USCS System - soil classification system used in engineering and geology to describe the texture and grain size of a soil. The classification system can be applied to most unconsolidated materials, and is represented by a two-letter symbol.



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

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

Cobbles - According to the USCS Soil Classification of a soil particle whose size is greater than 75 mm is called_____.

USDA System also called as Textural classification system

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

Soil Compaction

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.

Four reasons why soil, when placed in a dense state is to be compacted

1. To increase shear strength
2. To decrease future settlements
3. To decrease permeability
4. To increase the stability of slopes of embankments

The standard procedure for determining the field unit weight of compacted soil include:

- a. Nuclear method
- b. Sand cone method
- c. Rubber ballon method
- d. All of the above

Optimum moisture content - the moisture content at which the maximum dry unit weight is attained

Proctor Compaction Test - The laboratory test generally used to obtain the max dry unit weight of compaction and the optimum moisture content

Permeability

Permeability - the property of soil which permits flow of water or other liquids through or it is the case with which water can flow through it.

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

Coefficient of Permeability - the constant of permeability, a factor that indicates if the volume of flow is to be great or small, relatives to the ease or difficulty with which water moves through the soil.

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.

Transmissivity or Transmissibility - the ability of an aquifer to transmit water through its entire thickness.

Discharge velocity - quantity of water flowing in unit time through a unit gross cross sectional area of soil at right angles to the direction of flow

Constant head test - this is used to determine the coefficient of permeability of coarse-grained soil.

Falling Head Test - this is used to determine the coefficient of permeability of fine grained soil

The coefficient of permeability of soil depends on

- a. fluid viscosity and pore size distribution
- b. grain size distribution and degree of saturation
- c. roughness of soil particles and degree of saturation
- d. all of these

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

Effective Stress

Effective Stress -The sum of the vertical components of the forces developed at the

points of contact of the solid particles per unit cross sectional area of the soil mass.

Pore water pressure - stress induced by water pressure

Intergranular Stress - stress resulting from particle to particle contact of soil

Total Stress - sum of effective and neutral stress

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.

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.

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

Flow Nets

Equipotential line - a line along which the potential head at all points is equal

Flow Line - a line along which a water particle will travel from upstream to the down stream side in the permeable soil medium

Flow Net - a combination of a number of flow line and equipotential line

Stress distribution of soil

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.

Compressibility of Soil

The increase in stress caused by foundation and other loads compresses a soil layer

This compression is caused by

1. Deformation of soil particles

2. Relocations of soil particles
3. Expulsions of water or air from the void spaces

Three Categories

Primary consolidation settlement - The result of volume change in saturated cohesive soils because of the expulsion of water that occupies the void spaces.

Normally Consolidated - Type of clay whose present effective

BURDEN pressure is the maximum pressure that the soil was subjected to in the past.

Over Consolidated - Type of clay whose present effective OVERBURDEN pressure is the maximum pressure that the soil was subjected to in the past.

Secondary consolidation settlement - The result of the plastic adjustment of soil fabrics.

Immediate settlement - Caused by the elastic deformation of dry soil and of moist and saturated soils without any change in the moisture content.

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.

Swell Index - smaller in magnitude than the compression index

Coefficient of Consolidation - Generally decreases as the liquid limit of soil increases and its range of variation is rather wide.

Overconsolidation ratio - Ratio of preconsolidation pressure to present effective overburden pressure.

Shear Strength of Soil

Shear - Soil derives its strength from its capacity to resist

Which of the following is not a component of the soil mass.

- Gas
- Organic Matter
- Minerals

- None on the list

Direct Shear Test - It is the oldest and simplest form of shear test arrangement. The test equipment consist of a metal shear box in which the soil specimen placed.

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

Triaxial Shear Test It is one of the most reliable methods available for determining the shear strength parameters. It is used widely for both research and conventional testing.

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

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 - 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.

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

Deviator stress - The difference between the axial and radial stresses of a triaxial test sample

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.

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

Angle of shearing resistance - The ratio of effective shear and normal stresses mobilized at any state prior to failure

Mohr's Circle

Normal force - Force acting normal to the plane of reference

Mean normal stress - The mean value of the three orthogonal stresses

Principal stresses - Normal stresses acting in the direction of principal axes of stress

Shear stress - The force per unit area acting tangentially to a given plane or surface

Lateral Earth Pressure

Earth pressure

The force per unit area exerted by soil on a retaining wall

Active earth pressure coefficient - ratio between lateral and vertical principal effective stresses when an earth retaining structure moves away from a retained soil

Passive earth pressure coefficient - ratio between lateral and vertical principal effective stresses when an earth retaining structure is forced against a soil mass

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

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

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

Terzaghi's Bearing Capacity

Foundation - structure load to is that part of a structure which transmits the building, load into the underlying soil

Footings - consisting of a small slab for transmitting the load to the underlying soil.

Shallow foundation - one in which the ratio of the embedment depth to the minimum plan dimension, which is usually the width, is $D_i / B \leq 5$.

Embedment depth (D) - the depth below the ground surface where the base of the foundation rests

Ultimate bearing capacity - the maximum pressure that the soil can support

-defined as that pressure causing a shear failure of the supporting soil lying immediately and adjacent to the footing

Ultimate net bearing capacity - the maximum pressure that the soil can support above its current

Allowable bearing capacity or safe bearing capacity -the working pressure that would ensure a margin of safety against collapse of the soil from shear failure.

Overburden pressure - the pressure (effective stress) of the soil removed fraction of the total to place the footing

Factor of safety or safety factor - the ratio of the ultimate net bearing to the allowable bearing capacity or to the applied maximum vertical stress

Liquefaction - a process by which water saturated soil sediment temporarily loses strength and acts as a fluid

Bearing Capacity Analysis - method used to determine the ability of the soil to support the required load in a safe manner without gross distortion resulting from objectionable settlement

Terzaghi He was the first to present a comprehensive theory for evaluating the ultimate bearing capacity of rough shallow foundation. According to his theory the depth of the foundation is shallow if the depth of the foundation is less than or equal to the width of the foundation.

Circular Footing - Isolated/ spread footing that is circular shaped. Usually a shallow footing

Strip footing - Also see "Continuous footing." A horizontally long footing supporting a wall. Usually a shallow footing

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.

Continuous footing - Also see "Strip footing." A horizontally long footing supporting a wall. Usually a shallow footing.

Meyerhof - He proposed a correlation for the net allowable bearing pressure for foundation with the standard penetration resistance.

Hansen - he proposed what is referred to as the general bearing capacity equation given by the following equations

Skin-friction capacity -Also, skin resistance or side resistance. The bearing capacity for the shaft of one member of a deep foundation system

Retaining wall - structure whose primary purpose is to prevent lateral movement of earth or some material

Gravity retaining wall - usually built of plain

concrete. This type of wall depends only on its own weight for stability, and hence, its height is subject to some definite practical limits'

Semi-gravity wall -in essence a gravity wall that has been given a wider base"(a toe or heel or both) to increase its stability. some reinforcement is usually necessary for this type of wall'

T-shaped wall - the most common cantilever wall. For this type. of wall, the weight of the earth in the back Of the stem (the backfill) contributes to its stability'

L-shaped wall - used when property line restrictions forbid the use of a T-shaped wall' On the Other hand, when it is not feasible (due to construction limitation) to excavate for a heel, a reversed L-shape may serve the need

Counterfort retaining wall -main components: base, stem, and intermittent vertical ribs called counterforts, which tie the base and the stem together. These ribs, which acts as tension ties, transform the stem and heel into continuous slabs supported on three sides - at two adjacent counterforts and at the base of the stem.

Buttressed wall -constructed by placing the ribs on the front face of the stem where they act in compression.

Bridge abutment - short and typically accompanied by wing walls'

Cohesion - the component of shear strength of a rock or soil that interparticle friction

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

Sheet pile - Steel section panels that are driven into the ground to provide lateral support

Piles

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.

Friction pile - A pile that derives the majority of its

load bearing ability from the skin friction between the soil and the pile.

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.

Pile spacing -The distance from center to center of piles

Slope Stability

Bracing - used when temporary trenches for are opened in soil.

Braced cut - an excavation in which the active earth pressure from one bulkhead is used to support the facing bulkhead'

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

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.

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 fail

Failure envelope -For a given soil, the graph of the shear stress and normal effective stresses at which



shear failure occurs.

Base Failure It is a type of failure occurs in a such a way that the surface of sliding passes at a distance below the toe of the slope.

Slope Failure - It is a type of failure occurs in a such a way that the surface of sliding intersects the slope or above its toe.

Other terms

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.

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

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

