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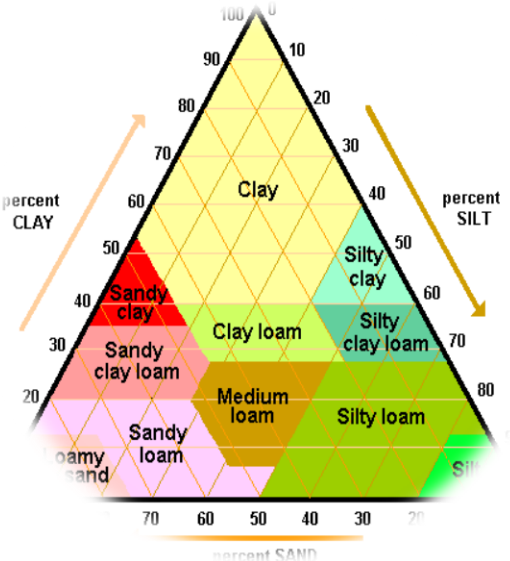

Course Name: Basic Soil for Civil Engineering

Assignment: Soil Mechanics.

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1.0 Introduction

Soil mechanics is a civil engineering discipline which deals with the prediction of soil characteristics, performances while utilizing the soil in engineering technologies of dynamic, fluid mechanics, and also other technologies. Soil mechanics in engineering discipline include the study of soil composition, strength, consolidation and the use of hydraulic philosophies to deal with matters regarding depositions, as well as other deposits.

Generally, soil mechanics is one of the main knowledge used in determining most problems related with geology and geophysical engineering.

In civil engineering, it is very important to have a good knowledge on soil mechanics. The skill necessity cover the knowledge which based on natures of structure, types of equipment’s that has to be used for construction, support materials and many other aspects of construction works in which this are largely affected by the soil mechanics.

Basically, in the study of Soil mechanics it involves the understanding of soil formation, physical and chemical properties of the soil, dynamic loading, permeability, consolidation etc.

1.1 The Soil Formation

Formation of the soil in general it involve a combination of various minerals and organic element that forms a solid, gaseous and aqueous form. In general soil consists with layers of particles formed from different forms of their original materials which may be in their physical, mineralogical, and chemical properties. Due to its relationships between the atmosphere and hydrosphere, rocks which have to been changed basing on the chemical reactions and the environmental effects.

The particles of the soil normally are formed from the fragmented rocks that have been changed due to chemical reactions, this include weathering and erosion. Soil particles are complete lightly, creating a soil form that consists of pore spaces. Determining the soil formation it is very important due to the fact that it helps the understanding on the formation and properties of soil in general. The adhesiveness, Cohesiveness, Soil acidity and other related factors that can easily be determined by the type of soil intends to deal with.

However, the basic characteristics of soil can be identified in terms of colour, texture and nature of the soil, thus in engineering discipline, the studies of soil properties should be carried down in order to ensure the stability of the constructed structures.

1.2 Basic Characteristics of Soil

In general soil consists of different states, which include solid, liquid and gas which basically depends upon the interaction compartment of the states, and the stress applied to it. The state of soil in solid formation include Clay; classified as non- clay minerals, and organic matters. These elements are further categorized upon their sizes as clay, sand and gravel. The liquid state in general composed with water which contains organic composites obtained from chemical spills, wastes and ground water. Gas state soil is normally the air, the sizes, forms, chemical properties, compressibility, and load carrying ability of the soil properties are determined by the soil mineralogy, which in general are science chemistry, structure and physical properties of mineral.

Moreover, the soil structures depends upon the arrangement of particles groups such as pore spaces, and the composition. The characteristics of soil are essential factors for determining the type of soil structure to be built and whatever external that could support the measures, if any of the characteristics, has to be taken into considerations to make the structure durable and bear the effects of earthquake, water leaching, and other external environment factors (Liao, 2009).

Also, consolidation of the soil is very important factor that could be taken into consideration during the study of soil properties, to ensure the strong enough and durability for the structures. Consolidation is a procedure in which the volume of soil is/ has to be reduced, through the application of stress due to the way in which the soil particles are packed together definitely by the decreasing of soil volume.

But with the removal of the stress, the soil are rebounded back and improves some of the volume that lost during the course of consolidation. The consolidation of soil factors in general involves the rate of association and the amount of consolidation. Also the most important factor of the soil to be considered are the permeability of the soil. Generally all factors are thoroughly linked with each other and they usually affect largely the design and construction process.

For example, if a structure has to be built on a soil with a fine grains, which have a low permeability, the flow of water through the soil voids will also be less. The volume of water content in this kind of soil may cause the structure to sink down due to its weight. The consolidation process of fine grained soils normally is very slow, and the abstraction of pore water is simple in the coarse grained soil since it moves freely within the region.

In general soil mechanics skill are used to determine the sideways of the earth's pressure, bearing capability of the soil and conduct the slope stability analysis of the soil. Civil engineers usually determined the design and construction with a better structures in which directly helps in mitigation for the structure's risk. If it is well known the soil mass and what it behave. Principally the tool for soil engineer in charge of a civil engineering project is a mechanics'. It mostly examine the mechanical and hydraulic properties of soil, such as the rigidity of soil, soil strength, dilating of soil, soil permeability and also the reaction of soil to hydration or dehydration. Also the isotropy of the soil properties are always considered, the pore pressure in the soil lead the engineers to consider the total stresses and the effective stress, in which these are actually supported by the soil skeleton.

1.2.1 Basic Different Types of Soil

Soil are determined based on their types, such as Sand, Clay, Silt and Loam. However soil can be defined in various ways in civil engineering, soil is a naturally occurring, loose/uncommented or weakly cemented or relatively unconsolidated mineral particles, normally as organic or inorganic characters, lying over the bed rock which is formed by weathering of rocks. It is formed by different particles such as gravels, rocks, sand, Silt, clay loam and humus.

Sand Soil

This are the type of soil which consists particles of rocks and hard minerals such as silicon dioxide, mostly sand is widely used as a building material.

Sand in general are the largest type of soil particles, whereas the particles normally is visible to bare eyes. Sand is relatively stable sand particles in which their sizes enables the increases of soil aeration, improvement on drainages in tight soils and creates plant growth supporting qualities, or gradient.

Sand; The particle size of course sand normally ranges from 2mm to 4,75mm, Medium sand particles sizes ranges from 0.425mm to 2mm and the fine sizes of sand ranges from 0.075 t0 0.0425mm.

Moreover, the bigger particle size of the sand it gives wet or dry sand soil a coarse texture when you scrub it between the portions of sand soil texture, also it makes the soil light in general, and powdery even when you try it together in the hand. The particle shapes are angular, sub angular, rounded, flat or elongated. And also the texture is rough, smooth or polished.

Silt Soil

Silt soil are type of soil in which its sediment materials are with intermediary sizes between sand and clay soil. Silt are normally carried by water during flooding in the form of a fertile deposit basically on a valleys floor of water. The silt particle size are usually ranges from 0.002mm and 0.06mm

In general silt in a wet condition is a non-plastic material due to its fineness, when wet it becomes a smooth sludge that can form easy into balls or other shapes when are handled into the hand, and also when silt is very wet it blends effortlessly with water to form fine runny ponds of sludge.

Clay Soil

The type of soil in which the particles are finest of all soil particles, the measurement of soil particles sizes are less than 0.002mm. Clay soil consists a tiny particles resulting from the chemical disintegration of rocks, clay is a fine grained unified soil, normally this type of soil stick together enthusiastically and form a sticky or gummy texture when are wet or dry.

However, clay it made up with over 25% of the soil is clay, this is due to the fact that the spaces found between clay soil elements holds a high quantity of water. Clay expands when are in contact with water and shrink when getting dry are. In comparison with sand particles, which are normally slender, clay soil particle are generally thin, smooth and enclosed with small plates. Organically, clay soil particles are highly compressible and its strength is very high when gets dry that is why clay soil it is used in building as a mud mortar or used for bricks making.

Loam Soil

Loam soil are type of soil in which it formed as an admixture of clay, sand and silt, these three different texture qualities of soil forms, allows the preferring in water retention, air circulation, drainage and fertility of the soil. The fertility of loam soil make it easy to work with, and also provides a good drainage. This depends on their principal composition made by either sandy loam or clay loam.

Loam soil is a form of soil which is a combination of other type of soil such as a soil 30% of clay, 50% of sand, and 20% of clay soil. In which basing on the order of their most domination type of soil particle, it is said to be called as clay loam, silt loam, or sandy loam which refers to the soils composed largely.

“Leaning Questions to be asked”

1.3 What are potential Necessity to Study Soil Mechanics in Civil Engineering?

The potential necessity for the study of soil mechanics in engineering discipline is that, we study about numerous properties of the soil since soil are highly been used in various engineering construction structures. Moreover, soil are usually use for transferring the whole load into the soil stratus, therefore it is advised to construct the foundations or retain structures that could withstand the loads and also for stability and durability of the structure built.

1.3.1Why is the Soil engineering very important?

Soil engineering is very important since among the properties of soils that are to be well known are penetrability, strength, compaction characteristics, drainage, shrinkage, grain-age, plasticity, and reactions. Also the most important to considered are depth of water table, depth to substratum and the soil gradients which may require remediation, or some sort of improvement that could allow the construction of the structure.

1.3.2 What is the Dynamics of Soil in Civil Engineering?

Usually, the structural dynamic is typically the structural analysis which covers the behaviours of a structure that is subjected to dynamic situation (actions having high acceleration). In which the dynamic loads may include, People, Wind, Waves, Traffic, Earthquakes as well as blast. For this case any structure can be subjected to dynamic loading which in more case, the situation have relationship with the application on soil properties.

1.3.3 What are the purposes of Soil Classification?

Soil classification is a way in which soil is grouped together such that the soil with a similar properties or attributes are kept into the same class. The purpose of soil classification intends to specify the soil with similar characteristics be grouped together so as to have a common use in their applicability. Whereby from the engineering stand point, it is the geotechnical properties like permeability, shear strength, and compression ability condition of the soil should be taken into account.

1.3.4 What is The Purpose of Soil Mechanics?

Soil mechanics is purposely used to study or analyse the deformations of Land/ soil and also the flow of fluids within a natural and man-made structures which may be supported on or made of soil, or structures that are submerged in soils. Example applications of buildings such as bridge foundations, retaining walls, dams, and any underground pipeline systems laid down.

1.3.5 What are three engineering properties of Soil?

Generally there are three properties of Soil that should be considered in engineering soil, this include; Cohesion, Angle of internal friction, and capillarity, Capillarity also includes permeability, compressibility and elasticity of the soil.

1.3.6 What is the Best Soil for Construction Works?

Widely, loam soil is the best material type for constructions due to the fact that loam soil in a combination of silt, clay and sand, this combination gives the best quality of the loam soil to be suit for building as this ideal the balances of the ingredients gives the best for support in a foundation. Loam soil does not shift, expand or shrink drastically and also it handles properly while are used in the presence of water.

1.3.7 Why is that the study of Soil dynamic in engineering is important?

The study of soil dynamic is important in engineering discipline because, most of the mechanical system associates with motion. Therefore due to this fact, there are various chances of acceleration which would course a forces. Those dynamic forces in one way or another could causes stresses on the structures.

1.3.8 Why are Soil Mechanics important for Civil Engineering Discipline?

In civil engineering discipline, soil mechanics is very much important since all the civil engineering works performed on the earth's strata, in which constantly it require investigation on the geological situation to give up the condition of the soil properties and the correlation on the type of construction that could be undertaken and where required the kind of soil improvement to be carried out. Since there a various methods that can be used to improve the soil properties to be suitable for the intended construction as well as help the economy for the structural construction works dealing with the soil.

1.3.9 What happen when the Soil is subjected to Dynamic Loads?

Dynamic loads are very much important to be considered for the soil properties during construction works, since when the soil is subjected to dynamic loads, it can results into;-

- The increases in lateral earth pressure due to the dynamic loads.

- The potential use of soil may lead to deliquesce when the soil are subjected to dynamic loads.
- Collapse of earth embankments when the soil are subjected to dynamic loads. And thus failure criteria for the construction works.

1.3.10 Why foundation for the Structures are so important to Civil Engineers?

This is because all civil engineering structures, ultimately rest on the soil. In which the transfer of whole loads are upon the soil capability, so we have to construct the foundation to retain these structures properly.

In case where the soil is hard that can provide a adequate strength a shallow foundation can be provided. Also the pore pressure in a soil, leads the engineer to consider the total stresses and the effective stresses being as actually that supported by the soil skeleton.

1.4 Most Terms and Definitions used in Soil Engineering

Terms	**Definitions and the usefulness of terms**
Volumetric Relation of Soil Void Ratio;	Soil Void Ratio are the volume of solids which is normally denoted by 'e' and it can be determined by the formula; e = Vv/V
Soil Porosity or Permeability	This are the ratio of volume of voids to the total volume. It is denoted as n; and the associated formula as n = Vv/Vt. It can also be expressed in a percentage 1/n= Vt/Vv; 1/n = (Vv+vs)/Vv. $\frac{1}{n} = \left(1 + \frac{1}{e}\right) + \frac{(1+e)}{e} = n = \frac{e}{1+e}$ …………………………………………… (a)

	$\frac{1}{e} = \left(\frac{1}{n}\right) - 1; = \frac{(1-n)}{n} = e = \frac{n}{(1-n)}$ …………………………………………… (b) Question (a) and (b) above the porosity should be articulated as a ratio and not a percentage (%).
Degree of Saturation	This are expressed as the ratio of the volume of water to the volume of voids. It is denoted by 'S'. where; S=$\frac{Vw}{Vv}$: the degree of saturation can also be expressed in a percentage. Where it is taken as equal to zero when the soil is absolutely dry and 100% when the soil is fully saturated.
Percentage Air Voids	This is the ratio of Volume of Air to the total Volume of water, typically it is expressed in percentage; $n_a = \frac{Va}{Vw}\ x\ 100$.
Air Content	The air content of a soil is the ratio of the volume of the air and the volume of Voids A = $\frac{Va}{Ve}$; also na = na.
Water Content	This is described as the ratio of the mass of water to the mass of solids W= $\frac{Mw}{Ms}$. It is also known as the moisture content (m) and it is expresses as a percentage and use as a decimal in computation.
<u>Volume Mass Relationship of Soils</u>	
Bulk Mass Density of Soil	The bulk density (ϭ) of soil is the total mass (M) per unit Volume; ϭ = $\frac{Mt}{V}$
Dry Mass Density	This is defined as the mass of solids per unit total volume ϭ$_{d}$= $\frac{Ms}{V}$
Mass Density of Solid	This are the ratio of mass of solids to the volume of solids ϭ$_{s}$= $\frac{Ms}{Vs}$
Saturated Mass Density	The saturate Mass density (ϭsat) is defined as the bulk density of the soil when it is fully saturated. ϭ$_{sat}$= $\frac{Msat}{V}$
<u>Terminology referred for different Types of Soils in Soil Mechanics</u>.	
Bentonite	This are type of clay soil with a very high percentage of clay mineral elements, usually its plastic clay is high, due to decomposition of volcanic ash. Usually the kind of soil its

	water absorbent is high and has also a high shrinkage rate and swelling properties
Black Cotton Soil	This are soil residual comprising a high percentage of the clay minerals element- montmorillonite. The soil has very low bearing capability, but high swelling and shrinkage characteristics.
Boulders	The boulders are the rock rubbles with enormous size, normally is large than 300mm.
Calcareous Soil	This are type of soil which comprises a large amount of calcium carbonate, normally the soil froth when verified with weak hydrochloric acid.
Caliche	This are soil type which contains gravel, sand and silt. The particles are concreted by calcium carbonate.
Cobbles	This are soil with large particle size ranging from 80mm to 300mm
Diatomaceous earth	This are minute unicellular marine creatures soil, it is a finest, light grey, soft grainy deposit of siliceous residues of skeletons of diatoms.
Dispersive Clay	This are special type of clay which deflocculated in water. Such type of soil are easily eroded when are exposed to water with low velocity.
Dune Sands	The dune sand are wind-transported soils. They are composed with comparatively uniform particles of fine to medium sand.
Expansive Clay	This are predisposed to large volume changes formed as the water content. These soils contain the mineral montmoriollonite (clay soil).
Fills	This are artificial deposits of soil and waste- materials, they are soil mounds raised above the ground surface. Normally the properties of fills depends upon the type of soil, soil water content and the degree of compaction.
Gravel	Type of soil (course- grained). The particle sizes are normally ranges from 4,75mm to 80mm, are also solidity –less material.
Hardpans	This are type of soil that offers excessive confrontation to the penetration of drilling tools during soil exploration. Usually such kind of soils are designed hardpans notwithstanding of

	their particle size. They mostly dense, well graded, interconnected aggregates of mineral particles, they are hardpans soil which do not disintegrate when submerged in water.
Humus	It is a soil type with a dark brown, organic amorphous earth of the topsoil, humus in fact consists of partly decomposed vegetable matters, this kind of soil is not suitable for most engineering works
Kankar	Type of soil which it is impure form of lime stone, it contains calcium carbonate mixed with siliceous materials.
Laterites	This are type of residual soils formed in tropical regions, the soil are very soft when freshly cut but becomes hard after long exposure. The hardness is due to cementing action of iron oxide and aluminium oxide.
Loam Soil	It is a mixture of sand, silt and clay, the kind of soil is generally used in agronomy, the soil is suitable in cultivation.
Loess Soil	This are windblown deposit of silt soil, generally are uniform gradation with the particle size ranging between 0.01mm and 0,05mm. Loess soil consists of quartz and feldspar particles elements, flagged with calcium carbonate or iron oxide. When the soil is wet it turn into soft and compressible due to losses in cementing action.
Marl	This are soil with a stiff, marine calcareous clay soil of greenish colour.
Moorum	This are pulverized rock which consist a small pieces of disintegrated rock of shale, or without stones.
Muck	This are the mixture of fine soil particle elements and highly disintegrated organic substance, it is black in colour and has extremely soft consistency. Muck soil can be used for engineering works. The organic matter constituents is in an advanced stage of disintegration.
Peak	This are type of organic soil having fibrous aggregates of macroscopic and microscopic particles elements, normally formed from vegetal matter under the conditions of excess

	moisture such as swamps. This kind of soil is not suitable in foundation making as it have high compressible.
Sand	This are coarse grained soil with particle size ranging between 0.075mm to 4.75mm, normally the particle sizes are visible with a naked eye, it is cohesion less and penetrable.
Silt	This are fine grained soil, with a particle size ranging between 0.002mm and 0.075mm. usually the particles size are not detectible by a naked eye, the inorganic silt consist of large, equidimensional grains of quartz, has little or no plasticity, and is cohesion less. However, silt contains an admixture of organic matter.
Till	This are type of soil formed by an unstratified deposit which are the results from glacier melting. The depots consists of particles of diverse sizes, ranging from stones to clay, generally the soil is well graded. It can be easily identified by compaction. Actually it is further known as stones –clay.
Top Soils	Normally this are soil of the surface land that support the growth of plants, they contain large quantity of organic matter, are not suitable for construction of foundations.

2.0 Essential Consideration for Soil based Structural

In Construction processes, civil engineers normally should provide the attention towards the soil properties of a given particular area that are to be built with, for all major land based structures such as dams, bridges, high-rise tower, viaducts, storage tower, petroleum and chemical reservoirs, power generator plants, this structure require much on foundation based on the soil (Shanmkha, 2016).

As well as for the underground structures such as tunnels, galleries, underground factories, gas storage tanks, petroleum storage tanks as well as water storage tanks are mostly supported by the action of soil, which are commonly known as the underground pressure.

For the offshore structures which are exposed to marine elements, the soil draws its stability from the support on the seabed, or their anchorage to the seabed

Basically, soil is a living material which are likely to change over time upon the influence of numerous natural and anthropogenic spectacles. Soil reinforcement and remediation are therefore given as the most consideration that are to be observed while are in contact with a structural.

The geotechnical engineer and also a team of geo-technicians mostly are the in charge of the interactions between soil and the structures. They work very close with the construction team so as to correlate the structures with the soil properties of a particular position. Civil engineers, normally consults to understand on the likely effects such as the deformation and stability of the construction that may arise over time which may be either influenced by the environmental changes such as rain, snow, drought, floods, storm, freeze- thaw, earthquake, explosion on the soil struts. A broad significant impact may also be considered like physical, hydraulic, ecological, as well as socio-economic interaction between the structure and the soil, are essential factors that should be assessed at a stand point.

2.1 Soil Classification

In general soil classification are the system in which a soil are organised according to their order of preference basing on the given set of physical requirement and conditions. However, the classification of soil does not necessarily have the similar order of preferences under some physical conditions.

Various number of soil classification system have been developed basing on the envisioned determinations. This process of soil classification has determined to be very useful tool in soil engineering discipline, as it provide a general guidelines in an empirical method for most of the field experiences in general. Moreover soil may be broadly classified basing on the following;- 1) basing on the Grain size, 2) Basing on Textural, (3) Classification system for AASHOT 4) a unified soil classification system. Geological Classification, 6) Structure classifications and preliminary soil type classification.

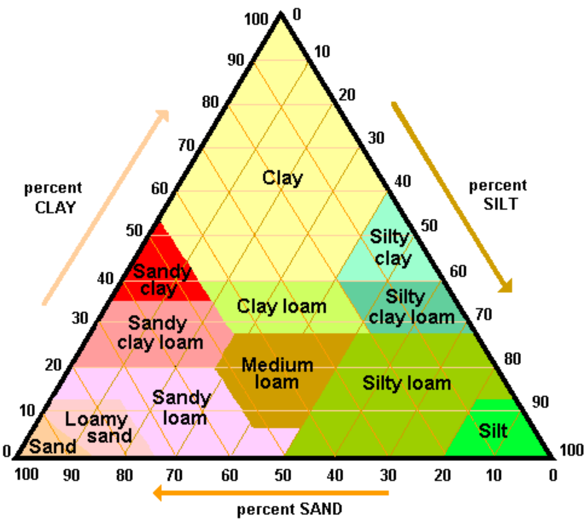
2.1.1 Classification Basing on Grain Size

The grain sizes are used in representing the soil basing on the particle sizes only, without signifying the nature of the soil type, such as sand, silt, clay and silt. However there are various ways of classification taken into consideration, where the commonly used classification systems are;

- International Classification that Proposed at the international soil Congress at Washington, DC (USA, 1927).
- Indian Standard Classification (IS: 1498-1970)
- Massachusetts Institute of Technology (MIT) system of Classification of U.S.A
- Public Roads Administration (PRA) System of the U.S.A

2.1.2 Classification Basing on Textural

Textural classification for the soil type are exclusively based on particle sizes and their percentage distribution. In which specifically the names of the soil depends largely on the percentage constituents of sand, silt and clay. In this case, the triangular charts are normally used to classify the soil (Odhiambo, 2022).



Textural Classification system

Basing on the soil texture classification system, the following are information which should be obtained from soil gradation curve and consistence test that should be provided in percentage passes as

- Passing Number: 4 (4,75mm) = 92%
- Passing Number: 10 (2.0mm) = 87%

- Passing Number: 40 (0.425mm)= 63%
- Passing Number: 200 (0.075) = 28%
- Passing Number: D10 =0.01mm, D30= 0.090mm, D60 =0.39, LL=46%, and PL = 35%

Moreover, according to the texture classification system the percentage of sand size ranges from 0.05mm to 2mm, Silt size ranges from 0.005mm to 0.05mm, and clay size is less than 0.005mm, the general description for the soil texture classification are plotted along the three sides of an equilateral triangle in which the equilateral triangle is divided into zones.

2.1.3 Soil classification by Geological

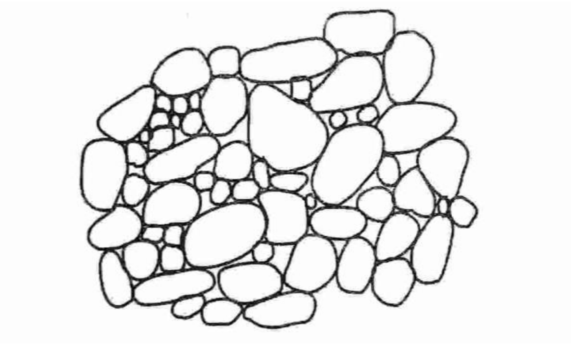
This are type of soil classification performed basing on the geological nature, the nature of the soil type may refer either its constituents or the interventions that responding to its present status. Such as the constituents of the soil like inorganic Soil or Organic Soil. Moreover, classification basing upon the interventions responsible for their present state, the soils may be father classified under the following types; ***Residual Soil type, Transported Soil type, Alluvial or Sedimentary Soil type, Aelian Soils type, Ice-cold Soil type, Lacustrine Soils type, and Marine Soils type***. Under the geological classification, the formation of soil are the results of the disintegration and weathering of rocks through various chemical and environmental reactions such as cementation, temperature, pressure and water reactions.

2.1.4 Classification of Soil by Structure

This are classification upon the average grains sizes and the conditions occurs under which the soil are formed and deposited in their natural state, this may be further categorized into the following types basing on their structure. ***Grained structure, Soils of honey- comb structure***, and ***Soil of flocculent structure***

2.1.4.1 Grained Structure Soil.

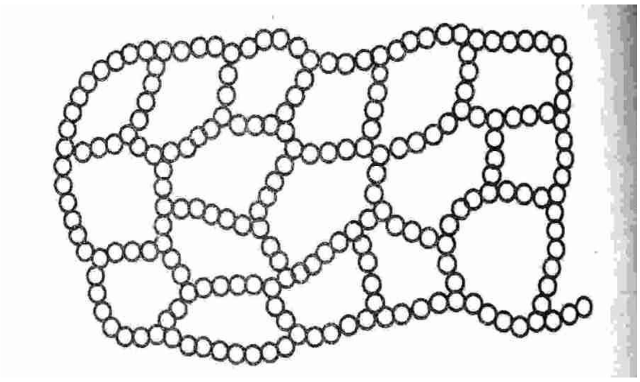
The grained structure of soil is observed in a coarse-grained soils such as gravels, sand and silts, the settling of that soil particles takes place independently and individually as due to out of interruption.



Graing structure of the soil structure

2.1.4.2 Soil of Honey-Comb Structure

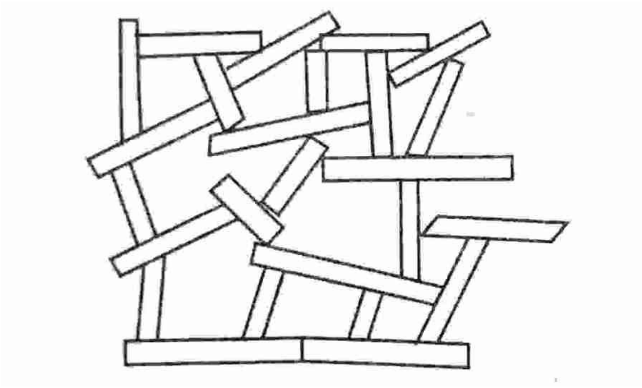
The honey comb structure soil are mainly observed in the soil particles with diameter of 0.0002mm to 0,02mm, in general this structure of soil are called silt (the figure below)



Honey –Comb Soil structure

The important roles plays in generating this type of soil structure, are gravitational forces and also a surface forces. The settling down of the soil grains at contact areas, took places dues to the forces applying upon the soil. Usually, the soils grains hold together and from min arches which are then relatively joined by large void spaces, in which this result to the structure termed as honeycomb structure. The structure normally has high void ratio as large amount of water is enclosed in it.

2.1.4.3 Flocculent Soil Structure



Flocculent soil structure

This are structure of soil which are generally observed in a clay soil, made with fine particles, the soil structure are formed due to electrical forces occurred between adjacent soil particles at the time of deposition that being attraction force.

This are normally formed when there is edge contact among the clay platelets, however, the additional concentration of dissolved minerals in water increases the tendency of flocculation.

2.1.5 AASHTO Classification System

Originary AASHTO classification is also known as PRA classification system. it was established by the U.S A Bureau of Public Roads (1920) for classification of soil for Freeway subgrade usage.

The AASHTO classification system was developed basing on the particle size and the plasticity characteristics for the soil mass. In general on this system the soil are divided into seven main groups. Where some of the main groups are father divided into subdivisions.

Proceeding from left to right of the soil classification chart, you will find out the first group in which the soil test will fill. Having the fine fractions of the particles where further classification is based on their group index. The group index are defined by the following equation.

Group Index = (F-35) [0.2+ 0.005 (LL- 400] +0.01(F -15) (PI- 10)

Where: F = Percentage passing 0.075mm size, LL = Liquid Limit, PI = Plasticity Index

Note that; when the group index value is high the quantity of the material state to be poor.

2.1.6 Unified Soil Classification System

This system was developed by Casa grade in 1948, it was originally known as airfield classification system. The system was based on both grain sizes and plasticity characteristics of the soil. However the system was adopted with some minor modification by the Bureau of reclamation and that U.S Cooperation of Engineers as well as ISI for general engineering purposes (ISI 498-1970). Generally, the IS system divides the soil into three main groups, the coarse grained, fine grained and organic Soils as well as other miscellaneous soil materials.

Whereby, Coarse Grained Soil are those soil with more than 50% of the materials lager than 0.075mm size. In which this soil has further been classified into gravels noted as “G” and the Sand noted as “S”.

Thereafter, gravels and sand are then divided into four subdivision according to gradation such as silt, or clay contents. The fine grained soil, are soil with more than 50% of soil particles finer than 0.075 mm size.

Moreover, the soil are then divided into three sub-divisions which include Silt (Ms), Clay (C), and Organic Salt and Clay (O), with regarding on their plasticity nature. They also added with L, Mandy H symbol to indicate low plastic medium plastic and high Plastic respectively.

For example; GM= Silt Gravel, SM= Silt Sand, CL = Clay of low plastic, ML Silt of Medium Plastic, MH = Silt of Higher Plastic, CH= Clay of higher Llastic, SP = Poorly graded sand, GP= Poorly Graded gravel, OH= Organic Silt and Clays of High plastic, OI Organic silt and sand clays of medium plastic, and GW= Well graded gravel.

However, soil identification in the field are suggested through the following tests for most fine grained soils

- Visual grains soils
- Militancy test
- Toughness test

- Dry strength test
- Organic content and colour
- Other identification test.

2.2 Soil Testing Methods for Constructions

There are various Soil test methods that are being accompanied to decide the quality of the soil required for construction of building. Some of the methods ate conducted in the laboratory and some in the field. Those test methods are such as; ***Moisture content test, Waterberg limits tests, specific gravity of soil test, Dry density of soil, compaction soil tests known as Proctor's test***.

2.2.1The Moisture Content of Soil Tests

The moisture content of the soil is defined that is the ratio of the weight of water to the dry weight of a soil in a solid particle of a given soil sample, it expressed in terms of percentages.

This methods it involve the analysis for the soil moisture contents or water content, the moisture content in the soil are very important parameter for the construction of building in which it is determined by using several methods such as; Calcium Carbide Methods, Torsion Balance Methods, Oven drying Methods, Pycnometer Method, Sand bath Method, Radiation Methods, and Alcohol Methods. Basing on the mentioned methods, the Oven drying Methods is the most common and precise method used for determining the moisture content of the soil.

This method is achieved by collecting soil samples weighed and put into the oven and dried at 100 $\pm$ 5^{0}C . Then after 24 hours, the soil is collected out from the oven and measured the weighed. Where the difference of weight between the two measured weights is noted as the weight of the moisture content in the soil.

In general, the engineering performance of the soil is largely influenced by the manifestation of the water with its amount present in the void of the soil, thus basing on the test, it is recommended as the one which is very much important for soil tests that should be done for various structures construction activities, it is essential to determine the amount of water in the soil and the capacity of soil to hold water at a given position.

The moisture content in a soil is therefore being calculated using the following formula

$\boldsymbol{W = \frac{Mw}{Ms}\, x\ 100\%}$ Where: M_w (Mass of water) = M2-M3; M_s (Mass of the dry soil solid) = M3-M1

This process, has to be repeated for at least three samples and the average of those three sample has to be considered as an actual moisture content of the given soil. The process can be achieved with the aide of the following table

S/n	**Mass of Empty can (M1)**	**Mass of can Containing moist Soil (M2)**	**Mass of can containing dry soil (M3)**	**Mass of Water Mw= M2-M3**	**Mass of dry soil solid Ms =M3-M1**	**Moisture content** $\boldsymbol{W = \frac{Mw}{Ms}\, x\ 100\%}$
1						
2						
3						
						Ws% /n

Note: During analysing a soil sample, the temperature of the oven should be maintained, but if the soil sample comprises with a significant quantity of gypsum or organic material, the temperature of the oven should be controlled at 60^0C to 90^0C. Carefully putting and taking out the can in the oven should be taken with precaution since hands can be burned.

2.2.2 Specific Gravity Soil Testing Methods

This method of soil testing is described as the ratio of unit weight of the soil in solid form to the weight of water, it is determined by various methods, such as by density bottle methods, pycnometers methods, Gas jar methods, Shrinkages limit methods and Flask measuring methods.

The density bottle Method and pycnometer tests are simple and commonly used methods. For example, in pycnometer test, a sample is weighed in four different cases that are empty weighed (W1) Empty + dry Soil (W2) empty + water +dry soil (W3) and pycnometer filled with water (W4) taken at a ambient condition. Whereby From those 4 masses a specific gravity is determined by making calculation using the following formula.

$$\boldsymbol{SG = \frac{(W2 - W1)}{(W2 - W1) - (W3 - W4)}}$$

In general, Specific gravity test method for Soil is well-defined as the ratio of the weight of soil in the air to weight of an equal volume of water at 4^0C, it can also accurately be calculated by the following question. **SG =** $\boldsymbol{\frac{Ys}{Yw}}$………………………………………………………..(1.1)

Where Ys= *Unit weight of soil;* Yw *unit weight of water*.

Note that; for any construction activities Soil engineering properties tests plays an essential role in the design and construction of the structure. So it is very much important to determine the engineering properties of soil in general before carrying construction activities.

Specific gravity of the soil is one of the most engineering properties of soil. This method is very useful in finding out the degree of saturation of soil and the unit weight of the moist content in the soil. Since the unit weight are necessary in the pressure, settlement and stability problems in the soil engineering.

In general, specific gravity of soil can be determined in the laboratory by using the following three methods; Pycnometer method, Flask method and density bottle method.

2.2.2.1 Necessary Apparatus for Specific Gravity Test of Soil

- Density Bottle (50ml with stopper).
- Constant temperature water bath at 27^oC.
- Desiccator (containing anhydrous silica gel).

- Thermostatic measured Oven controlled at a temperature of 105 to 110°C.
- Weight balancing device with an accurateness of 0.01gm.
- Plastic wash-down bottle filled with distilled water.

The procedure on calculating the specific gravity of soil is done with the use of density bottle methods following the IS code 2720 section three.

The procedure has to be repeated for two or more times, and the average of the sample results is taken as the specific gravity of soil at 27°C, the following table can be helpful in calculation.

S/n	Mass of Empty bottle (W1)	Mass of bottle Containing sample Soil (W2)	Mass of density bottle containing sample and distilled water (W3)	Mass of density bottle containing distilled water onlyW4	Mass of dry soil solid Wd =Ws-W1	Moisture content $SG = \frac{Wd}{Wd-(W3-W4)}$
1						
2						
3						
						Average=SG/n

Note that: During the soil sample testing, the soil must be free from inflammations, every mass taken during the experimentation must be precisely collected, any trapped air in the density bottle should be removed, and also the soil sample collected must be fully oven- dried.

2.2.3 Soil Test by Dry Density Method

Dry density test is a process in which a mass of soil elements in a given sample volume of soil is measured. The dry density of a soil depends upon the void ratio and specific gravity of soil. Where by upon the importance of dry density test a soil is categorized into high density, medium density and loose sets

However, by definition a dry density is the weight of a solid per unit volume of soil mass in which can be expressed mathematically as; Dry density (Y_d.) = weight of oven dried soil (W_d) / volume of soil (V); $Yd = \frac{Wd}{V}$. The potential Importance of soil tests for construction is done for the purpose of stability analysis, determination of bearing capacity and determination of degree of compaction of soil for building.

Dry density of soil can be achieved by ***core cutter method, sand replacement method*** and ***water-displacement method***.

2.2.3.1The Core Cutter Soil Test Method for Dry Density

Core cutter is a methods in which a cylindrical core cutter of standard dimensions is normally used to cut out the soil in the ground and then lift up the cutter with the soil sample. The sample of soil is then taken out to measure the weight and noted, the final water content for a given sample is determined by the dry density calculation.

2.2.3.2 Necessary apparatus required for Soil test use of Core Cutter Method

The following are necessary requirement that could allow the possible soil test by the use of core cutter soil test.

- A cylindrical core cutter with100mm internal diameter and 130mm height
- Steel dolley with 100mm diameter and 25 mm height.
- Steel rammer with 9kg
- Weighing device
- Palette knife
- Straight edge steel rule
- Sample extruder
- Apparatus for water content determination

Procedures for determination of soil test with core cutter methods follow the standard procedures as indicated in the table below, but determination of the cylindrical volume is determined using the following formula:

$$V = \frac{\pi d^2}{4} x H \ldots\ldots (3)$$

Also the process for soil sample test may be repeated for three or more times and the average density from the sample measured taken as the dry density of the soil.

S/n	Mass of Empty core cutter (Wc)	Mass of core cutter Containing sample Soil (Ws)	Bulk density Ys = $\frac{Ws-Ws}{V}$	Moist content (W)	Dry Density ($Yd) = \frac{Yd}{1+W}$
1					
2					
3					
					AVERAGE = (1+2+3)/N

Note That: the soil around the cutter should be removed before exciting it to avoid turbulences. Also the core cutter should be drives only till the dolly is halfway in the aground to avoid compaction of the soil in the cutter.

2.2.4 Soil Testing Dry Density by Sand Replacement Method

The method involve creating a hole in the ground by excavating the soil in which a dry density has to be found.

The hole is filled with a uniform sand of a known dry density. Then dividing the mass of sand poured into the hole with a dry density of sand it gives the volume of a hole. Therefore, the quantity of a soil sample can be calculated from the equation number two above.

Figure; ***Soil testing equipment by replacement method.***

2.2.5 Atterberg Limits Soil Test Method

This is used to measure the critical water content in a fine grained soil. In this method, three limits which exhibits the properties of fine grained soil at a different condition is provided.

Whereby those limits are Liquid limit, Plastic limit and shrinkage limit. In which these limits can be calculated independently.

2.2.5.1 Liquid Limit Test method of Soil

In this method a Casagrande's liquid limit device in normally used, the test comprise a cup with stirring up and down mechanism. In this process the cup are occupied with a sample of soil and then making a groove at the middle of a cup with an appropriate tool. Then when the cup is moved up and down with the help of handle, the groove it becomes closed at some point.

Letter down the number of setbacks required to close the groove. Then after that the water content of a soil is determined. This process should be repeated three times and then a graph should be drawn between log N and the water content of the soil sample, where by the water content corresponding to N = 25; becomes a liquid limit of soil.

2.2.5.2 Plastic Limit Test of Soil

This are the test performed on soil testing in which normally a soil sample and some water are mixed together to make it plastic enough to shape into small ball. Then leave the mixture for some time and after that the ball are placed into the glass plate and rolled into threads of 3mm diameter. This indicate that, when rolling the threaded soil, if it does not break when rolling it below 3mm diameter, the water content is said to be more than the plastic limit.

Therefore in that case the water content should be reduced, however, the situation should be repeated until the crumbing it occurs at 3mm diameters. Thereafter find out the water content of resultant soil which value is nothing but plastic limit.

General procedure involves taking a pieces of crumbed soil sample into a container for the determination of water content. Then the process can be repeatedly for a consecutive times such as three times with different samples, the analysis can also achieved with the aide of the following table.

S/n	**Weight of Container (W1)**	**Wet of Container and wet soil (W2)**	**Wet of container and oven – dry soil (M3)**	**Weight of water Ww = W2-W3**	**Weight of Oven –dry soil Ws = W3 – W1**	**Water Content** $W \frac{Ww}{Ws} x\ 100\%$
1						
2						
3						
						Average=W%/n

Then the average water content of the samples tested is taken as the plastic limit of the soil sample taken. Finally after determining the liquid limit and plastic limit, the plasticity Index can also be calculate as; *PLASTICITY INDEX (Lp) = Liquid limit – Plastic Limit.*

3. Conclusion

Briefly during the study of this course, regarding basic soil that are potentially useful in civil engineering works, I have learned a lot about the formation of soil, characteristics of the soil, types of soil and their behaviour that can be applicable in various construction structures.

Common basic soil terminologies that influences the description of soil has also covered to some extent. With respect to the technical definitions and their presentation that suffice the determination of soil properties and kinds of the soil stratus.

Moreover, the methods of soil tests have also passed through in order to align on the practical methods of soil testing and presentation with respect to the usage of the specific location such as Moisture content test, atterberg limits tests, specific gravity of soil test, dry density of soil, and compaction soil tests or Proctor's test. Remediation of soil for the safety and durability of structure. Advantage of understanding and consideration on the nature of soil for engineering practices, in which the properties of soil such as gravimetric volumetric data, strength parameters, compressibility indexes and permeability for various soil have also covered.

Additionally, Soil characteristics understanding for civil engineering practices has been considered into a very positive ways as the potential components that should be clearly leant, since most of the engineering works are performed just on or under the soil in which it require proper condition of soil to support the stability, durability and strength of civil structures in general. So the soil are the one in which the structural loads are basically transferred, therefore the properties of soil structure should in comply to withstand the forces or loads that are transferred with.

Therefore soil classification for civil engineering discipline is very important that plastically, require a critical skills, understanding the nature and behaviour of the soil condition that could suit for construction activities.

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