Module - 2 14/03/2017

SOIL STRUCTURE AND CLAY MINERALOGY

Soil Structure :- It is defined as the arrangement and state of aggregation of soil particles in a soil mass

* Soil structure in a larger sense includes the mineralogical composition, electrical properties, shape and orientation of soil particles, the nature and properties of soil water and it's ionic composition, the interaction forces between soil particles, soil water and their adsorption complexes.

* Adsorption

* Soil structure influences soil properties such as permeability, compressibility and shear strength.

Types of Soil Structure :-

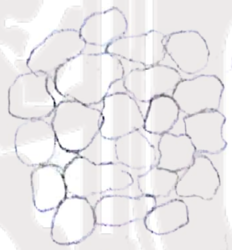
1 Single - grained structure [coarse -

② Honey combed structure [silt deposits]

③ Flocculated and Dispersed structure [clay deposits]

④ Coarse grained skeleton structure and cohesive matrix structure (composite deposits]

① <u>Single - grained structure</u> [coarse-grained soil]

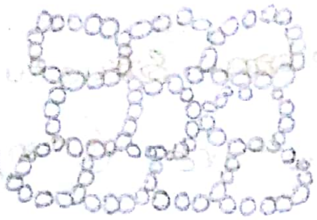


* Found in coarse grain deposits
* In this structure, the soil particles settle out of suspension independently of each other in water
* Gravitational force is the major force for deposition. Surface forces have negligable or no effect during deposition
* They may deposit in loose state with high void ratio or they may also deposit in dense state with low void ratio.

... in deposits depends on the relative

Size of the grains.

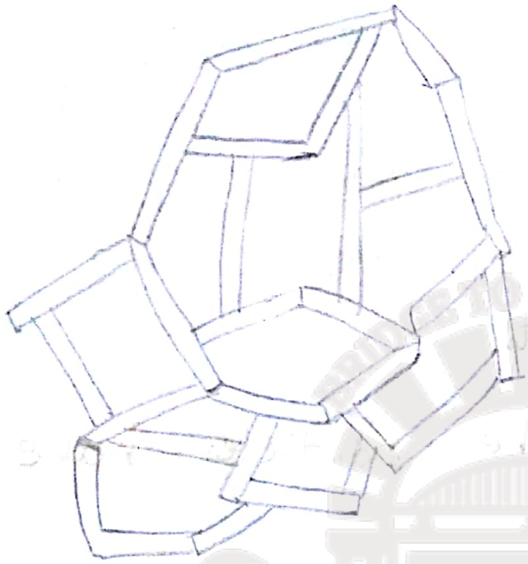
② Honey comb structure :- [silt Deposits]



* Found in silt deposits.
* In this structure the soil particles settle out of suspension in water and both gravitational and surface forces act on the soil particles to form this type of structure.
* when particles approach lower region of suspension, they will be attracted by particles already deposited as well as the neighbouring particles leading to the formation of arches.
* The combination of number of arches leads to the honey comb structure.
* The deposit has a high void ratio, so when the pile is driven through it there is a large reduction in volume due to break down of structure.

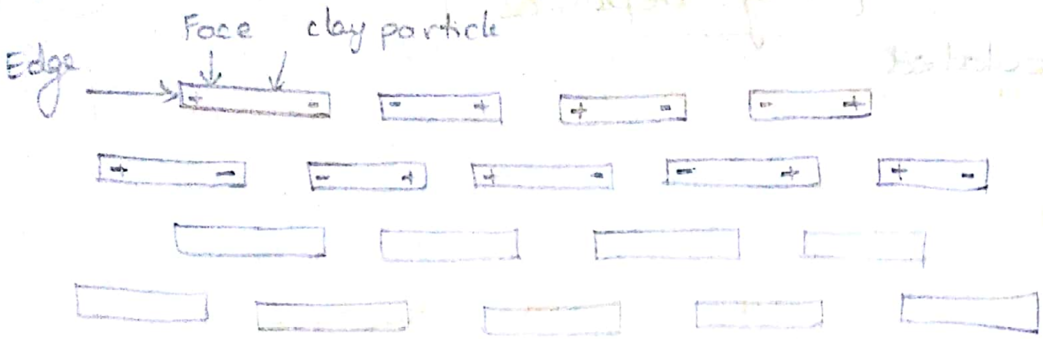
(3) Flocculated and Dispersed Structure [clay Deposits]

→ Flocculated



* These are Found in clay Deposits
* In this structure there is Edge to edge, edge to face and face to face contact between the particles.
* This type of formation is due to net electrical forces between adjacent particles at the time of deposition being attractive in nature.
* The concentration of dissolved minerals leads to formation of flocculated structure will have high void ratio. in case of marrine deposits.

(4) Dispersed structure



* Found in clay deposits
* In this structure the particles have face to face contact.
* This type of formation is due to net electrical forces between adjacent soil particles at the time of deposits being repulsive in nature.
* This type of structure is common in fresh water deposits.

Note :-

Clays with flocculated structure have high void ratio. Remoulding of such soils or application of pressure by compaction leads to slippage of particles resulting in dispersed structure with decrease in void ratio. Consolidation also tends to reorient the particles to form disperse structure with

4) Structure of composite soils :-

[Mixcture or mixed or combined]

2 types

(a) coarse - grained skeleton structure

(b) cohesive matrix structure

(a) coarse - grained skeleton structure

- Found in composite deposits in which coarse grained soil is more than fine grained soil

- The coarse grained particles form a skeleton with particle to particle contact and the void between these particles will be occupied by the fine grain particles.

- This structure is stable.

(5) Cohesive matrix structure.

* Found in composite deposits in which fine grained proportion is more than coarse grained fraction.

* In this case, the coarse grained particle will be embedded in fine grain fraction and will be prevented from having particle to particle contact.

* This type of structure is relatively more compressible compared to the more stable Coarse grained skeleton structure.

VALENCE BONDS

- Atomic bond → primary valence bond or Electrostatic bond (Atomic bond)
- molecular bond → Secondary valence bond

primary Valence bond

- Ionic bond
- Covalent bond

Secondary valence bond

- Vander Waal's bond
- Hydrogen bond (special Secondary bond)

Valence bond:

Two atoms that have unpaired electrons in their orbits which can overlap to give rise to a chemical bond.

Atomic and molecular bonds

Atomic bonds:- Atoms bonding to atoms forming molecules (intramolecular) are called atomic bonds or primary valence bonds.

molecular bonds: Atoms in one molecule bonding with another molecule (inter molecular) are called molecular bonds or secondary valence bonds

→ These are relatively weaker bonds compared to atomic bonds

primary valence bond or Electrostatic bond

Atom bonding with another atom to form a molecule. There are 2 types of bonds in this category (a) Ionic bond
(b) covalent bond

	Ionic bond	Covalent bond
What is it ?	Ionic bond also known as electro valent bond It is a type of bond formed from the electrostatic att-raction b/w appositively charged ions in a chemical compound These bonds are occur mainly betwn metallic and a nonmetallic ion	Covalent bond is a form a chemical bonding between two non-metallic atoms which is characterized by the sharing of phase of electrons between the atoms and other covalent bonds
Formation	An ionic bond is formed b/w a metal and a non-metal. Non metals (-ve ion) as stronger than metal (+ve ion) and can get electrons very easily from the metal. These two opposite ions attaract each other to form ionic bond	A covalent bond is formed b/w a two non metals that have similar electronegativ-ities. Neither atom is strong enough to attract electrons from the other. For stabilisation, they share where electrons from arter molecular orbits with others
Shape	No definite shape	Definite shape
Occurs between	one metal and one non metal	Two non - metals
Examples	Sodium chloride [NaCl]	Methane [CH4] (Hcl) Hydrochloric acid

melting point	High	Low
Boiling point	High	Low
State at Room temperature	Solid	Liquid or Gaseous

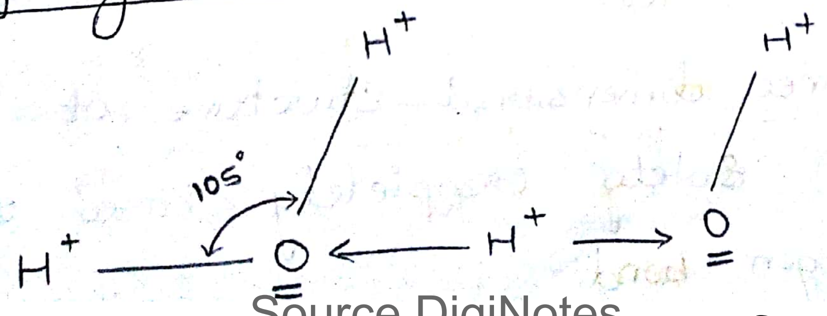
Secondary valence bond

- → Hydrogen bond
- → Van der Waal's bond or forces

* Atoms in one molecule bond with atom in another molecule is called secondary valence bond. These bonds determine
* the behaviour of molecule.

* These forces having unique importance as they contribute to clay strength and water holding capacity of Soil.

Hydrogen bond :-



Hydrogen bond occurs when an atom of hydrogen is strongly attracted by two other atoms

* Hydrogen cannot decide to which atom to bond and oscillates between them.

Ex:- The best ex of hydrogen bond is the bond between water molecules.

* It is the strong secondary valence bond
* Hydrogen bonds are too strong to broken under the stresses normally applied in engineering in soil system.
* water molecules have intermolecular hydrogen bonding.
* Each water molecule can bond with four another molecules because of the hydrogen bonding capability. This results a higher boiling point of a water.
* Hydrogen bond ~~determain~~ determine crystal of ice.
* The three dimensional structure of proteins and DNA solely completely based on hydrogen bond.

* Hydrogen bonds can be destroyed by heating and mechanical forces.

Vander waal's bond :-

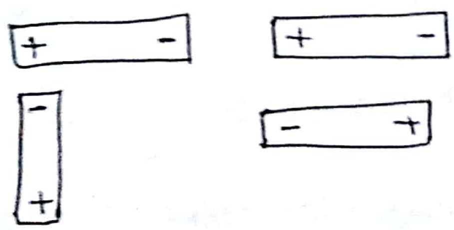
Vander waal's bonds are bonds which occur between any two or more molecules which are very close to one another due to slight fluctuations of electron densities, which are not always symmetrical around an atom. The fluctuation effects are

1. orientation effect [dependent on temperature]
2. Induction effect
3. Dispersion effect

* The Secondary valence bond caused by orientation effect is commonly known as the Van der waal's bond upset

Thermal agitation tends to accept the allignment of diperse, the orientation effect is highly dependent on temperature.

orientation effect



The forces are bonding caused by the orientation of permanent diperse is called orientation effect.

② Induction effect :- There is a force between a permanent dipole and a corresponding induced dipole.

③ Dispersion effect :- There is a forces between instantaneously induced dipole.

NOTE :- These bonds along with ionic, covalent and hydrogen bonds contribute to the three dimensional structure of proteins.

Difference between hydrogen bond and vanderwaal's bond

Hydrogen bonds occur between This electronegative atom could be flourine, oxygen or nitrogen.	

* wanderwall's forces can occur between two permanent dipoles, dipole induced dipole or 2 induced dipole.

* For wanderwaal's forces to take place the molecule should not necessarily have a dipole but hydrogen bonding takes place b/w two permanent dipoles.

* Hydrogen bonds are more stronger than the wanderwaal's forces

* **Electrical double diffuse layer**

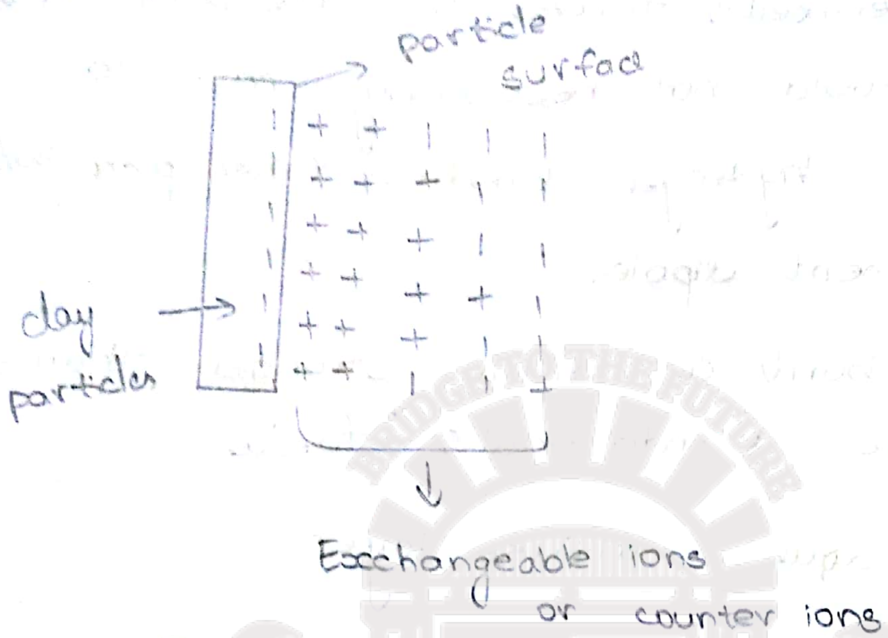
clay particles carry a net negative residual charges on their faces.

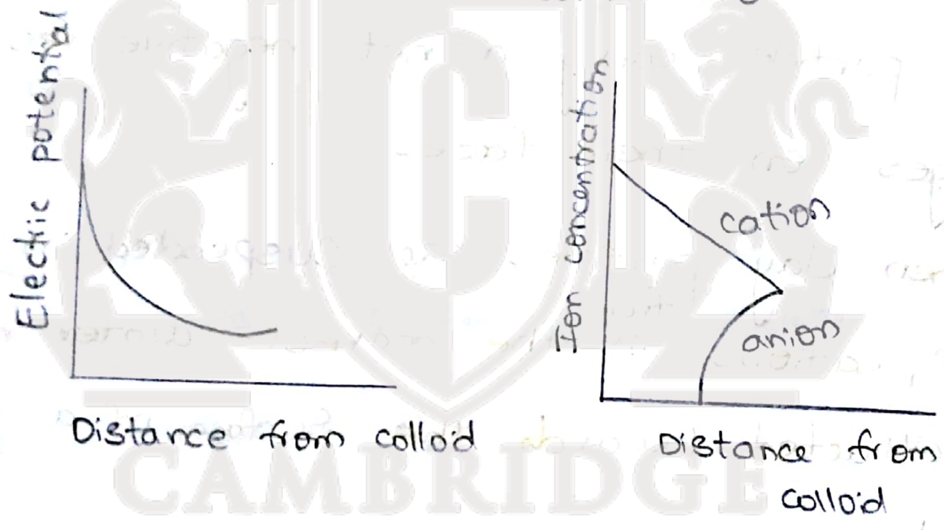
* when clay particles are suspended in the water, cations from the nearest water molecule are attracted towards the surface of a clay particle.

* So each particle is surrounded by cations and some anions and these ions are called counter ions or exchangeable ions. Since they can be replaced.

* The swarm or layer of counter ions and the surface charges of clay particles together constitute the difused double layer.

* The electric potential decreases with increase in distance from the surface of clay particle. Till from at some distance free water exist.





Variation in Electric potential and ion concentration with distance from colloid.

SOIL - WATER SYSTEM

* Water present in a soil mass is called soil-water.

It is broadly classified into two

① Free water or Gravitational water

② Held water

① Free water or Gravitational water :-

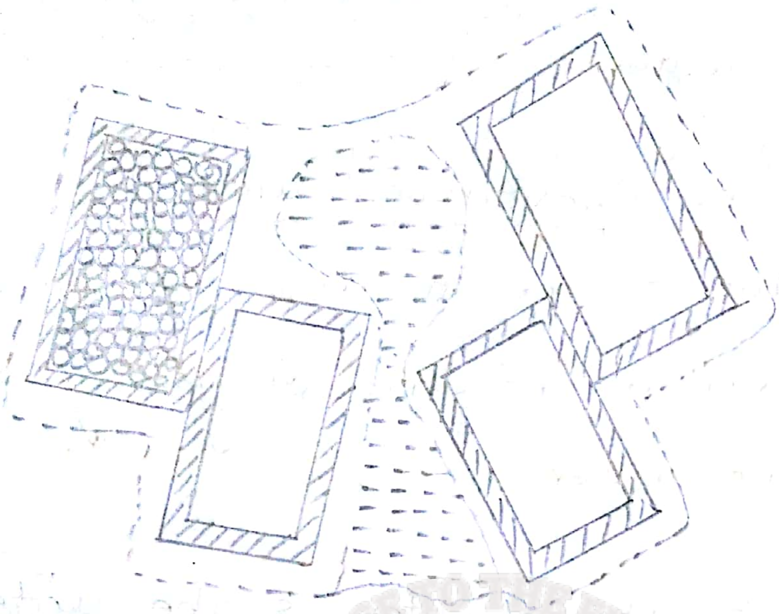
water that is free to move through a soil mass under a influence of gravity is known as free water.

② Held water :- Held water is the water which is held within a soil mass by soil particles. It is not free to move under the influence of gravity.

* Depending upon tenecity in which it is held by soil particles.

Held water is further classified as

① Structural water
② Adsorbed water
③ Capillary water
④ Solvate water



BASE EXCHANGE CAPACITY or

CATION EXCHANGE CAPACITY OF SOIL

structural water :- structural water is the water chemically combined in the cystalline structure of a soil particle. It cannot be removed without breaking the structure of the soil particle.

* The structure of the soil particle is not broken by loads applied in civil engineering practise. or by heating temperature [usually upto 110° C.]

* usually used for drying the soil in

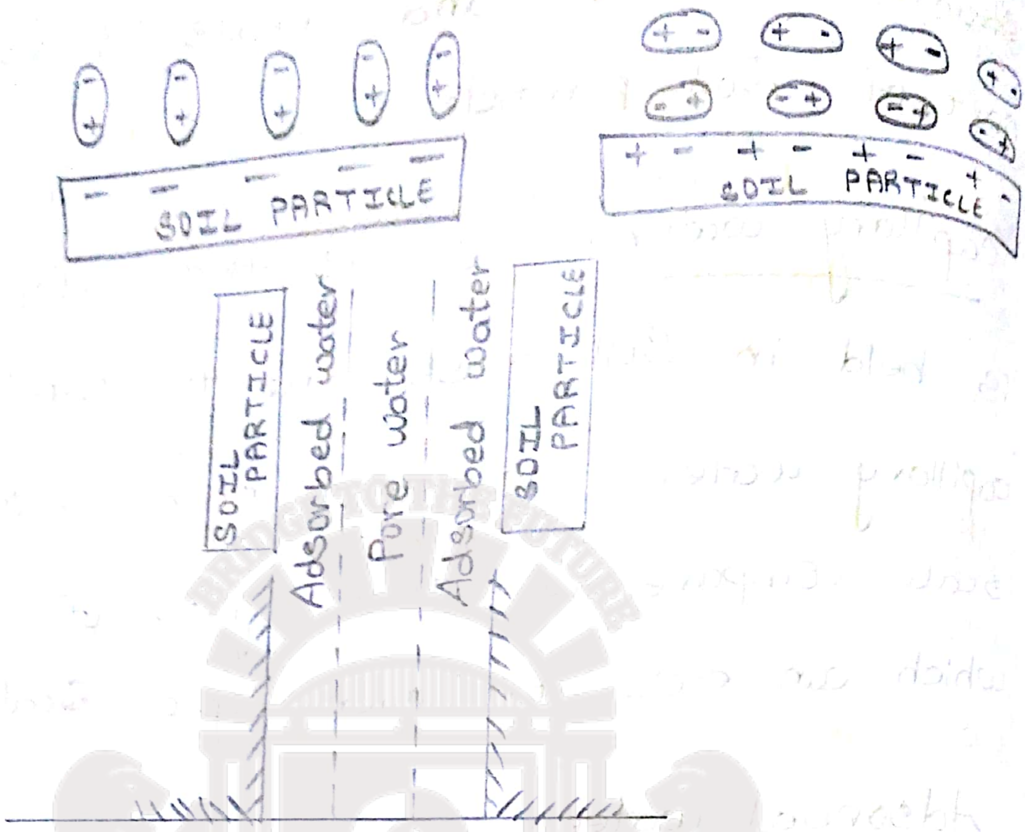
laboratory practice. Hence the geotechnical engineering is not must concern with structural water and treats it as a part of soil particle.

<u>capillary water</u> :- It is the water which is held in soil mass due to capillary action capillary water can exist on a maroscopic scale compare to other types of held water which can exist on microscopic scale

<u>Adsorbed water</u> :-

Adsorbed water is the water which is held by fine grained soil particles due to electro chemical forces of adhesion. It can be nearly removed by oven dried [usually at 105 - 110°C] but on exposure to atmospheric moisture the adsorbed layer is again formed due to moisture present in atmosphere. Hence it is also reffered to as hydroscopic water.

It may be noted that to completely remove the adsorbed water the soil has to be heated to a temp above 200°C.



It is that water which forms the hydration shell [presumably not more than 200 molecule thick] around soil grains it is subjected to polar electrostatic and ionic binding forces. it remains mobile under hydro dynamic forces, though it's density and viscousity are greater than those of ordinary water.

<u>Base exchange Capacity</u> or <u>cation</u>

exchange capacity of a soil

* The cations attracted to a negatively charged surface particles of the soil particles are not strongly attached.

* These cations can be replaced by other ions and are therefore known as exchangable ions.

* The soil particle and the exchanagable ions makes the system neutral. This phenomenon of replacement of cations is called cation exchange or base exchange.

* The net negative change on the mineral which can be satisfied by exchangeable cations systemed as base exchange capacity or cation exchange capacity of a soil. In other words, base exchange capacity is the capacity of the clay particles to change the cation adsorbed on the surface.

CLAY MINERALS

Basic structural units of clay minerals

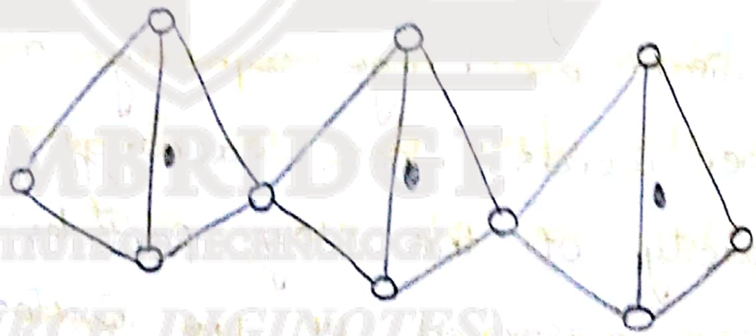
The flakes of platelets of a clay soil consists of many crystal sheets which have a repeating atomic structure. The atomic structure of clay minerals are built of two fundamental crystal sheets.

① Tetrahedral sheet
② Octahedral sheet

It is only the mode of stacking of these sheets, the nature of bonding forces and the different metallic ions in the crystal lattice, that go to make different clay minerals.

<u>Tetrahedral or silica sheet</u>

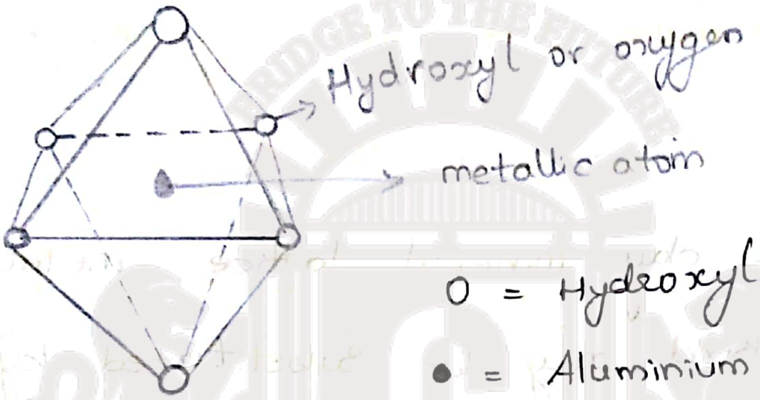
[4 triangular faces]



A tetrahedral silica unit consists of four oxygen atoms placed at tips of a tetrahedral enclosing the silicon atom. So the tetrahedral sheet is a results of combining any such silica tetrahedral units. The tetrahedral silica is represented by a symbol.

Silica sheet

(2) Octahedral sheet [Alluminium, magnesium or iron as cation]
[8 triangular faces]



O = Hydroxyl or oxygen

● = Aluminium, magnesium etc

An octahedral unit has 6 hydroxyl ions at the tips of an octahedral enclosing an alluminium or magnesium or some other metallic atom so the Octahedral sheet is a combination of many such octahedral units.

* If the atom at the centre is alluminium then the resulting sheet is called Gibbsite sheet

* If the atom at the centre is magnesium then the resulting sheet is called Brucite sheet.

Octahedral sheet is represented by

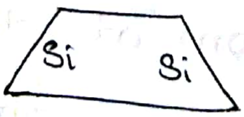
Octahedral sheet

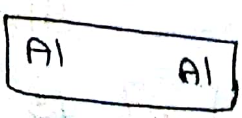
1. Kaoline
2. Illite
3. mont mosillonite

In a clay mineral lattice, metallic ions of one kind may be substituted by a other ~~molecule~~ metallic ions of a lower valen but of a

Such a substitution is called isomorphorou substitution and may lead to

Different clay minerals simply consists of two basic sheets

1. Tetrahedral or Silica sheet > 

2. Octahedral or Gibbsite sheet (Alluminium) > 

stacked together in a certain fashion with certain metallic ions prevent in there sheets. The structures of few important clay minerals are described below

most important clay minerals are

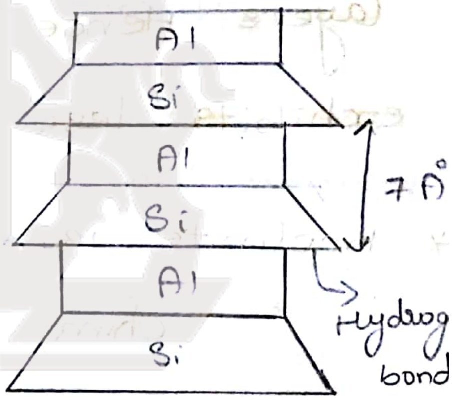
① K - Kaolinite

② I - Illite

③ M - Mont mosillonite

Kaolinite :-

This is the most common mineral of Kaolin group. Each structural unit of Kaolinite is a combination of two layers ~~of~~ with apeces of a silica layer join to one of a gypsite layer.



* The structural unit is represented by a symbol

* The successive layers of structural units are held together to form Koalinite particles which occur or platelates with thickness varying from 100 A° to 1000 A° and lateral

dimensions from 1000 Å – 2000 Å.

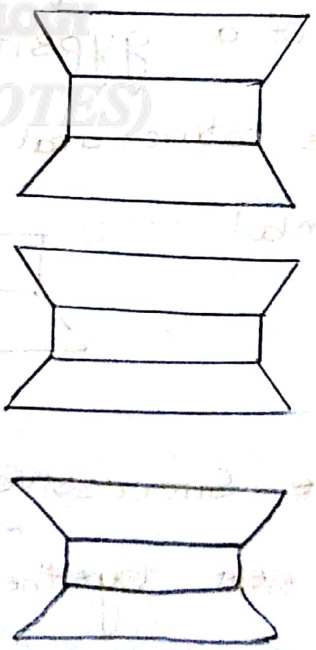
* The base of silica sheet wants bonds to hydroxyl of the gypsite sheet by the H-bond.

* H-bond is relatively strong and it is extremely difficult to separate the layers and therefore the koalinite mineral is relatively different.

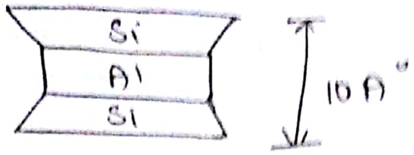
* water contact enter easily between the layers. Hence a clay containing kaolinite exhibits less swelling on wetting.

* Kaolinite is the main constituent on in China clay.

Illite :-



* Illite is a stacking of basic sheet like structural unit, with each unit, made up of gypsite sheet sandwitched by 2 silica sheets and is represented by the symbol.

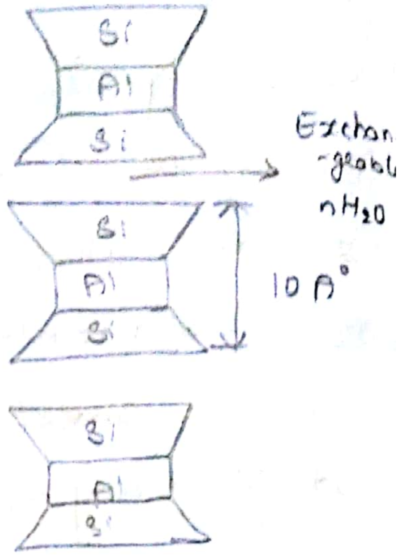


* In Illite there is some isomorphous substituents of Al for silica in the silica sheet and the resultant charged difficiency is pla.. balanced by potassium ions which bond the layers in the stack.
* The bond with non - exchangable K^+ ions are weaker than hydrogen bond of kaolinite. But is stronger than the water bond of mont morillonite.
* The illite crystal does not swell so much in the presence of water as thus mont-morillonites, the lateral dimensions of illite particles are same as that of mont - morrillonite particles 1000 to 5000 Å.
* However, the thickness is more and varies from 50 to 500 Å.

mont - morillonite :-

* The mont - morillonite structure is same as the illite minerals
* The thickness of each unit is about 10 Å
* Because of the fact that bonding is by

wanderwall's forces between silica sheet of adjacent structural sheets units is weak and there is a net negative charge efficiency in octahedral sheet so water and exchangable cation can enter and separate the layers



* The soil containing mont-morillonite varies from 10 A° to 250 A° width the lateral dimensions varies from 1000 - 5000 A°.

* It is the primarly constituent of black cotton soil, bendonite clay and expassive clay.

Engineering Applications of kaolinite :-

kaalinite is the most abundent clay mineral it is used for

(i) pottery and ceramics as filler for paint, rubber and plastics.

(ii) It is also important for the production of paper to produce a glossy paper

Such as is used in most magazines

③ It is used in pharmaceticals as an ingredient in some medications such as stomach soothers.

Engineering Application of mont-morillonite

① mont morillonite it is used in the soil drilling indurstry as a component of drilling mud making the mud slurry, viscous which helps in keeping the drill bed cool and removing drilled solids.

② It is also used as a soil adetive to hold soil water in drought prone soils, used in construction of earthen dams and to prevent the leakage of fluids.

③ It is also used as a component of foundary sand and as a dessicant to remove moisture from air and gas.

④ mont-morillanite are also used extensively in catallitic process.

⑤ The presence of sodium as a predominant exchangable cation can result in clay swelling to several times its original volume.

Hence Sodium mont morillonite is used as the major constituent in non-explosive agence for spliting rocks in natural stone quarries. In an effort to leaving the amount of waste or for the demolision of concrete structures where the use of explosive charges is unacceptable.

(6) The swelling property makes mont-morillonite containing bentonite useful as an annular seal or plug for water wells and as a protective liner for landfills.

(7) It is also used in medicine and pharmaco-logy and also pet food.

Compaction of Soils :-

Compaction of Soil may be defined as the process by which the soil particles are artificially rearranged and packed together in to a state of closer contact by mechanical means in order to decrease its porosity and here thereby increase its dry density.

Principle of compactions :-

compaction mainly involves ~~expansion~~ expulsion of air.

* moisture or water acts mainly as a lubricant within soil, sliding the soil particles together when the compaction is done.
* The highest density for most soils is ~~at~~ a certain water content for a given ~~compacting~~ compactive effort.
* The drier the soil more is its resistance to compactive effect.

Objectives of compaction :-

* To increase the shear strength and therefore its bearing capacity
* stability of slopes
* To reduce compressibility and subsequant settlements under working loads.
* To reduce soil permeability making it more difficult to water to flow through it.
* Compaction can prevent liquifaction during Earthquakes.

Factors affecting compaction :-

① water content
② Amount of compaction
③ method of compaction
④ Type of soil
⑤ Addition of admixtures

shear strength = 0 ← Liquifaction ↓ Liquid ↓ Soil acts as a liquid ↓ Soil flows

Effect of compaction :-

① Permeability
② Compressibility
③ Pore pressure
④ Shrinkage and Swelling
⑤ change in structure of soil
⑥ Shear strength

① Permeability :- compaction decreases permeability. In case of fine grain soils it has been found that for the same grain dry soil density soil compacted at wet side of optimum moisture content will be less permeable than that of compacted at dry side of optimum moisture content.

② Compressibility :- In case of soil samp initially saturated and having same void ratio, it has been found that in low pressure range a ~~wet~~ side compacted soil is more compressible than a dry side compacted soil.

③ Pore pressure :- In undrained shear test conducted on saturated samples of clay it has been found that lower pore pressure develop at low strains. when the sample is compacted dry side of optimum, compared to the case when the sample is compacted wet side of optimum but at high strains in both types of samples the development of pore pressure is same for same density and water content.

④ shrinkage and swelling :-
At same density a soil compacted dried of optimum shrinks appreciabily less than that compacted at wet of optimum also the soil compacted at dry of optimum exhibits greater swelling characteristics than samples of the same density compacted wet of optimum.

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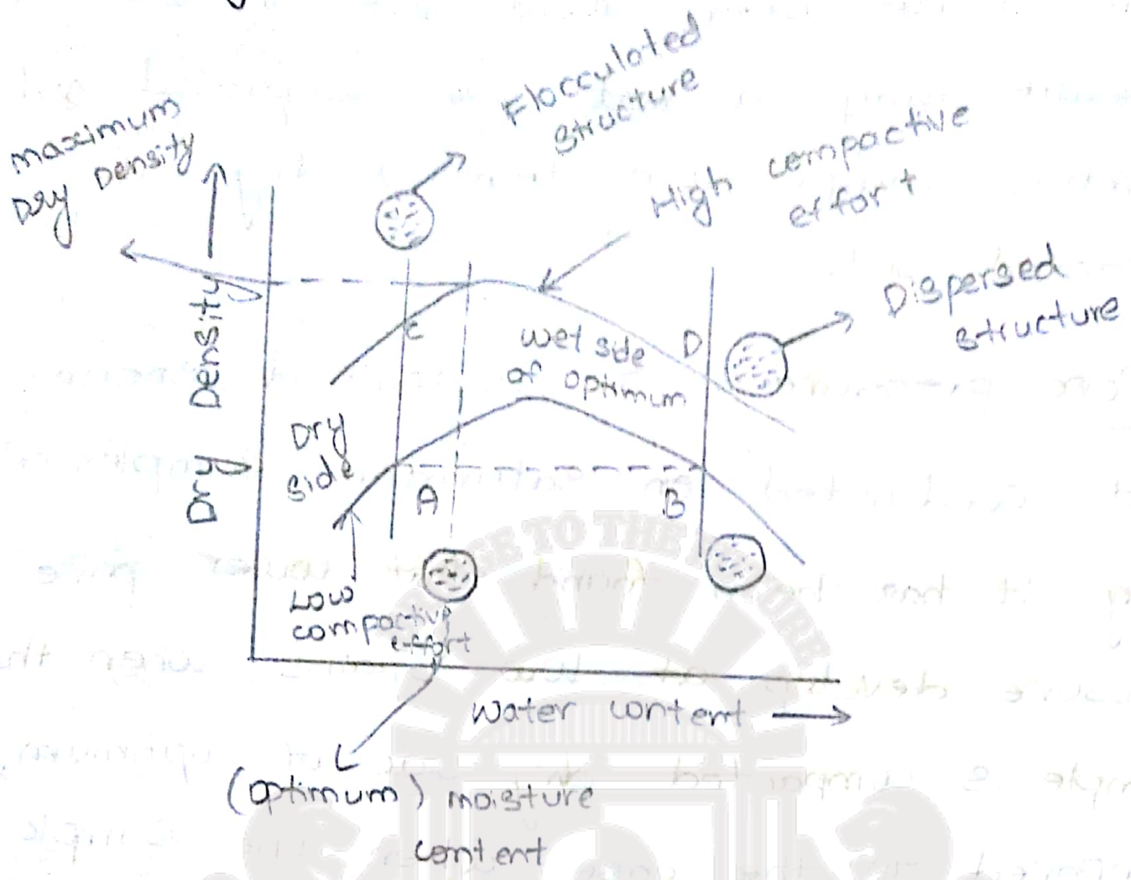
(5) change in structure of soil :-



(IS : 2720 (part - VII))

IMP

Standard Proctor Test (Standard compaction test)

It is the test to determine the dry density of given soil by compaction.

optimum moisture content :- It is the water content of soil at which the dry density of soil is maximum during compaction

Need and scope of the experiment :

It is quantitative test. proctor developed this test in 1933 in connection with the construction on an earth filled dam in california. If a soil is properly mixed with water and compacted there is a marked improvement in the engineering properties of soil such as increase in shear strength, density, decrease in permeability, seepage loss of water and settlement of dams etc.

Compaction means rapid reduction in voids by mechanical means and the consequent increase in dry density.

Compaction is different from consolidation. consolidation is gradual expulsion of water from the coarse of soil under continously acting static load over a period of time. * on the soil, resulting in increase in density.

Hence properly compacted soil is used as

1. Subgrade material for road, runway etc.
2. Fills in dams
3. Embankments

Equipments:

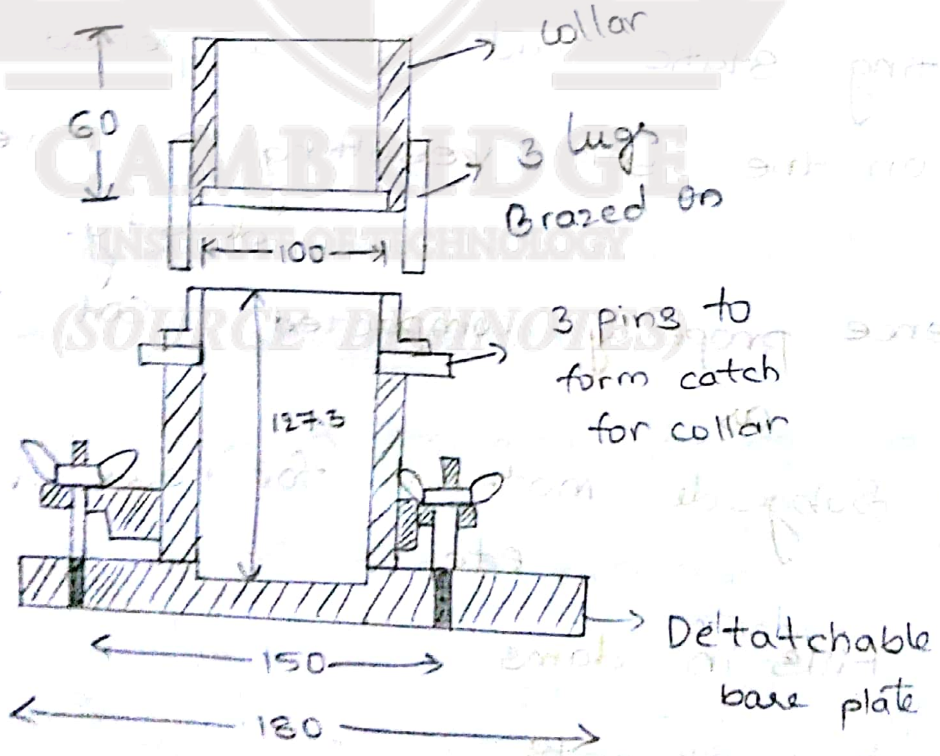
① A cylindrical metal mould of 10 cm of dia and 11.7 cm height with an internal volume of 1000 cc.

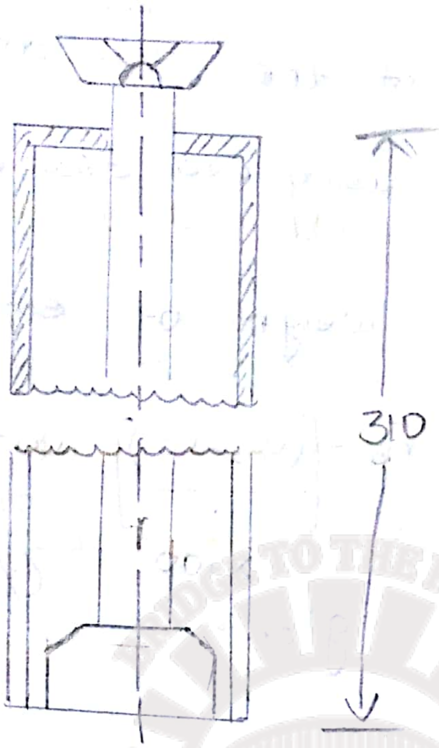
② A collar of 10 cm dia and 6 cm height

③ A base plate which can also be detached

④ A standard hammer or Rammer of height 2.6 kg. The hammer moves in an outer sleave. The height of fall is 300 mm

highest I.S Sieve of 20 mm Sieve.





Rammer of 2.6 kg weight

procedure :-

* Air dried soil sample passing through IS Sieve 20 mm size is taken
* It is then thoroughly mixed with small quantity of water in pan.
* weigh the empty mould w_1 and find its volume 'v'
* Fill the mould in three layers compacting each layer by 25 blows with a rammer make the layer surfaces rough by scratching with a tool after each layer of compaction.
* The total compacted depth of soil = 13 cm
* Then the soil is trimmed to top of the soil.

* weigh the mould with the soil i.e w_2

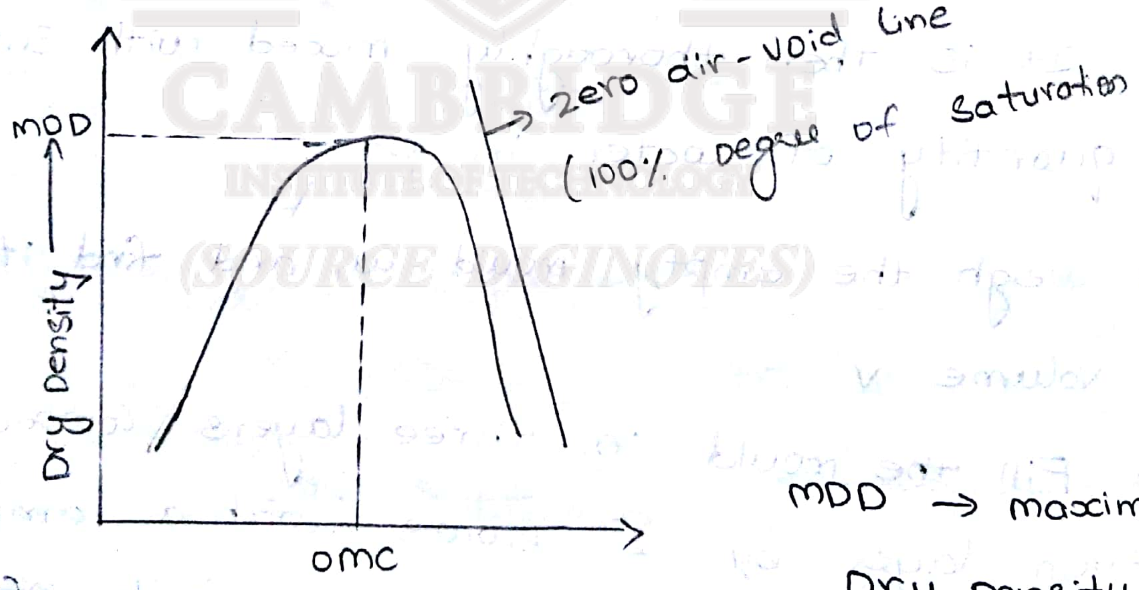
* Take a Sample of the soil and determine it's water content using oven drained method.

$V = 1000 \text{ cm}^3$, w_1 = weight of empty mould

SL NO	w_2 kg	$(w_2 - w_1)$ kg	$\gamma_b = \left[\frac{(w_2-w_1)}{V}\right] \times 100$ g/cm³	water content (%)	$\gamma_d = \gamma_b/(1+w)$ g/cm³
1					
2					
3					
4					

γ_d = Dry Density

γ_b = Bulk Density



MDD → maximum Dry Density

OMC → optimum moisture Content

COMPACTION CURVE

Zero air - void line (100% Degree of saturation)

It is the relation between moisture content and dry unit weight for saturated soils.

Note :- It is not possible to expel air completely by compaction. No matter how much compactive effort is used and in whatever manner.

modified proctor test [Heavy compaction]

It is according to IS : 2720 (part VIII) modified proctor test was developed to respresent heavier compaction than that in the standard proctor test. The test is used to simulate, the field conditions where
* heavy rollers are used. It is also known as modified AASHTO test.
[American Association of state highway officials]

* In the modified proctor test mould used is same as in standard proctor test. However the Rammer used is much heavier and as a greater fall height or greater drop

mould volume, $V = 1000\ cm^3$

weight of Rammer → 4.89 kg

Height of fall of Rammer → 450 mm

Compact soil in 5 layers

Number of blows is 25 blows.

The modified proctor test has 4.56 times more compative effect than Standard ~~com~~ proctor test.

FIELD COMPACTION METHODS

Three methods of compaction used in practise are rolling, Rammering and Vibrations.

* corresponding to these methods there are 3 categories of compaction equipments namely rollers, rammers and vibrators.

* In category of rollers we have essentially three types ① Smooth wheel Rollers

② Sheep foot roller

③ Pneumatic tyred Rollers

This type imparts compression to the soil

* There may be two or three large drums In 3 drums are used, two large ones in the rear and 1 in the front is the

common pattern.

* The compaction pressure are relatively low because of large contact area.

* These are most Suitable for compacting granular base forces and paving mixtures for highway and ~~airfree~~ airfield were rather than for compaction of earthfill.

* Smooth Surface is obtained and it acts as a seal and drains of rain water very well.

weight of roller is 80 KN to 100 KN Although the range may be as much as 10 KN to 200 KN.

* 300 N [30 kg] per lineal cm of ~~length~~ width of rear rolls may be the pressure.

* Number of passes Varies with the desired compaction, usually 8 passes is adequate to achieve the equivalent of Standard proctar compaction. This is a kneeding action compaction.

② Sheep foot rollers :-

Sheep foot rollers consists of a hallow drum with a large number of projections known as feet on its surface. This projections penetrate the soil layers during the rolling operations and cause compaction.

* The drums are moulted on a steel frame.

* The drum can be fulfilled with water or ballast to increase the mass.

* Sheep foot rollers are available both as a self propelled unit and towed unit.

* contact pressure is generally between 700 to 4200 KN/m^2

* The roller is sink in to the soil, if the contact pressure is more than the baring capacity of the soil.

* It is suited for cohesion soil compaction.

Light rollers – 15 cm

Heavy rollers – 30 cm of compaction
can achieve

when the roller is passed for the first time the projections penetrate the soil by compacting lower layers and gradually the upper layers are compacted in successive layer passes. Both damping and kneeding action is induced on the soil

③ Pneumatic tyred Rollers :-

* This type compacts primarily by kneeding action. They range in size from the smaller wobble wheel rollers to the very heavy rollers. A common form of pneumatic roller consists of a box or platform moulded bounded between two axles

* The rear which has one more wheel than the front, the wheel moulded on the front axles being arranged to tracks inbetween those moulded on a rear axles

* Smaller roller tyre pressure = 250 kN/m²
having roller pressure = 400 - 1050 KN/m²

* The pneumatic tyred rollers are loaded with kentledge such that when the tyres are inflated to their desired pressure, the some of the contant widths of the tyres approximately equals 80% of the width of the roller

* The wobble wheel robler has wheels mounted at slight angle with respect to the axle axle. So as to provide the kneeding

* The rollers are normally towed by either truck layering or a pneumatic tyred tractor.

~~Stability~~ Suitability of various compaction Equipments

* performance of a compaction equipments depends upon soil type, particle size distribution and water content.

* In general Smooth wheel rollers are most Suited for crushed rock, hard core, mechanically stable, gravel, Sands.

* They can also be used Satisfactorily or moderately cohesive soil.

* In cohesionless Sands and gravels vibrating types equipment, crawler tractors and rubbered type rollers are effective in producing densities upto about 100% of modified proctor test.

* Sheep foot rollers are recommended for compacting cohesive Soils, but are not considered effective on coarse grained cohesionless Soils.

* The kneeding action of sheep foot rollers results in a better bond between compacted layers compared to other types of rollers

* The action of pneumatic tyred rollere is a combination of pressure and kneeding and they are Suitable both on cohesionless soils and gravels and on Cohesion soils

* Rammers are used for compacting soils in confined placed.

* Vibratory rollers are helpful for cohesionless Soils.

PLACEMENT WATER CONTENT:

* The water content used in the fied compaction is called placement water content. which may be equal to lower or higher than OMC distrubuted in the water content optimum moisture content in laboratory.

* Cohesive subgrades under pavement should preferbly be compacted wet of optimum so that they may not exhibit large expansions and swelling pressure on Submergence

* Highway embankments on cohesive soils Should be compacted some what dry of optimum in order to achieve high strength and resistance to deformation and low Value of ...

* High earth dams should be compacted at a placement water content 1 to 2.5% less than the optimum to reduce the probability of the development of high core pressure.

* However the impervious worse should be desirably be compacted on wet side of optimum ~~to~~ order to achieve low permeability and greater safety against cracking due to differential settlements or other cause.

* For a given soil the laboratory omc and the field omc may differ depending upon the type of compaction equipment is used.

* U.S. Bureau of Reclamation has found that the BMC laboratory corresponding to the standard proctor test is approximately equal to the compaction achieved in field by 12 passes of the 20 tone dual drum sheep foot roller used by it on 15cm compacted lifts.

FIELD COMPACTION CONTROL

maximum density is the density of soil At optimum moisture content after compaction

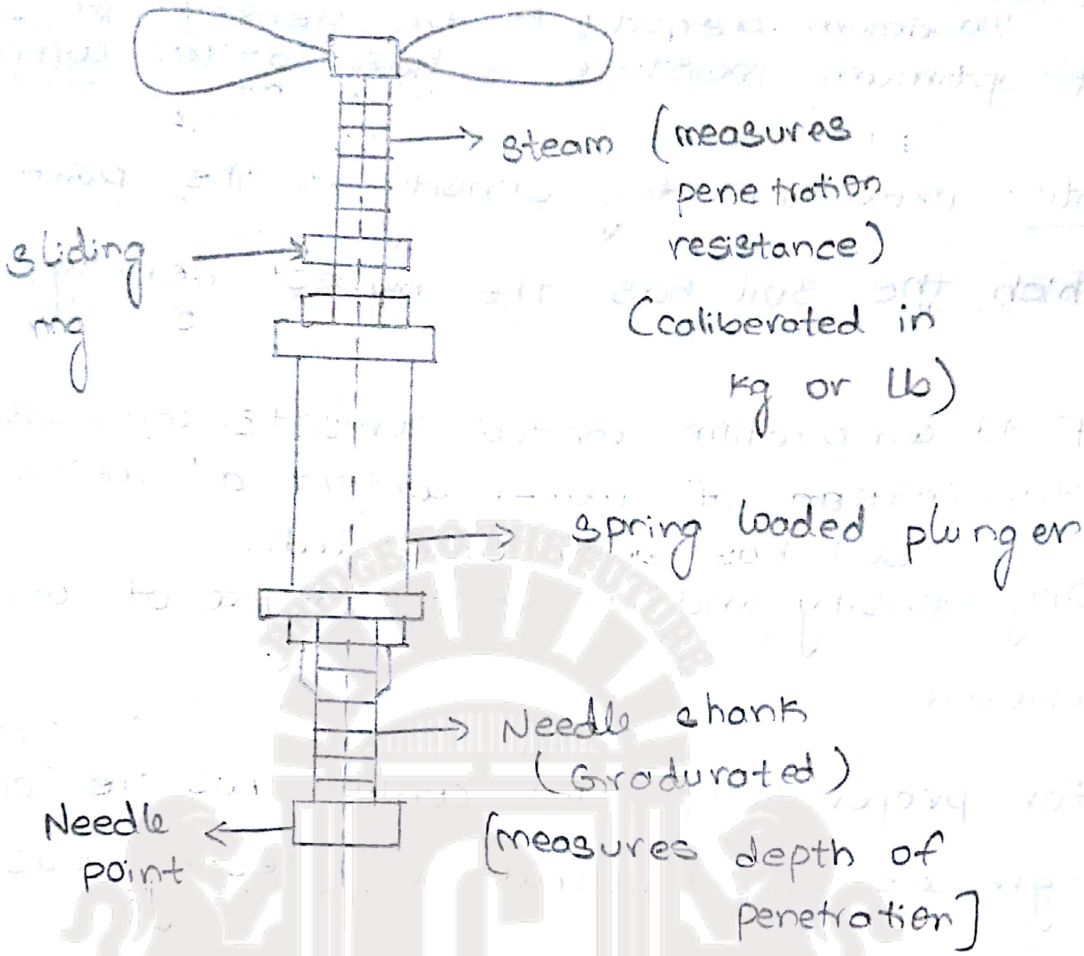
Note :- maximum dry density is the point at which the soil has the highest density.

* Field compaction control consists consists of determination of water content at which the soil has been compacted
* Dry density and hence the degree of compaction achieved
* For proper compaction control has the work progresses rapid methods of testing must be used.
* The rapid determination of water content can be done by two methods.
  (i) calcium carbide
  (ii) proctor needle method

proctor Needle method :-

proctor Needle method is commonly used in the field to know the field water content.

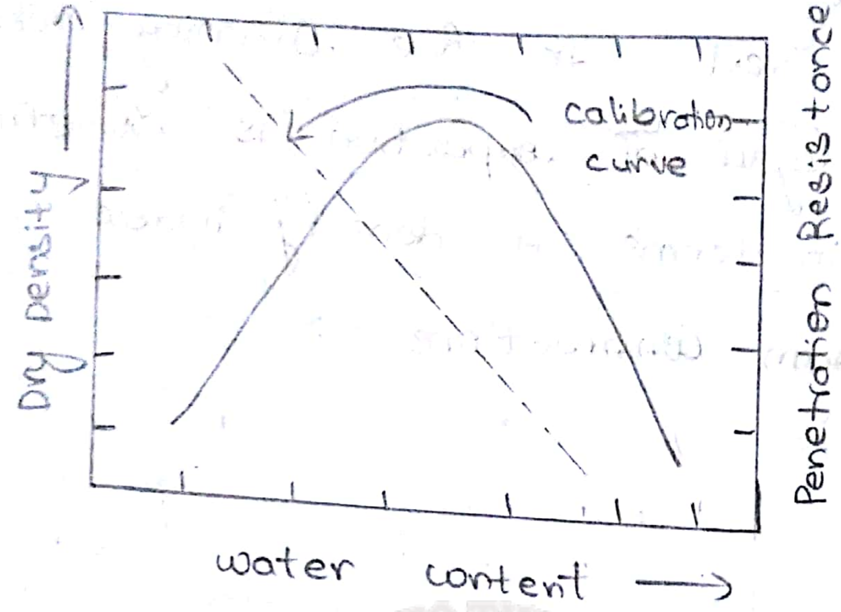
* proctor Needle consists of a needle point attached to graduated needle shank which in turn attach to a spring loaded plunger.



* The needle of varying cross sectional area are available so that a wide range of penetration resistance can be measured.

* The penetration force is read on a loaded guage fixed over the handle.

* To use the needle in the field, a caliberation curve is plotted in the laboratory within the penetration resistance ordinate (vertical or 'y' axis) and the water content as the abscissa [horizontal or 'x' axis]



* The laboratory penetration resistance is measured by inserting the proctor needle in the compacted soil in the proctor mould. The penetration resistances corresponding to various water contents are thus noted at the end of each proctor compaction and a caliberation curve is plotted.

* This curve may be used to determine the placement water content.

* The penetration resistance of the compacted soil field is determined with proctor's needle and it's water content is read off from the caliberation curve.

* The degree of compaction obtained in the field is measured by relative compaction or the percent compaction which is depends on the ratio expressed as a percentage of the field dry density to the maximum

dry density obtained in the laboratory compaction test. In free-draining cohesionless soils, the degree of compaction is sometimes expressed in terms of density index, particularly in earth dam constructions.