TRANSPORTATION GEOTECHNICS.

Pr Ahmad Ali Shah
MS CEM
ID / Roll No: 13573.

① Explain weathering & erosion

Erosion: Erosion is the geological process in which earthern material are worn away and Transported by natural forces such as wind or water.

Erosion is opposite of deposition. Most of the erosion is performed by liquid water, wind or ice.

Types of erosion

① Physical Erosion: Process of rock changing their physical properties without changing their basic chemical composition. Physical erosion often causes rocks to get smaller or smoother.

② Erosion by water: Liquid water is the major agent of erosion on earth. Rain, rivers, floods usually carry away the particles of the soil/rock and also sand resulting in the erosion.

③ Erosion by wind: Aeolian processes constantly Transport dust, sand and ash from one place to another which causes the erosion of the rock. In dry areas, windblown sand can hit the rock with extreme force which gradually wear away the rocks.

(4) Erosion by Ice: Glaciers can erode the earth and create great changes. when glaciers moves slowly down the earth it transports tiny grains to huge boulders along. Rocks which carried by glaciers erodes both the ground and the rocks. (2)

(5) Thermal erosion Warm temprature can cause ice to break down in huge chunks often carrying soil & vegetation with them.

(B) Weathering

Weathering can be defined as the physical and chemical decomposition of rock at or near the earths surface. It can also be said that natural breakdown disintegration of rocks into minor fragments, soils and sediments.

→ Types of weathering

① Physical weathering (Mechanical weathering.
② chemical weathering
③ Biological weathering

① Physical / Mechanical weathering: (contd) In this weathering their is no change in the chemical composition of rock. The primary process of physical weathering is abrasion. In this rock blocks are reduced in their size. Particles are transported by wind, glaciers, gravity or running water.

② chemical weathering: In this process decomposition of earth surface material occurs. It is done by chemical reactions. In this the reactions are exothermic and result in increase in volume hence disruption of rock occurs.

Mechanical weathering (contd)

1. Mechanical unloading → Process in which vertical expansion of rock chasms occurs. The resulting erosion reduces the load opening fractures.
2. Mechanical loading → ~~Impact~~ Results due to impact and abrasion of wind particles in deserts and affect of the intense rain drops.
3. Thermal Loading: Results due to freezing water and also due to high and low tempratures.
4. Crystallization: Formation of crystals in fissures and pores in solution.
5. Pneumatic Loading: These results due to waves effect on trapped air in cliffs.
6. Frost Action. (cryofracturing) In these the volume increases due to freezing process. Screes and Breccia deposits.
7. Frost heaving: ~~In areas~~ Result in areas which include permafrost. In this Ice lenses are formed at depth upto 30 mm. which results in heaving.
8. Insolation: In this process the outer layer of rocks split due to rise in temprature. The process ~~..~~ is known as exfoliation. Cracks also ~~also~~ forms salts and water cause decomposition and increases weathering.

Major processes in chemical weathering. (5) (7)

① Solution → It is the process of dissolving mineral by water or acid.

→ CO_2 (Soil) + water → H_2CO_3 (Carbonic Acid)

② Hydration → It involves two processes. hydration and hydrolysis. Hydration involves absorption of water. Absorption of water expands clays and hasten processes.

③ [crossed out] Carbonation: As rainwater falls through the atmosphere - the atmospheric carbon dioxide when dissolved in water forms carbonic acid. Carbonic acid plays vital role in chemical weathering.

④ living organisms: Lichens are grown on/under the rock. They produces acids that result in wheathing of rock chemically.

⑤ Oxidation; In this process the atmospheric oxygen combines with the metal of ions of minerals to form oxides.

⑥ Acid Rain Acid rain causes chemical weathering. Burning coal, oils and gas when burnt react with water in atmosphere result in chemical weathering.

Biological weathering Depends upon biotic and abiotic factors.

① Man & animals →

② Plants & Roots → The roots penetrates into the rocks results in mechanical breakup of rocks. Rock surface. is kept damp by plants which increase

~~③ Microorganisms~~ solvent action

③ Microorganisms; Bacteria in anaerobic minerals to establish spaces expansion of by product

(4.2) Q2 Shear Strength of Soil.

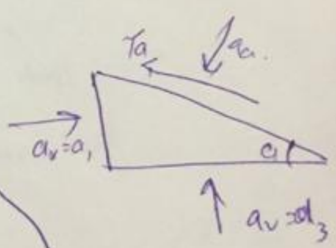
Shear is the internal resistance per unit area that the soil mass can offer to resist failure and sliding along any plane inside it.

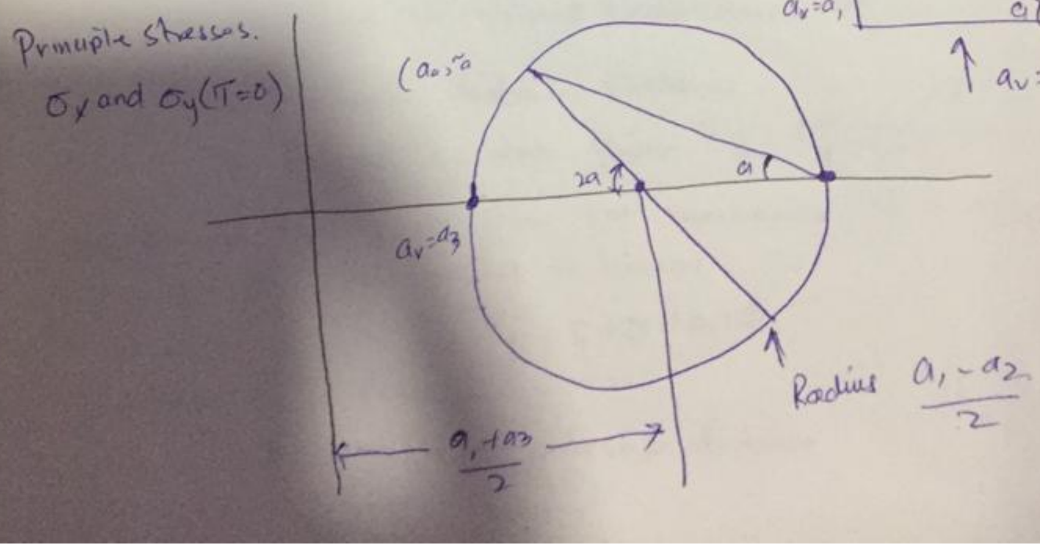
If load or stress in a foundation or earth slope is increased until deformation become unacceptably large it is called failure.

Gravity generates stresses in the ground at different points. Stress on a plane at a given plane is at a given pt is viewed in terms of 2 components

- Normal stress which tends to compress soil particles towards each other.
- Shear stress which tends to slide soil particles relative to each other.

Analysis of Stress using Mohr Circle





$$\sigma_a = \frac{\sigma_1 + \sigma_3}{2} + \frac{\sigma_1 - \sigma_3}{2} \cos 2a.$$

$$\tau_a = \frac{\sigma_1 - \sigma_3}{2} \sin 2a.$$

Any straight line drawn through the pole will intersect the mohr circle at a pt a which represent a state of stress on a plane inclined at the same orientation in space as the line.

- A material fails because of critical combination of normal stress and shear stress.

Functional relationship b/w normal stress and shear stress on a failure plane can be expressed

$$\tau_f = f(\sigma)$$

- Shear strength of soils can be determined from
  - direct shear & test
  - Ring shear Test
  - Triaxial compression test.
  - Unconfined compression test.

→ Mohr columb failure Criteria.

The failure envalope given by $\tau_f = f(\sigma)$ is a curved line. but for soil mechanics it is assumed that this relationship is linear

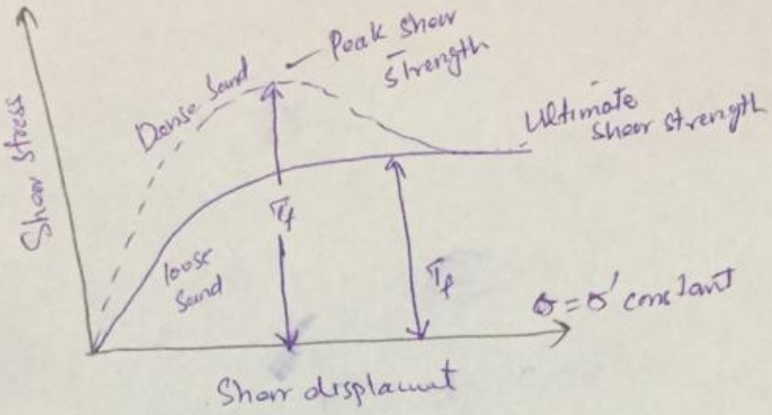
$$\tau_f = c + \sigma \tan\phi$$

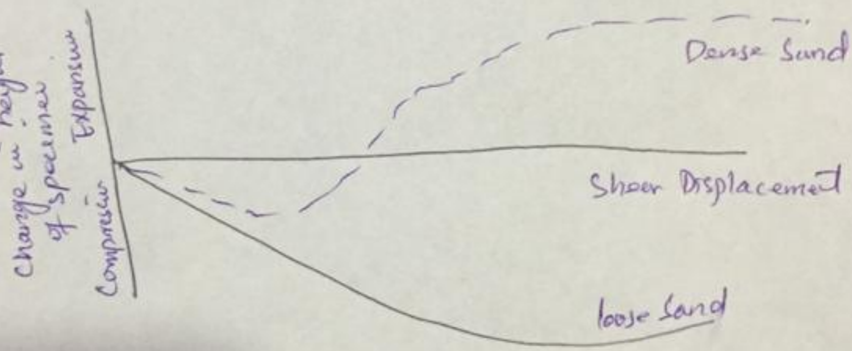
where c = cohesion

ϕ = angle of internal friction.

(7)

...fect of Strain on shear Strength in Soils.





Q3. a) What is meant by effective size D10

D10 → D stands for equivalent diameter of particles

→ 10 stands for percentage finer.

Thus, D10 is termed as effective particle size means only 10% particles are finer than that size and 90% are coarser.

Size of sieve (mm)	% Finer Total % passing through that size
4.75	100
2.00	95
1.00	60
0.425	40
0.150	30
0.075	10

D10 = 0.075

→ It can also be considered as permeability of soils, In which we can predict the soil movements and also Frost susceptibility.

Atterburg Limits & Consistency Indeces.

1. Liquid Limit
2. Plastic Limit
3. Shrinkage Limit
4. Plasticity Index.

① Liquid Limit

It is also known as upper plastic limit, it is the water content at which the soil changes from the liquid state to plastic state. It is minimum moisture content at which the soil flows upon application of very small shear force.

L.L can be determined using casagrande cup method or cone penetrometer.

② Plastic Limit: Also known as lower plastic Limit, is the water content at which soil changes from the plastic state to semisolid state.

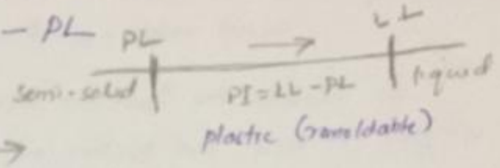
The plastic limit test is performed by repeated rolling of an ellipsoidal-sized soil mass by hand on non-porous surface. If thread crumbles smaller then 3mm its wet. If crumbles greater then 3mm the soil is drier.

③ Shrinkage Limit: It is defined as the water content at which the soil changes from semi-solid to solid state. At this moisture content the volume of soil mass ceases to change with further drying of material. The shrinkage limit is less frequently used then the liquid and plastic limit

...sticity Index.

Plasticity index is the difference b/w Liquid limit and plastic limit.

$$PI = LL - PL$$



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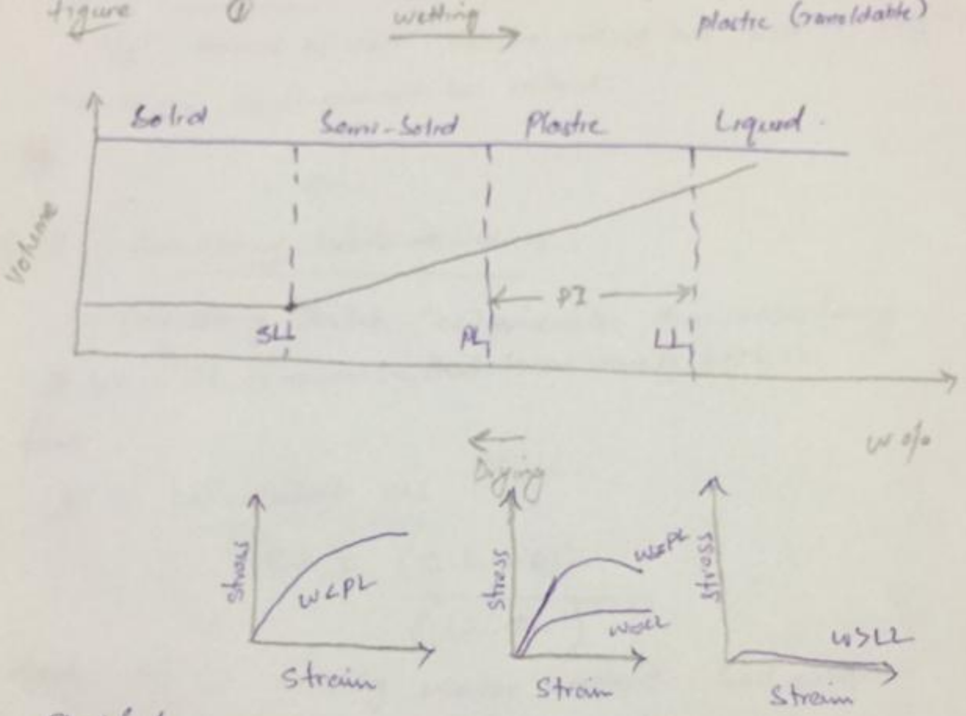

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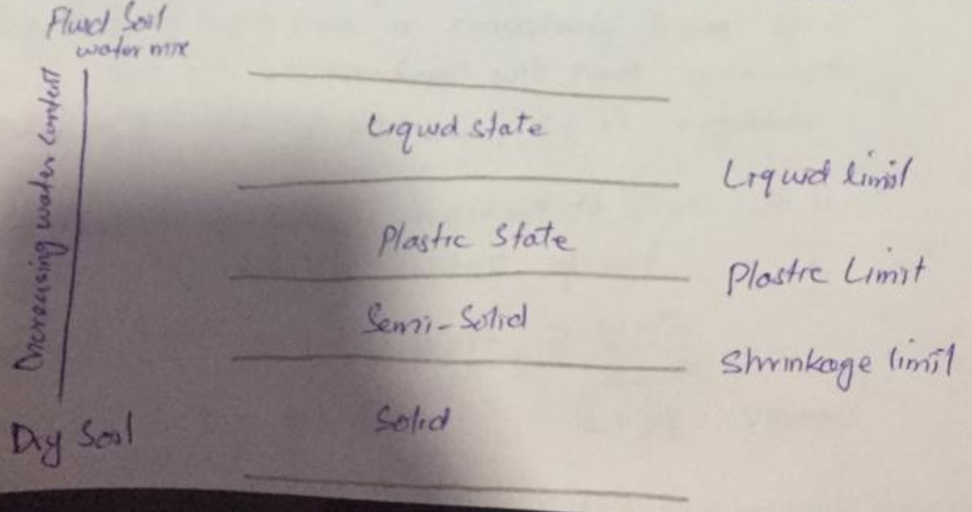


things on Basis of Lab.

(1) Liquid limit — the water content at which a groove cut in a soil paste will close upon 25 repeated drops of a brass cup with a rubber base.

(2) Plastic Limit — the water content at which a 1/8" thread of soil can be rolled out but it begins to crack and cannot be rolled.

(3) (c) Consistency ~~limits &~~ Indeces.

Consistency Index (CI) indicates the consistency of soil. It is meant that how much soil is firm.

It is calculated as.

$$CI = \frac{(L.L - W)}{(LL - PL)}$$

where W is existing water content. Soil with liquid limit will have a consistency Index of 0 while soil at plastic limit will have a consistency Index of 1 and if W > LL, CI is negative.

→ Property of soil is resistant to flow. It is affected by moisture content of soil

(4) Liquidity Index. $LI = \frac{W - PL}{PI} = \frac{W - PL}{LL - PL}$

LI < 0 (A) Brittle

0 < LI < 1 (B) plastic

LI > 1 viscous.

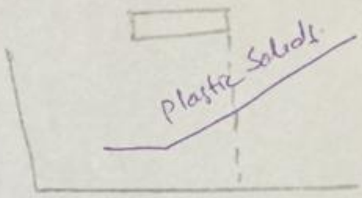
*astic.

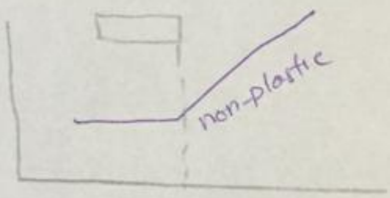
(12)

If PI of soil is 0 or non of the atterbergs test is performed, the soil is said to be non-plastic.

Plastic

If PI of soil is more than 1 and test is performed of atterbergs, the soil is said to be plastic.





Q4) (a) Soil Compaction (Compaction In Soils)

Compaction is the application of mechanical energy to a soil to re arrange the particles and reduce the void ratio.

Compaction is
- Increase in soil density
- decrease in air volume
- No change in water content
- Function of water content, dry density, soil type and compaction effort.

- Soil compaction is done to improve the bearing capacity of soil and reduce subsequent settlement under working loads.

Factors Affecting Compaction

1. Nature and type Soil
2. Water Content at time of compaction
3. Site condition eg weather type of site, layer thickness
4. Compaction Effort.

Most common lab Test for Soil compaction

- Standard Procter
- Modified Proctor.
- Field Density Test.

Finished

(b) Moisture Density relationship & its effect on Soil compaction of soils. (12)

(i)

Moisture content of soil is defined as the ratio of mass of water to the mass of solids present in soil sample

$$w = \frac{m \text{ of water}}{m \text{ of solid}} = \frac{m_w}{m_s}$$

Dry Density

Dry density of soil is defined as the ratio of mass of solids to the total volume of the soil.

$$\rho_d = \frac{\text{Mass of Solids.}}{\text{Total volume of Soil}} = \frac{m_s}{V}$$

To obtain the relationship of moisture content and dry density multiply the numerator and denominator expression of dry density with "M" which is mass of soil sample

$$\rho_d = \frac{m_s}{V} \times \frac{M}{M} = \frac{M}{V} * \frac{m_s}{M}$$

$$\rho_d = \frac{M/V}{\frac{m_s + m_w}{m_s}}$$

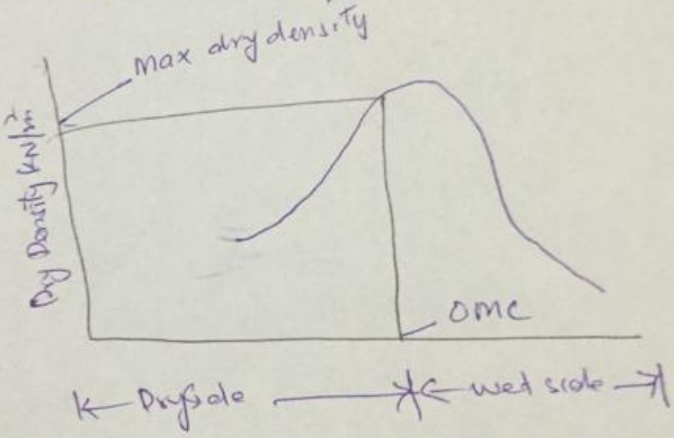
Therefore,

$$\rho_d = \frac{\rho}{1+w}$$

Hence to obtain dry density we need bulk density and moisture content of soil sample.

②⑮

..en we add water to soil water form
thin film round each soil particle and this
will help particles to contact with each other.
thereby the soil becomes denser under compaction.
At one point of time the volume of air in the
soil becomes minimum and dry density of soil
become maximum. This is called maximum
dry density. The moisture content corresponding
to the max dry density of soil is called
Optimum moisture content.



The results obtained are used to draw the
compaction curve as a result the amount of
compaction required will be known.

(5) Q Note on Geophysical Testing

Geo physical testing is carried out to develop a more complete understanding of sub-surface conditions at site. It supplements drilling and sampling with a variety of geophysical methods. These non-distructive test methods facilitate coverage of a much broader area that can be achieved by drilling alone.

Geophysical method indicate general boundaries of drastically dis-similar layers. Most commonly used geophysical methods are.

1. Seismic or Refraction Method
2. Resistivity Method.

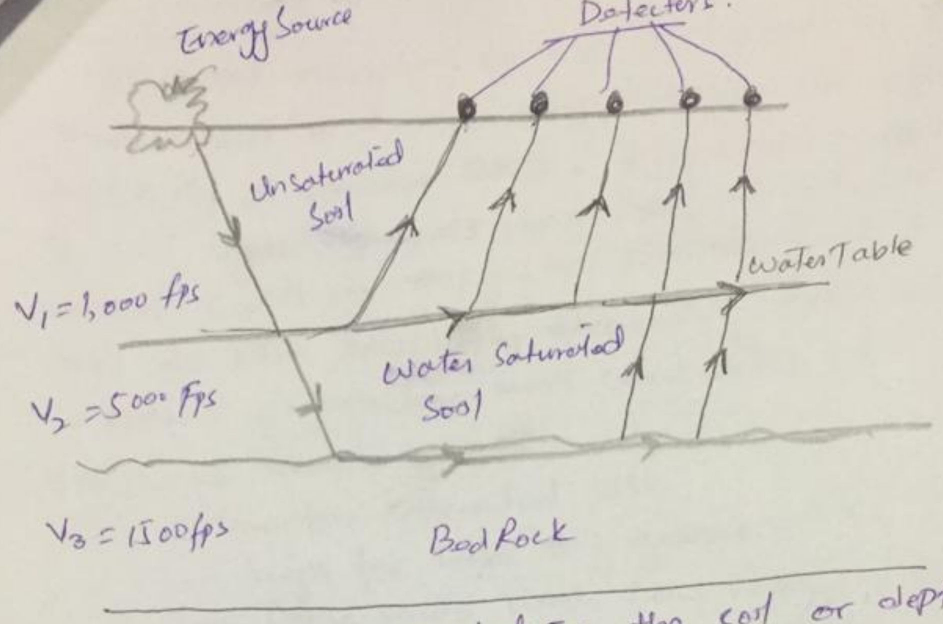
(1) Seismic or Refraction Method.

A shock wave propagates in an elastic medium with velocity $V = (M/\rho)^{1/2}$

M - Modulus ρ - mass density

wave velocity in Soils - 150 to 3000 m/s
Rocks - 1500 to 6000 m/s

→ Responses of a shock wave emenating from a source or pit are picked up by geophone at known distance.



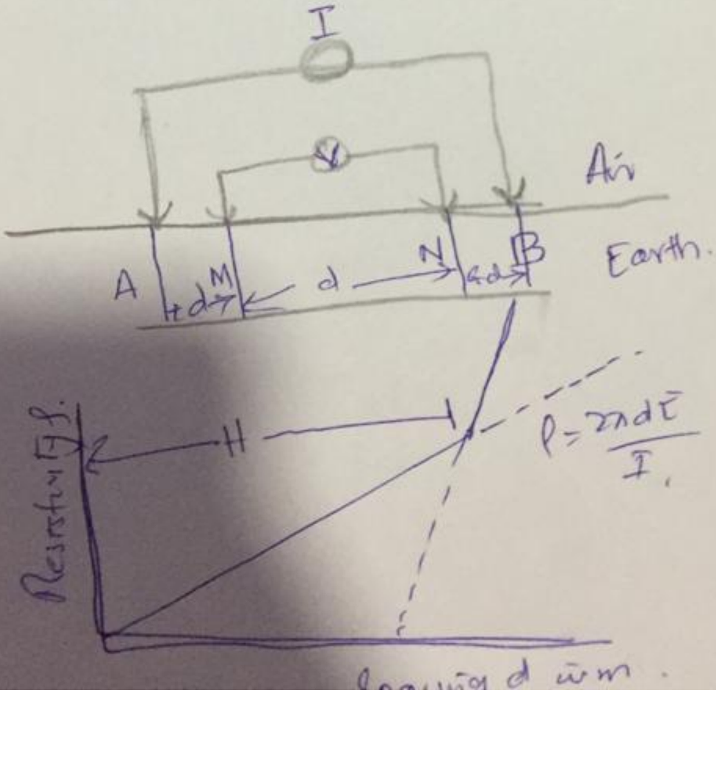
→ The depth of rock underlying the soil or depth of water table can be obtained, shock waves emenating from a dynamite charge forming a source travel through soil and are picked up at geophones at different distances

→ The wave velocity through the lock layer is many times greater than through soil layer so time of arrival by a longer route is shorter than that by the shorter route through top soil.

Resistivity Method. (18)

Electrical resistivity method is based on the measurement and recording changes in mean resistivity of various soils. Electrical conductivity of soil layer depends upon the concentration of ionized salts in the soil pores. Each soil has its own resistivity depending upon water content, compaction and composition.

Electrical resistivity is
- low for saturated silt.
- high for loose dry gravel
- Dense rocks with few voids and little WC has high resistivity.
- Soft saturated clays and organic deposits have low resistivity.



$$\rho = \frac{2 \times 3.14\, dE}{I}$$ (9)

where

ρ = mean resistivity

D = distance b/w electrodes.

E = potential drop b/w outer electrodes

I = current flowing b/w outer electrodes.

R = Resistance.