Geotechnical Engineering.

* Soil is defined as the uncemented aggregate of mineral grains and decayed organic matter (solid particles) with liquid and gas in the empty spaces between the solid particles.

* Soil mechanics is the branch of science that deals with the study of the physical properties of soil and the behaviour of soil masses subjected to various types of forces.

* Soil Engineering is the application of the principles of soil mechanics to practical problems.

* Geotechnical Engineering is the subdiscipline of Civil Engineering that involves natural materials found close to the surface of the earth. It includes the application of the principles of soil mechanics and rock mechanics to the design of foundations, retaining structures and earth structures.

Rock cycle and origin of soil: →

* Soils are formed by weathering of rocks and decomposition of organic matter.

* The physical properties of soil are by the minerals that constitute the soil particles and the rock from which it is derived.

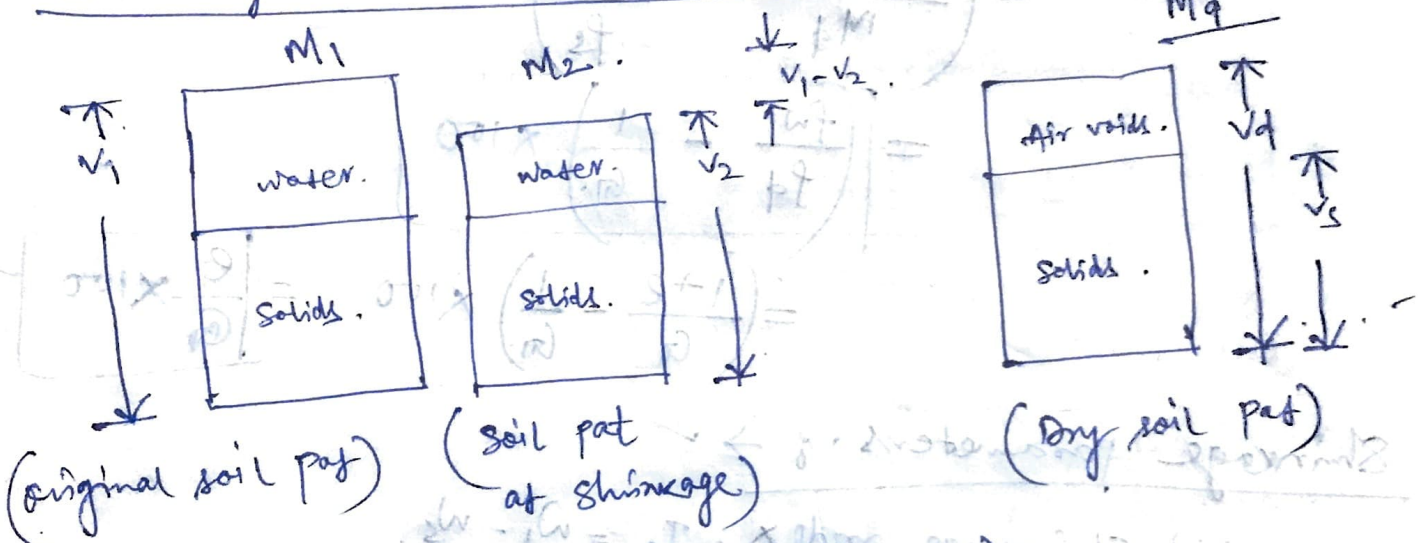
Plastic limit determination :-

* Take soil specimen passing through 425 μ sieve, mixed thoroughly with distilled water.
* A ball is formed with about 8 gm of this plastic soil & rolled into a thread of dia 3mm, if the thread just start to crumble, the water content corresponding to this condition is known as plastic limit.

Toughness index (I_T) = $I_T = \frac{I_p}{I_f}$

* It is a measure of the shearing strength of the soil, at the plastic limit.

Shrinkage limit determination :→



$$w_s = \frac{(M_1 - M_d) - (V_1 - V_2)\rho_w}{M_d} \times 100$$

$$= \left[\frac{M_1 - M_d}{M_d} - \frac{(V_1 - V_2)\rho_w}{M_d}\right] \times 100$$

$$= \left[w_1 - \frac{(V_1 - V_d)\rho_w}{M_d}\right] \times 100$$

Module - II

Models of occurrence of water in soil :→

Soil water is broadly classified into, two categories

(1) Free water.
(2) Held water.

Free water, moves in the pores of the soil, under the influence of gravity.

Held water is retained in the pores of the soil, and it can not move under the influence of gravitational force. Held water is further divided into, '3' types.

(i) Structural water.
(ii) Adsorbed water.
(iii) Capillary water.

(i) Structural water. :→ It is chemically combined water in the crystal structure of the mineral of the soil. The water can not be removed, without breaking the structure of the mineral. A temp^r of more than 300°C is required, for removing the structural water. Structural water is considered as an integral part of the soil solid.

(ii) Adsorbed water :→ Due to net negative (-ve) charge on the surface, the clay particles attract cations (such as potassium, calcium and sodium) from the moisture present in the soil, to reach an electically balanced equilibrium.

Hence it is believed that there is thin, very tight held layer of water, about 10 Å is present around the particle. Beyond this thickness, a second layer in which water is more mobile. This second layer extends to the limit of attraction. and is known as. diffuse layer.

Both the layers combines is called, diffuse double layer.

Module - III

Soil Compaction: →

It is compression of soil mass by mechanical means to improve Engineering properties. It is due to escape and compression of air present in the soil mass. Volume reduction occurs due to escape of air under short term loading under constant water content.

→ Due to compaction, permeability, void ratio, compressibility decreases and shear strength increases.

→ Compaction tests are done to determine (i) amount of compaction (ii) the optimum moisture content (OMC) & MDD.

→ Indian standard light compaction Test (similar to standard proctor Test)

(i) Test results used for highways, embankments, canal banks.

(ii) Mould volume is 1 litre, soil in 3 layers. Each layer is given, 25 hammer blows. 593.01 kJ/m³

(iii) Hammer weight 2.6 kg and height of fall 31 cm.

→ Indian standard, Heavy compaction Test (similar to modified proctor Test):

(i) Results used for modern express highways and Runways. 2703.88 kJ/m³

(ii) Mould capacity 1 litre, soil in 5 layers, each layer 25 hammer blows.

(iii) Hammer weight 4.9 kg and height of fall 45 cm.

→ The compactive effort in the modified proctor test is about 4.56 times, than that in the standard proctor test.

→ If % soil retained on 4.75 mm IS sieve is > 20%, large mould of capacity 2.25 litres is recommended. In such case no. of blows per each layer shall be 56 for both SPT, MPT.

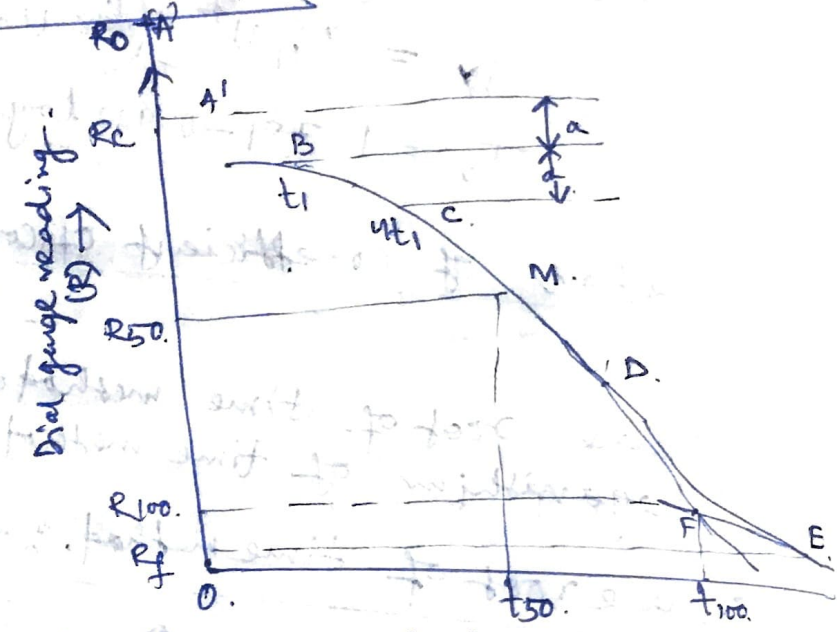
where, $d = \frac{1}{2}\left(\frac{H_i + H_f}{2}\right)$ Double Drainage

$d = \left(\frac{H_i + H_f}{2}\right)$ · Single Drainage.

where, H_i = Initial thickness.

H_f = Final thickness.

(2) Logarithm of time method :→



curve consists of,

(i) An initial portion, parabolic in shape.

(ii) A middle portion which is almost linear.

(iii) last portion of curve.

Rc → corrected dial gauge reading corresponding to zero primary consolidation.

F → % correspond to, 100% consolidation, Obtained from, intersection of two linear parts.

Rc − R100 → Range of primary consolidation.

$R_c - R_{50} = \frac{1}{2}(R_c - R_{100})$

for, U = 50%, Tv = 0.196.

$C_v = \frac{0.196 d^2}{t_{50}} = \frac{T_v d^2}{t}$

Final Settlement of a soil deposit in the field :→

Settlement of soil deposit consist of two parts

(i) Computation of magnitude of, final settlement.

(ii) Determination of, time rate of settlement.

* For final settlement, co-efficient of volume change or compression index is required.

* For time rate of, computation co-efficient of consolidation is required.