Importance of soil mechanics in Civil Engineering Projects:

In soil mechanics, we study various properties of soil to be used for various Engineering construction works. The engineer must study this branch of engineer to know many things about Design and Construction of Projects.

i) Foundation:
All civil engineering Projects or structure rest on soil. They transfer the whole load to the soil. So we have to construct the foundation to retain there structures. In case of hard soil/having sufficient strength, we provide shallow foundation. On the basis of strength of soil, we can decide the choice of foundation. If the strength of soil is weak, then we provide deep foundation/Pile foundation.

2) Earthen Dams: There are so many earthen dams constructed to retain the water. The soil should be used in this case are suitable enough to use it in construction. Various Properties of soil such as permeability, strength, and density are checked on regular basis to know if the soil compacted to required density or not. The earthen dams are costly structure and have high risk of failure, so they must be design with great care.

3) Embankment: The embankment constructed to raise the level of highway on the plains because there are chances of floods etc and also it is required to keep the foundation of the pavement above water table. The embankment are generally constructed of soil which is tested for its various purposes.

4) Canal or other retaining and under ground structures:- The canals are also formed by the soil which are to be constructed to be impermeable and enough strength. The retaining walls are constructed to the retain the soil/earth. The properties like earth pressure, shear strength etc give us the idea of to disign the retaining structures.

Capillary Action: The ability of liquid to flow in narrow spaces without the assistance of, or even in opposition to, external forces like gravity.

Capillary Water in Soils:-

Water held in the voids of soil due to capillary forces is called Capillary of water in soil.

The voids in soil may act like a narrow tube & thus the water rise above the ground water table due to surface tension.

Water Table:

While considering the movement of water in soil, it is easy to measure all pressures reference to atm. pressure which is taken as zero.

Thus water table is defined as an imaginary surface within the soil joining the points at which the pore water pressure is zero.

Most soils are ~~par~~ practically saturated below the water table & above the water table, they maybe partially saturated or dry.

The depth of water table below ground surface varies with the soil type, tropography & the climate.

There may also be seasonal variation as a result of the changing balance b/w rainfall & evaporation, at diff. times of year.

When rainfall exceeds evaporation then water table may come close to the surface in the soil of low permeability.

Soil Suction:-

It is the negative pressure in soil due to which water may rise above the ground water table. Soil suction is of two types:

1- Capillary / Matrix Suction
2- Osmatic / Solute Suction

Stress = F/A experienced by material ⇒ Internal force exp by a material
P = F/A external quantity
Stress is generated internally when external force acting on a body
It is internal resistance

Normal Vertical Stress in Soils:-

1- Total Stress σ:

Total stress at any point in a soil is equal to the wt. of overlaying soil for the x-section area of soil at that point.

Mathematically,

pressure is exerted on solids liquids and gases

$$\sigma = \gamma h \quad \text{for homogeneous soil}$$

where

γ = bulk unit wt. if soil is partially saturated

$\gamma = \gamma_d$ if soil is dry

$\gamma = \gamma_{sat}$ if soil is saturated

stress is exerted on solids.

h_1	γ_1
h_2	γ_2
h_3	γ_3

$$\sigma = \gamma_1 h_1 + \gamma_2 h_2 + \gamma_3 h_3$$

for layered soil

Total pressure consists of two parts:

a- Intergranular / Effective Stress σ':

The part of the total stress that is carried by soil grains at their points of contact.

In other words it is grain to grain contact pressure.

Mathematically,

$$\sigma' = \gamma' h \quad \text{for submerged soil}$$

It is called effective stress because it is effective in decreasing voids ratio.

Flexural strength. It is also known as bend strength is a material property. The highest stress experienced within material at its moment of yield b- Pore Water / Neutral Pressure μ:

It is a pressure transmitted by water in the voids of the soil.

Mathematically, it is equal to unit wt. of water × piezometric height of water.

$$\mu = \gamma_w h_w$$

Total Stress

$$\sigma = \sigma' + \mu$$

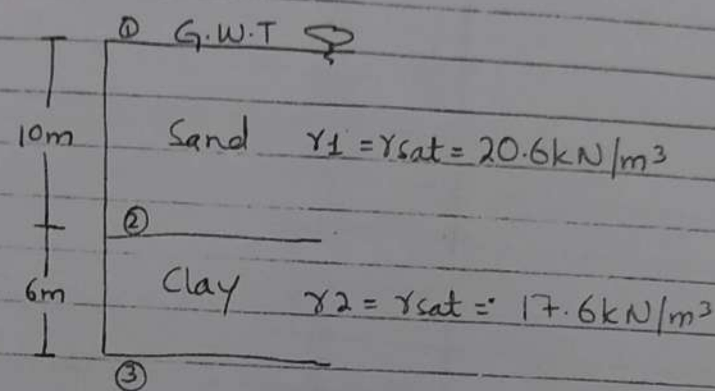
$\mu = 0$ if soil is dry

$$\sigma = \sigma'$$

Example:

A 10m thick weight of sand is underlay by a layer of clay of 6m thickness. Draw total stress, pore water pressure & effective stress variation with depth of water.

If water table is at ground surface. Also find effective stress at the middle of clay layer.



At Point ①

$\mu = 0$

$\sigma' = \gamma h = \gamma(0) = 0$

$\sigma = 0$

At Point ②

$\mu = \gamma_w h_w = 9.81 \times 10 = 98.1 kN/m^2$

$\sigma = \gamma_1 h_1 = 20.6 \times 10 = 206 kN/m^2$

Total $\sigma = \sigma' + \mu =$ ~~98.1 + 206 = 304.1 kN/m²~~

$\sigma' = \sigma - \mu = 206 - 98.1 = 107.9 kN/m^2$

$107.9 + 98.1 = 206.1 kN/m^2$

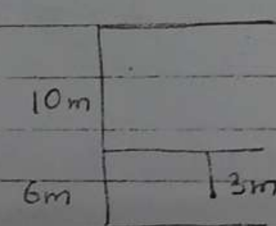
At Point ③

$\mu = \gamma_w h_w = 9.81 \times 16 = 156.98 kN/m^2$

$\sigma = \gamma_1 h_1 + \gamma_2 h_2 = 206 + 17.6 \times 6 = 311.6 kN/m^2$

$$\sigma' = \sigma - u = 311.6 - 156.96 = 154.64\ kN/m^2$$

At Middle of Clay Layer



$$u = 9.81 \times 13 = 127.53\ kN/m^2$$

$$\sigma = \gamma_1 h_1 + \gamma_2 \frac{h_2}{2}$$

$$= 20.6 \times 10 + 17.6 \times \frac{6}{2} = 258.8\ kN/m^2$$

$$\sigma' = \sigma - u = 258.8 - 127.53 = 131.27\ kN/m^2$$