SNS COLLEGE OF TECHNOLOGY

An Autonomous Institution
Coimbatore – 35

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Approved by AICTE , New Delhi and Affiliated to Anna University , Chennai.

DEPARTMENT OF AGRICULTURAL ENGINEERING

19AGB303 – IRRIGATION AND DRAINAGE ENGINEERING

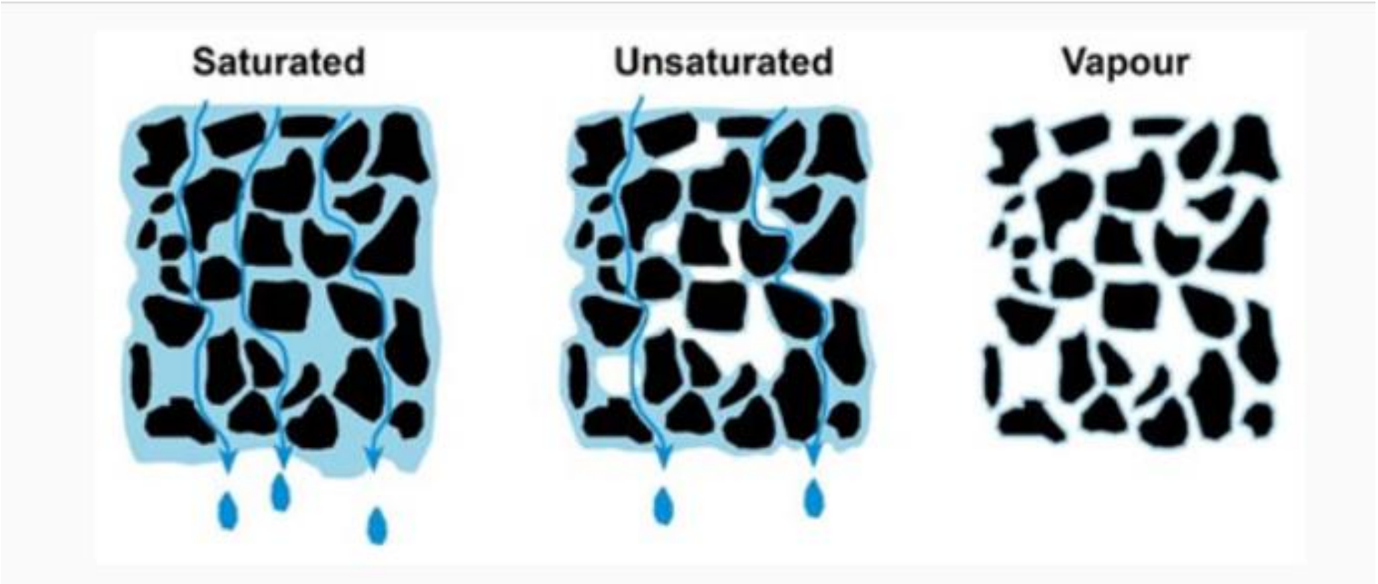
III – YEAR VI SEMESTER

UNIT 1 – SOIL WATER TENSION AND MEASUREMENT OF SOIL WATER

TOPIC 5– MOVEMENT OF WATER IN SOILS

Soil Water Movement

- Movement of water within the soil is a highly complex phenomenon due to the variation in the states and directions in which water moves and the variation in the forces that cause it to move.
- Generally three types of water movement within the soil are recognized –
  - Saturated flow,
  - Unsaturated flow
  - Water vapour flow



Soil Water Movement in Saturated Condition

- Under saturated conditions of soil, all the macro and micro pores are filled with water, and any water flow under this condition is referred to as saturated flow.
- The saturated flow of water depends upon two factors namely hydraulic gradient i.e., the hydraulic force driving the water through the soil and hydraulic conductivity i.e., the ease with which the soil pores permit water movement.
- Assuming the soil to be a bundle of straight and smooth tubes, knowledge of the size distribution of the tube radii could enable us to calculate the total flow through a bundle caused by known pressure difference, using Poiseuille's equation:

$$q = \frac{P\pi r^4}{8l\mu}$$

The above equation indicates that the pore size is of outstanding significance, as its fourth power is proportional to the rate of saturated flow. Generally the rate of flow follows:

Sand > Loam > Clay

Unfortunately, soil pores are not like straight tubes, but are of varying shapes and sizes, highly irregular and interconnected. This complexity in shape causes change in fluid velocity from point to point, even along the passage. For this reason, flow through complex porous media is generally described in terms of macroscopic flow velocity vector, which is the overall average of the microscopic velocities over a total volume of soil. The quantity of water flowing through a section of saturated soil per unit of time is given by the Darcy's law.

Unsaturated Water Movement

- As gravity drainage continues the soil macrospores emptied and are mostly filled up with air and the micro pores or capillary pores with water and some air.
- Movement of water occurring under this condition is termed as the unsaturated flow condition. In the case of unsaturated flow condition, the water potential is the sum of metric potential (ψm) and gravitational potential (ψg) .
- Metric potential is only applicable in the case of horizontal movement of water. In the case of downward movement of water, capillary and gravitational potential act together.
- In the case of upward capillary movement of water, metric potential and gravitational potential oppose one another.

Double Ring Infiltrometer

- For unsaturated flow condition of water through soil
- Darcy's law can be applied in the case of unsaturated flow conditions with some modifications. Unsaturated, 1-D horizontal flow is given by

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial x}\left[K(\theta)\frac{\partial \Psi}{\partial x}\right]$$

- Unsaturated, 1-D vertical flow is given by

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial z}\left[D(\theta)\frac{\partial \theta}{\partial z}\right] + \frac{\partial K(\theta)}{\partial z}$$

Reference Videos

https://www.youtube.com/watch?v=sL3AfZ37Kf4

See You at Next Class!!!!