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

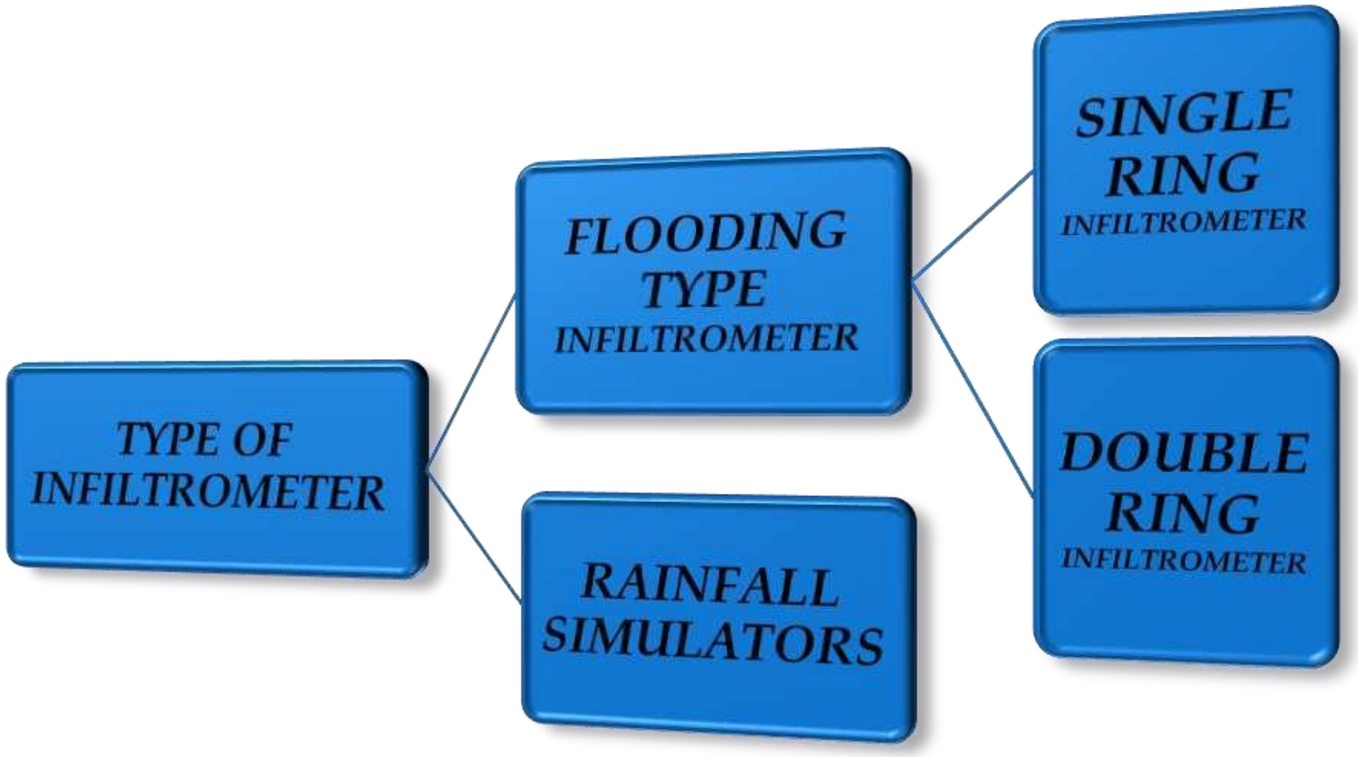
III – YEAR VI SEMESTER

UNIT 1 – SOIL WATER TENSION AND MEASUREMENT OF SOIL WATER

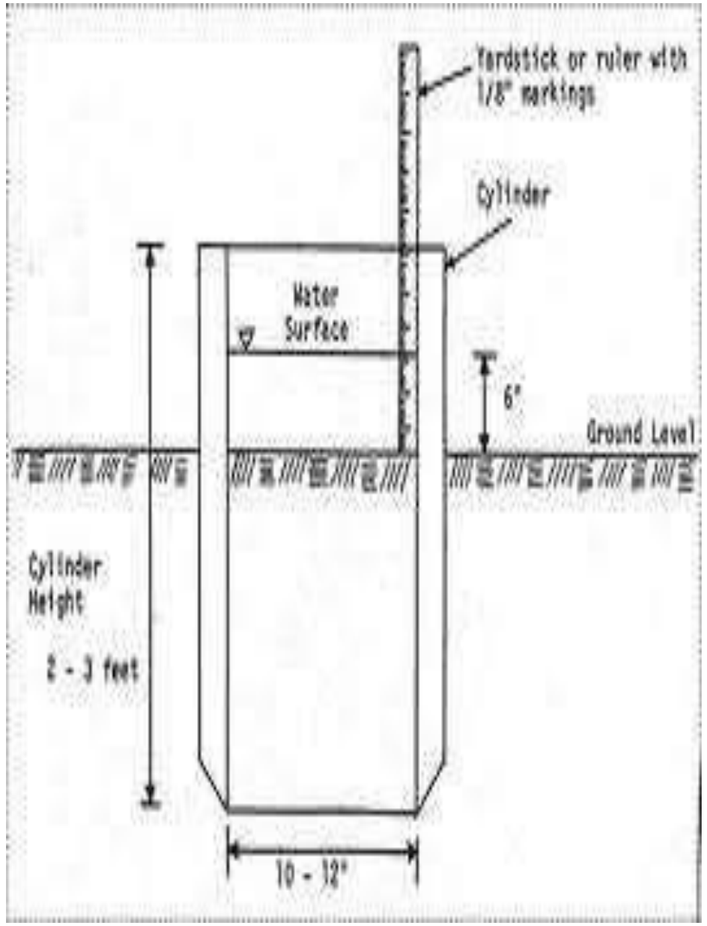
TOPIC 4 – MEASUREMENT OF INFILTRATION –PERMEABILITY-DETERMINATION

MEASUREMENT OF INFILTRATION

- **Infiltrometer** is a device used to measure the rate of water infiltration into soil.

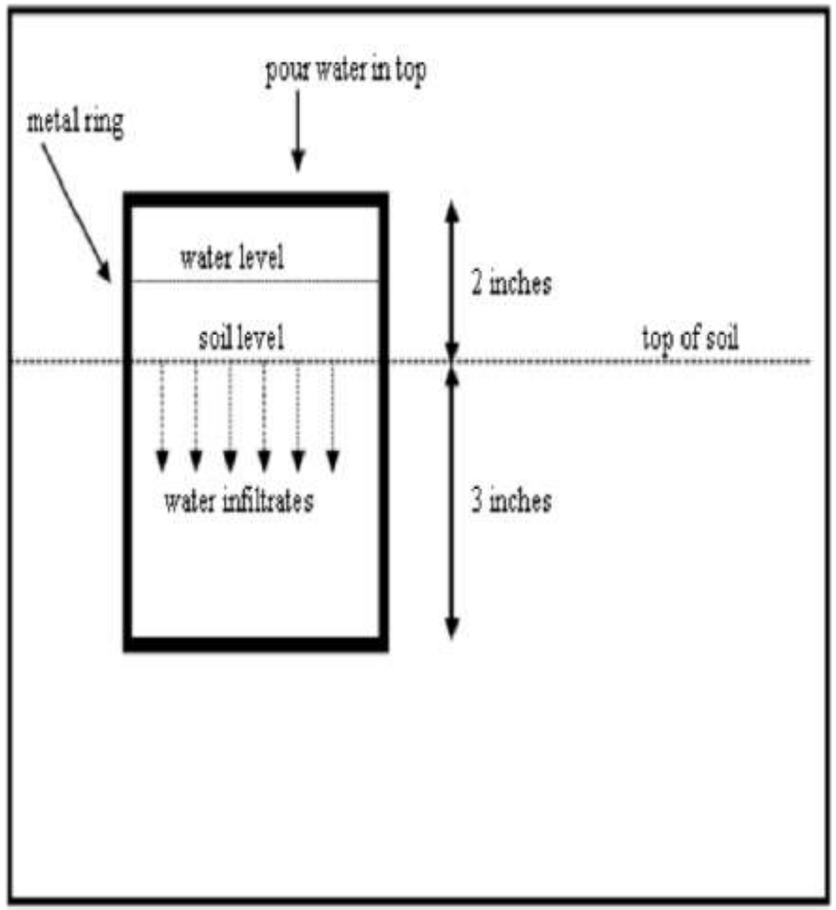


Single Ring Infiltrometer



- This consists of a metal cylinder of diameter 25 cm to 30 cm and length of 50 cm to 60 cm, with both ends open. length of cylinder= (2 x diameter)
- It is driven into a level ground such that about 10 cm of cylinder is above the ground.
- Water is poured into the top part to a depth of **5 cm** & pointer is set inside the ring to indicate the water level to be maintained.
- The single ring involves driving a ring into the soil and supplying water in the ring either at constant head or falling head condition.
- Constant head refers to a condition where the amount of water in the ring is always held constant means the rate of water supplied corresponds to the infiltration capacity.
- Falling head refers to a condition where water is supplied in the ring, which is allowed to drop with time. The operator records how much water goes into the soil for a given time period.

Disadvantages of single ring infiltrometer

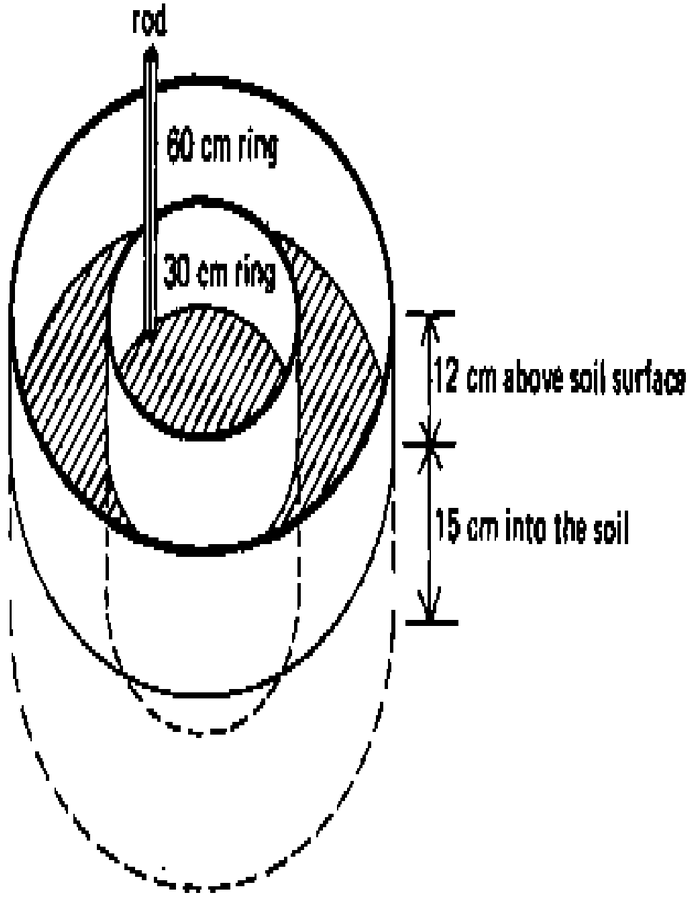


- The major drawback of the **single-ring** infiltrometer or **tube infiltrometer** is that the infiltrated water percolates laterally at the bottom of the ring.
- Thus the tube is not truly representing the area through which infiltration is taking place.

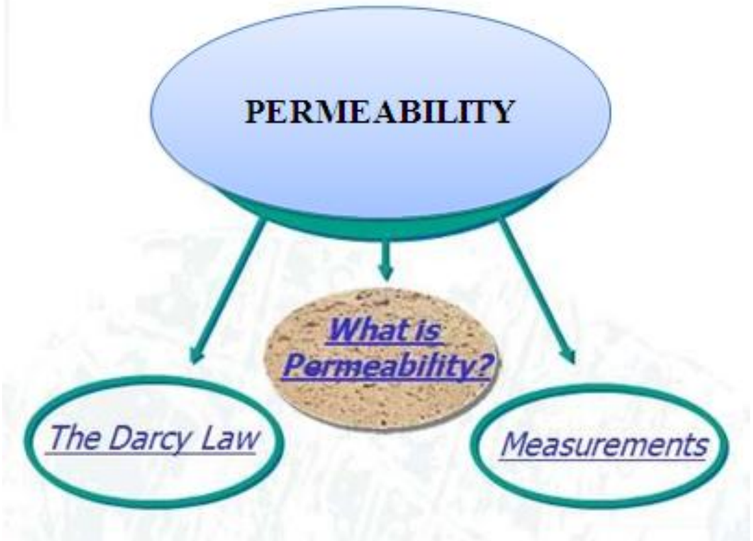
Double Ring Infiltrometer

- This is the most commonly used flooding type infiltrometer.
- It consists of two concentric rings driven into soil uniformly without disturbing the soil to the least to a depth of 15 cm. The diameter of rings may vary between 25 cm to 60 cm.
- An inner ring is driven into the ground, and a second bigger ring is around that to help control the flow of water through the first ring. Water is supplied either with a constant or falling head condition, and the operator records how much water infiltrates from the inner ring into the soil over a given time period.

Double Ring Infiltrometer

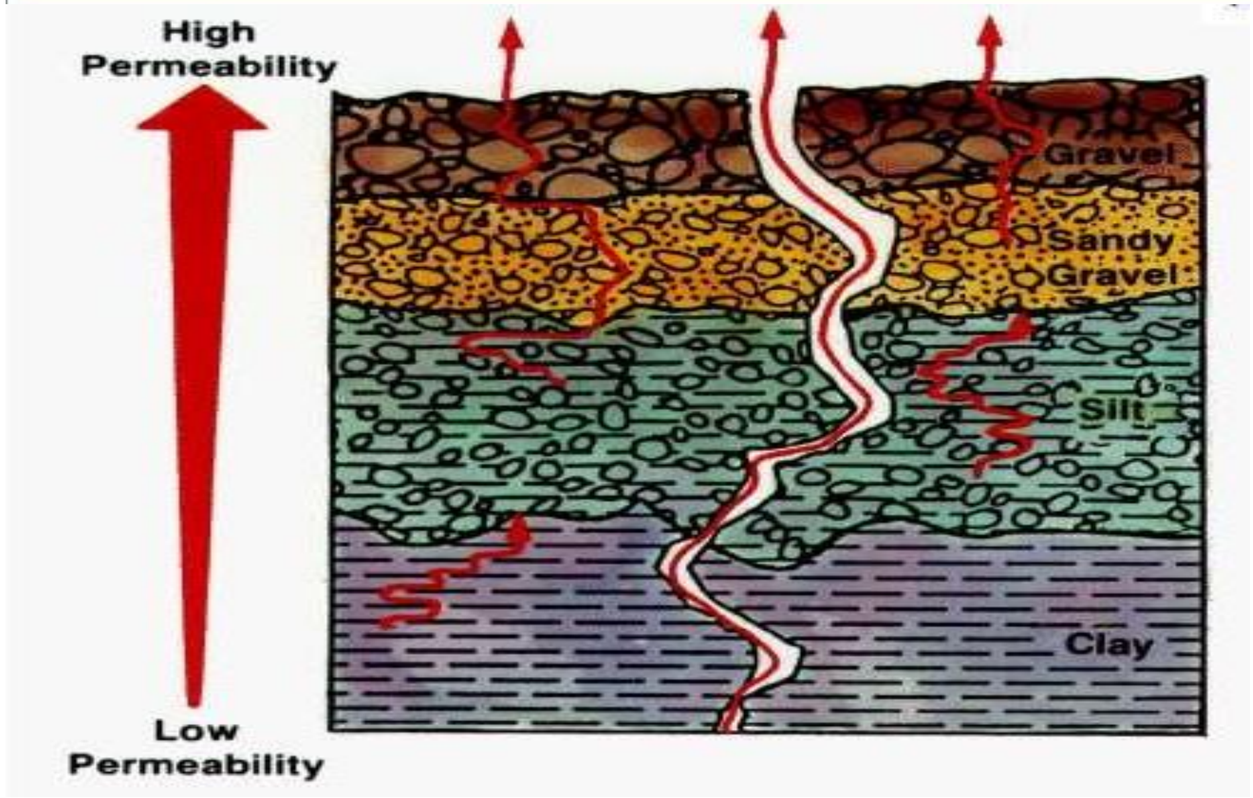


Permeability



- Property of a soil which permits the flow of water
- Permeability is defined as the property of a porous material that permits the passage or seepage of water through its interconnecting voids.
- Gravels ⟹ highly permeable
- stiff clay ⟹ least permeable


Compare
2 minutes
2 hours
200 days
200 years
1 meter
Gravel
Sand
Silt
Clay

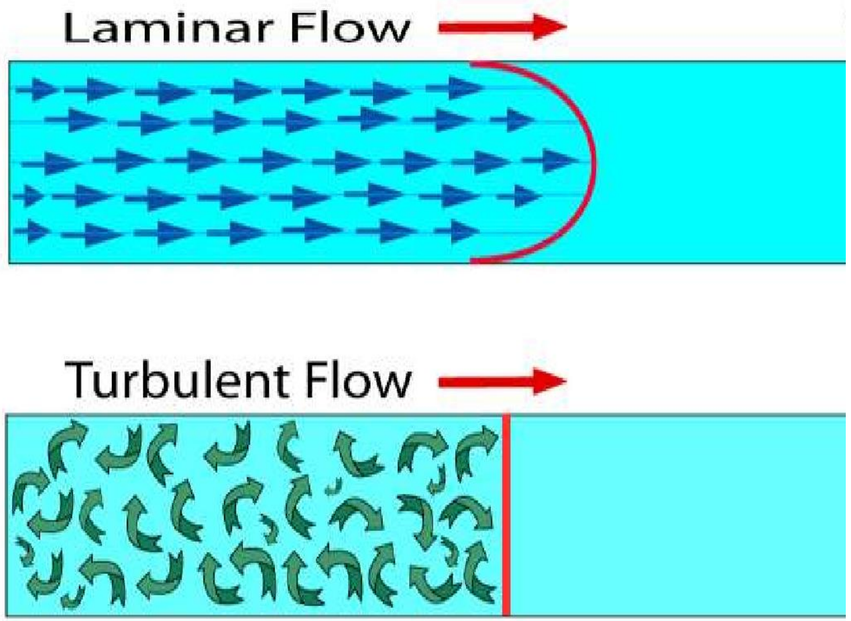

High Permeability
Low Permeability
Gravel
Sandy Gravel
Silt
Clay

Permeability through soil is important for the following engineering problems:

- **Calculation** of uplift pressure under hydraulic structure and their safety against **piping.**
- Ground water flow towards wells and drainage of soil.
- Calculation of seepage through the body of earth dams and **stability** of slopes.
- Determination of the rate of **settlement** of a saturated compressible soil layer.

Flow of water through soils may either be a laminar flow or a turbulent flow

- Each fluid particle travels along a definite path that never crosses the path of any other particle
- Paths are irregular and twisting, crossing at random



Coefficient of Permeability

Depends not only on the properties of soil but also on the properties of water

Absolute permeability

Independent of the properties of water

It depends only on the characteristics of soil.

The absolute permeability only depends on the geometry of the pore-channel system.

Relative permeability is the ratio of effective permeability of a particular fluid to its absolute permeability.

Henry Darcy (1803-1858), Hydraulic Engineer. His law is a foundation stone for several fields of study

Darcy's Law

who demonstrated experimentally that for laminar flow conditions in a saturated soil, the rate of flow or the discharge per unit time is proportional to the hydraulic gradient

$$q = vA$$

$$v = ki$$

$$q = kiA$$

Bernouli's Equation:

- Total Energy = Elevation Energy + Pressure Energy + Velocity Energy

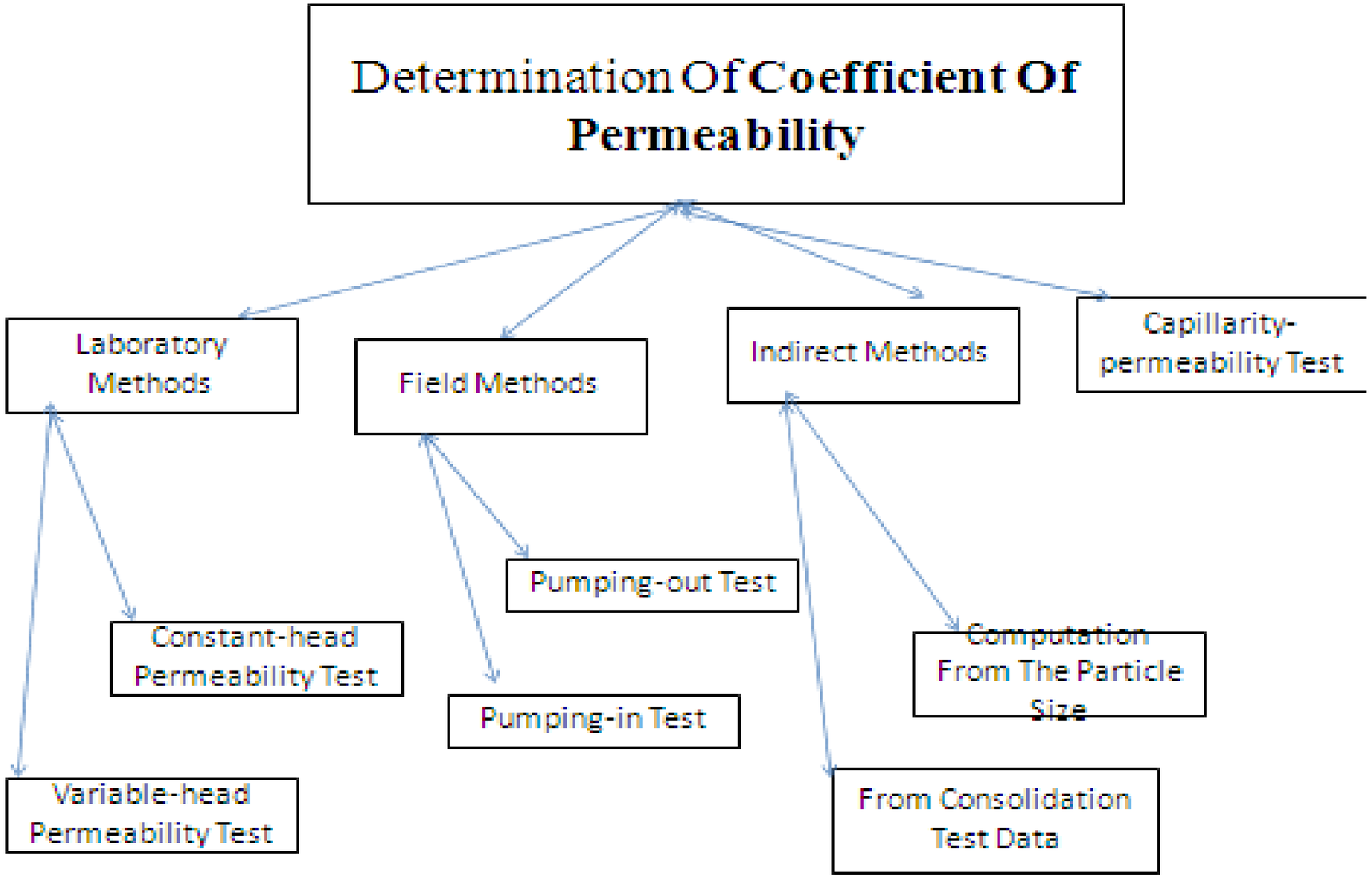
- Total Head = Elevation Head + Pressure Head + Velocity Head

$$H = z + \frac{v^2}{2g} + \frac{p}{\rho g}$$

- Total head of water in soil engineering problems is equal to the sum of the elevation head and the pressure head

Factors Affecting Permeability

- Particle size
- Structure of soil mass
- Shape of particles
- Void ratio
- Properties of water
- Degree of saturation
- Adsorbed water
- Impurities in water


Determination Of Coefficient Of Permeability
Laboratory Methods
Field Methods
Indirect Methods
Capillarity-permeability Test
Constant-head Permeability Test
Variable-head Permeability Test
Pumping-out Test
Pumping-in Test
Computation From The Particle Size
From Consolidation Test Data

Constant Head Permeability Test

- Quantity of water that flows under a given hydraulic gradient through a soil sample of known length & cross sectional area in a given time
- Water is allowed to flow through the cylindrical sample of soil under a constant head
- For testing of pervious, coarse grained soils

$$k = \frac{QL}{Aht}$$

K = Coefficient of permeability

Q = total quantity of water

t = time

L = Length of the coarse soil

Variable head permeability test

- Relatively for less permeable soils
- Water flows through the sample from a standpipe attached to the top of the cylinder.
- The head of water (h) changes with time as flow occurs through the soil. At different times the head of water is recorded.

$$k = \frac{2.30aL}{At} \log_{10} \frac{h_1}{h_2}$$

t = time

L = Length of the fine soil

A = cross section area of soil

a= cross section area of tube

K = Coefficient of permeability

By Indirect Method

Allen hazen's formula

$$k = cD_{10}^{2}$$

Kozeny carman equation

$$k = \frac{\gamma_w}{(C_s \mu S^2)T^2} \frac{g\rho}{1+e} e^3$$

Loudon's formula

$$\log_{10}(kS^2) = a + bn$$

Consolidation test data

$$k = C_v \gamma_w m_v$$

constants.,a= 1.365
b=5.15
c=value b/w 100 & 150
T= Tortuosity
S = surface area

Reference Videos

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

See You at Next Class!!!!