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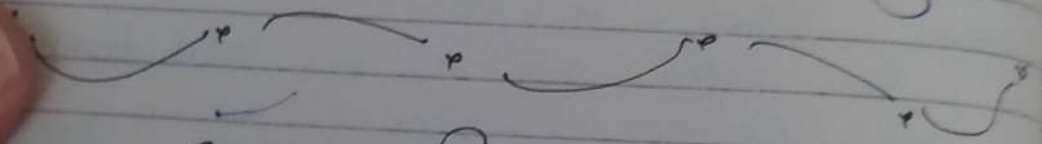
uplifting forces caused by the swelling. These uplifting forces may cause cracking and breakup both of Building and foundation slabs. The depth below ground surface upto which periodic change of moisture and volume change of soil occur is called active zone.



CHAPTER:. PERMEABILITY OF SOIL

Permeability of soil is the property of soil due to which it permits the passage / seepage of water through its inter connected voids. The soil which has more and larger interconnected voids will be highly permeable such as gravel. while the soil having less and smaller non connected voids will be least permeable such as clay.

Permeability of soil is imp in soil mechanics for estimating the quantity of underground seepage under various hydraulic structures, For investigating problems involving the pumping of water for underground construction (Dewatering

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For making stability analysis earth dams and earth retaining structures that are subject to seepage forces.

HYDRAULIC GRADIANT:

In soils water flows from point of high energy oblique energy head to point of low energy. Thus hydraulic gradiant is defined as the energy head loss per unit length of the flow path.

If a water flow through a soil from point of energy head h_1 to another point with energy head h_2. let the distance b/w two point is "L" then the hydraulic gradiant

$$i = \frac{h_1 - h_2}{L} = \frac{\Delta h}{L}$$

DARCEY'S LAW:

It states that for laminar flow, the rate of flow in saturated soil is proportional to the hydraulic gradiant.

$$V \propto i$$

$$V = ki$$

k = Coefficient of Permeability

$$AV = kiA$$

$$Q = kiA$$

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A = Total x-section
i = hydraulic gradient

~~V = Velocity of flow~~
Discharge velocity
V = velocity of flow / discharge velocity.

$$i = \frac{h_1 - h_2}{L}$$

$$q = KA\left(\frac{h_1 - h_2}{L}\right)$$

DISCHARGE VELOCITY (FLOW VELOCITY):-
It is rate of discharge of water per unit of total cross sectional area A of the soil

$$V = \frac{q}{A}$$

$$V = V_s + V_v$$

$$A = A_v + A_s$$

SEEPAGE VELOCITY / TRUE OR ACTUAL VELOCITY:-
Since in soil the water flow to voids of soil, thus the seepage velocity is defined as rate of discharge of water per unit cross sectional area of voids perpendicular to the direction of flow.

Since $A_v < A$

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Thus $V_s > V$

RELATION B/W V_s AND V_v.

$Q = AV$

$Q = AVV_s$

$\Rightarrow AV = AVV_s$

$V_s = \frac{AV}{AV}$

$V_s = \frac{AVL}{AVL}$

$V_s = \frac{V \cdot AL}{AVL}$

$V_s = \frac{V \cdot V}{V_v}$

$V_s = \frac{V}{\frac{V_v}{V}}$

$V_s = \frac{V}{n}$

$V_s = \left(\frac{1+e}{e}\right)V$

$a = Av$

$Av = AvV_s$

$V_s = \frac{AV \cdot L}{AV \cdot L}$

$V_s = \frac{AL \cdot V}{AVL}$

$V_s = \frac{V \cdot V}{V_v}$

$V_s = \frac{V}{\frac{V_v}{V}}$

$V_s = \frac{V}{n}$

$V_s = \left(\frac{1+e}{e}\right)V$

Coefficient of Permeability (K):-

According to Darcy's Law the coefficient of Permeability is defined as the average velocity of flow with which water will flow in soil under unit Hydraulic gradiant

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ie $U = kCi$

$U = kC \quad i = 1$

The unit of k is that of velocity which is usually express as cm/s, m/day, mm/ft etc.

FACTORS AFFECTING PERMEABILITY:-

The coefficient of Permeability depends upon several factors, some of these are as follow.

1) Properties of pure fluid especially viscosity & unit weight:-

Generally permeability is directly proportional to its unit weight and $\frac{1}{\text{viscosity}}$ proportional to viscosity. As the viscosity changes with temp, thus temp also effect permeability.

2) EFFECT OF GRAIN SIZE:-

Permeability varies as square of grain sizes. According to Allen Hazen (k) is proportional to D_{10}^2 ie

$k \propto D_{10}^2$

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$K = C D_{10}^2$

D_{10} = Effective grain size It is the particle size which corresponds to 10% finer in the particle size distribution curves.

C = 100 is Allen Hazen Constant

3) Effects of Voids Ratio:.

The effects of voids ratio on the Permeability is expressed by following equation

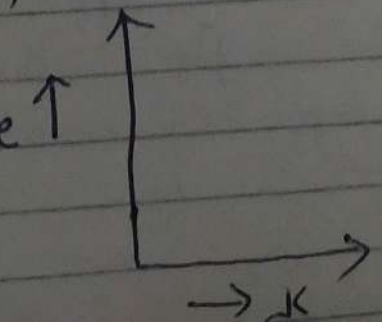
$$\frac{K_1}{K_2} = \frac{\left(\frac{C_1 e_1^3}{1+e_1}\right)}{\left(\frac{C_2 e_2^3}{1+e_2}\right)}$$

C_1 and C_2 are constant.

K_1 = Coefficient of Permeability at e_1

K_2 = " " " at e_2

It has been found that the semi logrithmic plot of voids ratio is approximately straight line.



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4) Effect of Structural Arrangement of particles.

Depending upon method of compaction, size may have different structural arrangements. The effect of structural arrangement on permeability is much pronounced in fine grain size. In Layerd/ stratified soil permeability parallel to stratification is always greater than the permeability perpendicular to stratification.

5) Effects of Degree of Saturation:.

The permeability reduces as the degree of saturation decreases. This is because in partially saturated soil air in entrapped in the voids which is dissolved in the pore fluid also presence.

6) Effects of Absorbed water:.

The absorbed water does not move and occupies some space arround soil particles, thus reducing the effective course space available for the flow of water, thus reducing permeability.