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17/ENG03/011

Civil engineering

13 April 2020

Permeability and Capillarity of soil

# **Abstract:** This paper discusses the permeability and capillarity of soil. The paper describes the permeability and capillarity of the different soil types used in construction of roads, buildings, dams etc. as well as the best suited soil to be used in the mentioned constructions. The paper also provides information on determining permeability and capillarity of soil. Finally this paper describes the effects of permeability and capillarity soil in construction.

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Introduction:

As an aspiring civil engineering the importance of the study of soil cannot be neglected as it is one of the cornerstones of the profession. The study of soil entails the investigation of different physical, chemical and sometimes biological components or aspects of the soil i.e. understanding the strength, grain size, etc. under physical aspect and also the structure, chemical properties and reactions under chemical aspect and final the study flora and fauna inhabiting the soil under biological aspect. But in this paper we will be focusing more on the physical aspect, more specifically the permeability and capillarity of soil.

Description and Determination of permeability soil

Permeability of soil:

Permeability of soil can be defined as the property of soil or ability of soil to transmit water or air i.e. ability to allow water or air to flow through it. It is a very important physical factor in civil engineering because it determines the resistance to weathering by water or air of a building, dam or any other civil engineering construct. Transmission of water or air through soil takes place through void spaces, which are interconnected.

Importance of permeability of soil

1. Permeability of soil influences the rate of settlement of a saturated soil under a load.
2. The knowledge of permeability is used in the design of filters made of soil.
3. Dam construction is based heavily on the permeability of soil especially in the case of earthen dams.
4. The stability of retaining structures can be affected by the permeability of soil involved in the construction.

PROPERTIES OF PERMEABILITY OF SOIL

1. Estimating the quantity of underground seepage.
2. Solving problems involving pumping seepage water from construction excavation.
3. Stability analysis of earth structures and earth retaining walls subjected to seepage forces.

FACTORS AFFECTING PERMEABILITY OF SOIL

1. Grain size:- The size of the soil grain affects permeability in the sense that the bigger the grain size the lower the permeability rate and the smaller the grain size the higher the permeability rate. Permeability can be calculated using grain size according to the equation below:-

K=CD210

The above equation was given by Alan Hazen. The equation calculates permeability by depending on the shape and size of soil particle.

1. Void ratio:- It is the ratio of voids present in a soil sample. It is given by the equation below:-

$K=\frac{e^{3}}{\begin{array}{c}1+3\\\end{array}}$

1. Composition of soil:- The composition of soil refers to the chemical make-up of the soil i.e. the chemical elements that make up the soil, for gravels, sand and silts the presence of mica can decrease the permeability of the soil likewise for clay, water attracted between clay particles reduces the permeability.
2. Structural arrangement:-The arrangement of soil particles affects permeability because it determines the size of voids present in the soil. Remoulding of natural soil reduces permeability of soil. If soil contains more rounded particle structure, the permeability is higher.
3. Stratification:-This refers to the layers or strata present in a soil sample, such layers are formed from different density soil in which higher density soil is below while lower density soil is above. When flow of water is parallel to strata, permeability will be more when compared with flow perpendicular to strata.
4. Presence of foreign particles and entrapped air:-It affects permeability by reducing void space and it blocks the interconnectivity between the pores.
5. Degree of saturation:-If the soil is dry or partly saturated the permeability of the soil is always less.

 Determination of soil permeability

 The laboratory test for determine soil permeability is called constant head permeability test. The soils suitable for this test are sand, gravel, soils while silt content cannot be tested with this method. The can be employed to test granular soils either reconstituted or disturbed. The aim of the test is to determine the coefficient of permeability of a soil which helps in solving problems related to:

1. Yield of water bearing strata
2. Stability of earthen dams
3. Embankment of canal bank
4. Settlement issues

Soil permeability can also be determined by using Darcy`s law. The law states that the rate of fluid flow through porous medium is proportional to the potential energy gradient within that fluid. The constant of proportionality is the Darcy`s permeability of soil.

 $V=Ki=K\frac{∆h}{\begin{array}{c}L\\\end{array}}$

Description and Determination of capillarity soil

capillarity of soil: Capillarity of soil can be defined as the force that enables the soil to retain water as well as to regulate its movement. Capillarity allows the upward and sideways movement of water which has infiltrated the soil.

Capillarity rise in different soils

The rise of capillarity in the soil is determined by the particle size and shape of the soil grain i.e. capillarity is best in rounded sediments of smaller size, fair in rounded sediments of larger size and worse in angled sediments of mixed size.

 Effects of capillarity rise in soils

Capillarity rise in the soil may saturate the soil and it has effect of the effective stress. If the water table is below the soil strata saturated due the capillary action then the effective stress is increased by an amount equal to the depth of the water table multiplied by the density of the water risen to soil strata.

 Determination of soil capillarity

Soil capillarity can determined by measuring the speed at which water rises in the soil and the extent to which the water rises. Capillarity depends on the size of the spaces between soil particles i.e. the smaller the space the higher the water rises in the soil this means that clay soil allows water to rise highest compared to sandy soil and loamy soil.

Types of soil with their permeability and capillarity

|  |  |  |
| --- | --- | --- |
| Soil type | Permeability (cm/hr) | Capillarity  |
| Sandy  | 5 | Lowest  |
| Loamy  | 1.3 | Medium  |
| Clay  | 0.05 | Highest  |

Conclusion: In conclusion I would like to state that the importance of the study of soil permeability and capillarity has not been fully stressed in this paper due to my lack of thereof enough personal experimental data but my hope is that the above points be enough to spark an interest in the topic.

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