TERM PAPER ON SOIL PERMEABILITY AND CAPILLARITY

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Table of Contents

Title page

Abstract

Table of figures

Introduction

What is soil permeability?

Importance of soil permeability

Factors affection soil permeability

Testing soil permeability

What is capillarity?

Relationship between soil permeability and capillarity

Summary and conclusion

ABSTRACT

The relationship among soil moisture tension, air permeability, and water permeability at saturation was determined for several disturbed soil samples ranging in texture from coarse sand to clay loam. A typical graph of tension versus air permeability shows that a slight tension is necessary before the air permeability is different from zero. With increasing tension, air permeability increases sharply until it levels off near the value of water permeability. The air and water permeability’s are nearly the same for tensions > 100 cm of H2O, unless cracking occurs. Then air permeability greatly exceeds water permeability.

C

apillarity is a manifestation of the cohesion of matter

due to strong, short-ranged forces between adjacent par-

ticles. Examples abound: The curving meniscus in test tubes

and the soaking up of liquids by a sponge reflect the balance

between the adhesive forces between the walls and liquid

and the cohesive forces or surface tension of the liquid. In

fluids and other deformable media, capillary forces—a gen-

eral term that encompasses adhesive and cohesive forces

and surface tension—tend to minimize the surface area of

a given volume and are responsible for the spherical shape

of isolated drops. Although qualitatively straightforward to

describe, capillary pheno

Capillary phenomena are relevant mostly for the surface of liquids in contact with their vapor and are significant for defining the shape of crystals. The overall trend on the free-surface side of capillarity research has been a shift from static shapes to the dynamics of free-surface flows, breakup, and fragmentation. Capillarity phenomena have the distinguished feature of being rooted at a very small scale, yet having consequences at macroscopic scales.

**INTODUCTION**

In soil mechanics, engineering students must know how much water is flowing through the soil in unit time. This knowledge is required to design earth dams, determine the quantity of seepage under hydraulic structures, and dewater before and during the construction of foundations.

The amount, distribution, and movement of water in soil have an important bearing on the properties and behavior of soil. The engineer should know the principles of fluid flow, as groundwater conditions are frequently encountered on construction projects. Water pressure is always measured relative to atmospheric pressure, and water table is the level at which the pressure is atmospheric.

**WHAT IS SOIL PERMEABILITY?**

**Soil permeability**: is the property of the soil to transmit water and air and is one of the most important qualities to consider for fish culture. A pond built in impermeable soil will lose little water through seepage. The more permeable the soil, the greater the seepage.

**Seepage**: in soil engineering, movement of water in soils, often a critical problem in building foundations. Seepage depends on several factors, including permeability of the soil and the pressure gradient, essentially the combination of forces acting on water through gravity and other factors.

Silty clay: 0.25

Clay loam: 0.8

Clay: 0.05

Sand: 5.0

**Soil permeability relates to soil texture and structure**

The size of the soil pores is of great importance with regard to the rate of infiltration (movement of water into the soil) and to the rate of percolation (movement of water through the soil). Pore size and the number of pores closely relate to soil texture and structure, and also influence soil permeability.

**IMPORTANCE OF SOIL PERMEABILITY**

1. The design of earth dams is very much based upon the permeability of the soils used.
2. Filters made of soils are designed based upon their permeability.
3. Permeability influences the rate of settlement of a saturated soil under load.
4. The stability of slopes and retaining structures can be greatly affected by the permeability of the soils involved.
5. Soils are generally made up of layers and soil quality often varies greatly from one layer to another. Before pond construction, it is important to determine the relative position of the permeable and impermeable layers.
6. Almost all the civil engineering structures are constructed on the soil and if the soil below them is pervious, may result in the percolation of the water, and may also result in the piping action, which will reduce the strength of the soil to take the structural weight.

**FACTORS AFFECTING SOIL PERMEABILITY**

1. Particle size
2. Impurities in the water
3. Void ratio
4. The degree of saturation
5. Absorbed water
6. Entrapped air and organic matter.

**TESTING SOIL PERMEABILITY**

1. **Prediction methods**

a. Particle size analysis can be used to predict the hydraulic conductivity of unstructured sands and sandy loams. This relies on equations that take values measured in the lab. It is quite a good predictor for loamy sands on sports fields, for example. On the other hand, it is not suitable for well-structured soils, especially clays, as structure can make a clay act more like gravel.

b. Permeability class can be estimated from the texture and degree of structure. This relies on a look-up table and gives a range; for example, 2–20 mm/hour for strongly structured clay loam but 1–5 mm/hour for a weakly structured clay loam.

2**. Field measurements on intact soils**

a. Single infiltration ring**.** A metal ring at least 30 cm across is driven about 5 cm into the soil surface, and water is poured into it. The time it takes for the water to soak in is timed. This method is adequate for measuring the surface infiltration rate of sandy and reasonably uniform soils.

b. Double infiltration ring**.** Two metal rings, a smaller one inside a larger one, are driven into the soil surface, and water is poured into both. The water in the outer ring blocks lateral (sideways) flow from the inner ring, so the water in the inner ring contributes solely to downward flow, which is what we measure. The method is suitable for soils that tend to swell when wet. It is no better on very sandy soils than the single ring method.

c. Well permeameter. A tubelike instrument is inserted into a hole drilled with an auger, and the rate at which water flows into the underlying soil is measured. This tool is good for measuring subsurface drainage in field soil at depths of 100 to 1000 mm. In contrast to the infiltration rings, this method measures intrinsic saturated hydraulic conductivity (*K*sat).

3. **Laboratory measurements on intact soils**

A soil core is collected in a stainless steel tube driven into either the surface soil or a subsurface layer carefully exposed with a sharp spade. Small cores are used for very uniform, sandy, unstructured soils (e.g., sports field soils). Larger cores are used for structured field soils. With practice and care, anyone can learn to take intact soil cores, but most SESL clients prefer a consultant to visit. Several cores are needed. They are carefully packed so as not to disturb the soil and so artificially increase the hydraulic conductivity, and are brought back to the lab for measurement.

4. **Repacked soils**

Loose or disturbed samples are repacked in the lab for measurement. This method is not suitable for anything other than unstructured sand, loamy sand, sandy loam, loam, clayey sand and fine sandy clay loam. It will give wildly inaccurate results for anything else.

a. AS 4419**.**This method applies no compaction and provides some idea of whether the soil will stand up to continual water flow for 24 hours without structural collapse. It is designed for landscaping soils, which are usually sandy and unstructured. It is somewhat artificial as, in practice; landscaping soils do get some degree of firming down.

b. Hydraulic conductivity compaction curve**.** This method uses increasing degrees of compaction to provide a good estimate of how the soil will behave in urban environments. It is the preferred method for landscaping and sports field soils.

c. US Golf Association**.** This method applies the maximum possible compaction to a soil and hence gives a “worst case” of heavy compaction from pedestrians or other traffic. It is usually used to assess A grade playing field soils, but may be used to assess the effect of excess compaction on any soil. It can also be used to assess the permeability of landfill and dam liners where clay is deliberately compacted to prevent water flow.

**WHAT IS CAPILLARITY?**

Capillarity is the ability of a liquid to flow in narrow spaces without the help assistance of, and in opposition to, external forces like gravity.

Capillary action is sometimes called capillarity, capillary motion or wicking.

**Examples**:

1. Drawing up of liquids between the hairs of a paint brush.
2. Drainage of constantly produced tear fluid from the eye.
3. Observed in thin layer chromatography.
4. Draws ink to the tips of fountain pen nibs.

**Types of capillarity**

There are two types of capillarity

1. Capillarity Rise
2. Capillarity Fall

**Capillarity Rise**

Tendency of liquids to rise in tubes of small diameter in opposition to, external forces like gravity.

**Capillarity fall**

Tendency of liquids to be depressed in tubes of small diameter in opposition to, external forces like gravity.

**Relationship between soil permeability and capillarity**

Permeability is the capacity of the rock or body of sediment for transmitting a fluid. This ability is dependent upon pore spaces between sediments, be they sediments compromising soil or those compacted and cemented within a classic sedimentary rock.

Capillarity is the action by which water actually move against the downward pull of gravity. Water is able to travel upwards and sideways within rock material. Surface tension created by the forces of cohesion (attraction between water molecules) and adhesion (attraction between water molecules and the rock material) allow slow migration within pores spaces between rock particles.

Summary and Conclusion

Soil permeability is a property of soil that allows the flow of fluid through its interconnected void spaces. It is a measure of how easily a fluid like water can pass through the soil. There are several factors affecting the permeability of soil like particle size, impurities in water, void ratio, the degree of saturation, and absorbed water to entrapped air and organic material.

   My hypothesis was that if I take white roses, mums, carnations, and tulips then the roses would drink fastest because they do not seem to need that much water. But it was wrong because the tulips drank quickest. My problem question was if I take a bunch of white flowers which will drink quickest? It was the tulips. This can help people know more about capillary action and if tulips can drink quicker