

AFE BABALOLA UNIVERSITY ADO EKITI (ABUAD)

TERM PAPER

ON

SOIL PERMEABILITY AND CAPILLARITY

UNDER

SOIL MECHANICS

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17/SCI14/013

SUBMITTED TO

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ABSTRACT

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.

Clay loam: 0.8

Silty clay: 0.25

Clay: 0.05

Sand: 5.0

Permeability refers to the movement of air and water through the soil, which is important because it affects the supply of root-zone air, moisture, and nutrients available for plant uptake

Capillary action is the same effect that causes porous materials, such as sponges, to soak up liquids. Capillarity is the primary force that enables the soil to retain water, as well as to regulate its movement. Capillary action is the movement of a liquid through or along another material against an opposing force, such as gravity

PERMEABILITY and CAPILLARITY

This lesson explores the relationship between sediment shape and size with respect to the ability of water to travel through and in between sediments as well as the ability of pore spaces between sediments to hold (store) water.

Some definitions to note are as follows

Sediments - Solid fragmental material that originates from weathering of rocks and is transported or deposited by air, water, or ice, or that accumulates by other natural agents, such as chemical precipitation from solution or secretion by organisms, and that forms in layers on the Earth's surface at ordinary temperatures in a loose, unconsolidated form; e.g., sand, gravel, silt, mud, alluvium.

Infiltration - Soaking into ground of water on surface. The flow of a fluid into a solid substance through pores or small openings; specifically, the movement (percolation) of water into soil or porous rock.

Permeability - The permeability of rock is its capacity for transmitting a fluid. The degree of permeability depends upon the size and shape of the rock material and the size and shape of the pores (spaces between sediments).

Porosity - Percentage of open space (pores) in rock or other earth material. Porosity determines how much water rock material or soil is able to store (hold).

Capillarity - The action by which a fluid, such as water, is drawn up in small pore spaces as a result of surface tension. Syn: capillary action. The forces of cohesion between water molecules and also adhesion, between the water and the rock material, create a surface tension which allows water molecules to migrate upwards and sideways against the opposing downward pull of gravity.

Soil - Material that forms at earth's surface as result of organic and inorganic processes. Soil varies with climate, plant and animal life, time, slope of land, and parent material.

Soil Profile - A vertical strip of soil stretching from the surface down to the bedrock and including all of the successive soil horizons.

PERMEABILITY

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 comprising soil or those compacted and cemented within a plastic sedimentary rock. Optimum permeability exists where sediments are rounded and large. Pore spaces are also large and water easily passes in between sediments. Permeability is poorest when sediments are of mixed sizes and shapes. Igneous and metamorphic rocks, with their intergrown crystals, are too dense to allow water infiltration unless they have many interconnected cracks. In such a situation, water can enter these cracks. plastic sedimentary rocks, on the other hand may have pore spaces between sediments that comprise the rock and so water may infiltrate some specimens belonging to this rock group.

Good Permeability: Water is able to infiltrate and permeate smaller sized, rounded sediments, though not as quickly as with the larger sediments in the box to the left. Size matters when it comes to permeability!

Poor Permeability: Water does not easily infiltrate and permeate a mixture of rounded and angled sediments.

Poor Permeability: Water does not easily infiltrate and permeate a mixture of angled sediments. This is true whether the angled sediments are the same size or a mixture of different sizes.

Best Permeability: Water is able to easily infiltrate and permeate quickest when large, rounded sediments are present. Size and shape matter

POROSITY

Porosity is the ability of the rock or body of sediment to hold, or store, water. Water is stored in pore spaces between sediments so the more pore space that is available, the better the porosity. Rounded particles allow for maximum pore space and so rocks or soil comprised of a large percentage of rounded sediments will be more porous. It does not matter what size the rounded particles are; large or small sediments allow for ample pore space between particles. However, rocks and soil composed of angled sediments or a mixture of rounded and angled sediments, be they small or large in size, will not exhibit good porosity. The angled edges of particles "fill in" pore spaces, closing them and prohibiting water from entering or being stored between the rock fragments. Igneous and metamorphic rocks, with their intergrown crystals, are too dense to allow pore spaces between crystals. Water storage cannot occur within the rock however in nature, water may lie in large cracks in rocks belonging to these groups. An exception would be porous, vesicular igneous rocks such as pumice, scoria and vesicular basalt. Sedimentary rocks, on the other hand may have pore spaces between sediments that comprise the rock and so water may infiltrate and be stored in some specimens belonging to this rock group. Therefore, some plastic sedimentary rocks can be porous.

Good Porosity: Maximum Porosity occurs when sediments are rounded. Size does not matter but shape does! Round is best! The porosity of this sample and the one to the left is the same.

Poor Porosity: Sediments that are angled, jagged and irregular in shape do not allow for sample pore spaces between each particle. Therefore, soil made up of such a mix of sediments would not be porous and would not be suited for water storage.

Good Porosity: Sediments that are rounded naturally create larger pore spaces between each particle. Pore spaces hold water. The storing of water makes sediment porous.

CAPILLARITY

Capillarity is the action by which water actually moves 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 pore spaces between rock particles. Capillarity is best when sediments are round and small. The smaller the pore space, the better the capillarity. Capillarity is worst when sediment is poorly sorted with angled particles and mixed sizes and shapes present. The angled particles prevent ample pore space between rock fragments so there is no space available through which water can migrate. Capillarity is not present in igneous and metamorphic rocks nor is it at its best within the structure of plastic sedimentary rocks. It is most prevalent and most important in unconsolidated (loose) sediments as would be present in soils.

Fair Capillarity: Capillarity does occur when sediments are rounded. However, these particles are large in size and the larger the pore spaces between particles, the poorer the capillarity.

Best Capillarity: Maximum Capillarity occurs when sediments are rounded and smaller in size.

Size matters when it comes to capillarity!

Poor Capillarity: Capillarity does not easily occur when sediments are angled and also when they are angled and of mixed sizes. These particles have very little pore space between each other and so capillarity is poor to none.

CONCLUSION

Permeability, Porosity and Capillarity are important. In order for vegetation to survive, water must be able to infiltrate and permeate down into the soil to reach the root level. Soils that are porous will be able to hold and store water between periods of precipitation. Capillarity insures that water which has permeated past the root zone will be able to migrate upwards and sideways over time, bringing additional water back to the root zone even during times when precipitation is not taking place. Capillary water, held in soil pore spaces against the force of gravity, is the main source of water for plants.