SOIL PERMEABILITY IN RELATION TO NON-CAPILLARY POROSITY

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The permeability of a soil profile for water is one of the more important factors to be considered in soil-water relationships. It is known that sandy soils percolate water rapidly and that clays are usually somewhat impermeable. Various means have been used to evaluate the permeability of the profile. The best known direct methods are the determination of the infiltration rate of soils in situ and the measurement of the percolation rate of either disturbed or natural samples in the laboratory. Indirect methods are usually associated with some attempt to characterize the soil pore space.

Schumacher (6) in 1864, discussed water movement in soils and introduced the concept of capillary and non-capillary porosity. The non-capillary pore space was designated as those pores that would not hold water tightly through capillary forces but would permit the percolation of water and the ready entrance of air. This concept has been developed rather extensively by many of the Russian investigators, especially by Doiarenko and his co-workers (5), Burger (4) investigated the effect of forest cover on the properties of the soil and found that the infiltration capacity of a soil depended upon its air capacity or non-capillary porosity.

The author has observed on numerous occasions that soils with apparent low permeabilities always had small air capacities. Soils have been found with an air capacity of as low as 2% of the entire soil volume. Such soils were almost completely impervious to water (1). Moreover, it has been suggested that the differences between the permeability of various soils can be rather simply understood on the basis of the relative amounts of capillary and non-capillary pores in the horizons of the profile (2). Zwerman (7) has recently confirmed this belief by showing that field measurements of infiltration rates can only be interpreted in light of laboratory studies on pore space relationships.

In defining non-capillary porosity terms of sizes of pores that do not hold water by capillary forces, it is obvious the tension under which a soil is dried will affect the amount of non-capillary porosity. Under most conditions the soil is dried by capillarity and allowed to drain by gravity. Little information exists on the pore space relationships of a given tension.

This investigation was undertaken to find out the relationship of the non-capillary pore space content of soils at various tensions to the rate of percolation of water through them. This paper represents a progress report of the results of such work. It is hoped that additional data will permit a mathematical analysis of the results.

A wide variety of soils was included in the investigation, including textures from sands to clays. Lateritic and non-lateritic clays usually show different physical properties. Several types of clays were investigated. Soils as well as soils in their natural structure were included. The same soil was studied under different degrees of compaction.

The technique of determining the capillary and non-capillary pore space and the permeability of the soil is as follows:

A given volume of soil, about 360 cc., is placed in a brass cylinder and clamped onto a porous plate that is in contact with a water surface. The tension on the plate is automatically controlled by water suction which operates through a manometer system. By using a core sampler which permits the insertion of this brass cylinder, it is possible to obtain a column of soil in its natural structure and study its properties similarly as a sieved soil. The apparatus was designed by Bradfield (3). After placing the soil on the porous plate, the column is slowly wetted from below until there is zero tension on the surface.

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2 Professor of Soils. The author wishes to express his sincere appreciation for the excellent work of his student assistant, C. A. Carlson, during this investigation.