The measurement of the permeability of soils by direct determination of their percolation rates results frequently in erratic data that are difficult to interpret. Investigators have been led to seek indirect methods of measurement. Earlier investigations attempted to define permeability in terms of some property that related to the texture of the soil. In later investigations more recognition has been given to the fact that soil permeability is closely related to soil pore space and its variable characteristics of pore size distribution and continuity.

Pore space analyses generally are based on the drainage of saturated soils under some single hydraulic tension or series of tensions. The larger or "noncapillary" pores drain under the lower tensions.

Baver (1) presents sufficient evidence to show the basic relationships of porosity to permeability and states that, "... soil permeability is dependent on noncapillary porosity if the tension at which this porosity is determined is chosen correctly". He suggests the tension that marks the flex point of the drainage curve as the one that is most apt to be correct. Elsewhere, Nelson and Baver (6) propose a tension of 40 cm of water to define noncapillary porosity where only one tension is to be used.

Leamer and Shaw (4) take issue on this point and contend that for practical field studies it is desirable to use a tension that more nearly approximates natural conditions.

Smith, Browning, and Pohlman (8) present data for pore space analyses where soil pores are differentiated into size classes by water tensions of from 0-10, 10-40, and 40-100 cm. The best correlation between rates of percolation and percentage of pore space was obtained when the effect of pores equivalent to tensions of from 40 to 100 cm was included in their porosity factor. They point out further that percolation rates greater than 0.01-inch per hour are seldom to be expected from soils that have no pores that drain at less than 100 cm of water tension. The cumulative evidence indicates that some tension of not greater than 100 cm of water is sufficient to drain all of the pores that contribute appreciably to the permeability of most soils.

The porosity factor that is developed by Smith, Browning, and Pohlman assigns respective weightings of 1, 1/4, and 1/10 to the effect on permeability of equal volumes of pores of their size classes. This is a step-wise summation of what should be, theoretically, an integrated function. That is to say, an increase in tensions should result in still better agreement between permeability and the porosity factor.

Practical difficulties prohibit any extensive in size classes over the number reported by investigators. However, the general relationship to be expected between rates of water removal of different classes of pore sizes has been determined by Bradfield and Jamison (3). It can be inferred from their data that the length of time allowed for drainage is a factor which influences the system that is drained at any tension, provided that it is not carried to equilibrium conditions.

This should be so, since larger capillaries tend to drain faster than smaller ones. It occurs to us that a time factor might be used to give some indication of the variable characteristics of pore size classes that work advantages over the step-wise summation of Smith, et al., and still serve to adjust a measurement of total pore space drained at a single tension to a satisfaction with soil permeability. Such a measurement would be simple enough to meet the needs of some routine determinations.

This paper reports the effect of time of drainage on the amount of pore space drained, and its relation to soil permeability.

APPARATUS AND PROCEDURE

The equipment that was used in these studies for percolation and pore space (Fig. 1) is similar to that described by Smith, et al., but is simpler in design. Each base for the soil cores or samples are 5-inch sieve bottom pans. A hole is drilled in the center of each pan and a short section of copper tubing is sealed to form a water outlet.

The tension plate on each base consists of a piece of blotting paper that is laid on the pan bottom and covered by a double thickness of blotting paper.

Rubber tubing connects the base to a constant level device. Air and water can be applied by raising or lowering the constant level device.

Soil cores or samples are held in casings that are sections of seamless steel tubing, 4 inches in diameter about 4 inches high. They have a capacity of 1 liter.

The core is placed in the tension plate pan and a paraffin-kollolith mixture is poured around its base and an air- and water-tight system. This eliminates drainage from the blotter surface and prevents air leaks at the blotter edge. The air which might cause a loss of tension also makes it possible to apply positive pressure to the core when that is desired.

Capacity for a head of water over the core is provided by placing a 2-inch collar on top of the core casing, which is sealed with the melted paraffin-kollolith mixture.

The core is allowed to wet up slowly under tension. When free water appears on its surface, positive pressure is applied until a shallow head of water is formed and the core is held at a constant level.

Effect of the Time of Drainage on the Measurement of Soil Pore Space and its Relation to Permeability

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