The Effect of Heating the Soil on Permeability under Prolonged Submergence of Soil in Water

Perméabilité de sols préalablement portés à différentes températures puis immergés

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Summary

Soil samples are heated to different temperatures, after which the permeability to water is measured under normal temperature conditions. From room temperature (30 °C) up to 60 °C, the permeability decreases due to shrinkage of the soil particles. From 60 °C to 650 °C, the permeability increases due to aggregation. Over 650 °C the permeability decreases due to the incipient fusion which decreases the porosity.

Sommaire

Des échantillons de sols sont portés à différentes températures, après quoi la perméabilité à l'eau est mesurée à des températures normales. De 30° C à 60° C, la perméabilité diminue en raison de la contraction des particules du sol. De 60° C à 650° C, la perméabilité augmente en raison de l'agrégation. Au-dessus de 650° C la perméabilité diminue car la fusion commençante restreint la porosité.

Soil permeability is a property of great importance and application in engineering as well as agricultural practice. The changes in soil permeability with time on prolonged submergence of the soil in water has been studied by earlier workers (*Allison*, 1947; *Christiansen*, 1944; *Christiansen*, 1947; *Fireman*, 1944). The permeability characteristics of saline and alkali soils have been studied by *Christiansen* (1947). The effect of the microorganisms which are normally present in soil, on the final permeability when the soil is in continuous contact with water has been worked out by *Allison* (1947).

The effect of soil heating on permeability changes with time has not been studied so far. A study of this aspect of the subject has revealed very interesting features.

The gangetic alluvial soil of Delhi (India) was chosen for the study. Permeability measurements were carried out by using the vertical tube permeameter and adopting the constant water level arrangement. The soil was heated to the following temperatures: 60 °C, 150 °C, 225 °C, 360 °C, 600 °C, 650 °C, 800 °C and 1,000 °C. The permeabilities of each one of these heated soils along with those of the normal soil at room temperature (about 30 °C) have been measured at 35 °C in a thermostat. The changes in permeability with time are indicated in Fig. 1.

The common features of the permeability-time curve of any soil are, the initial decrease of the permeability to a minimum, the subsequent increase to a maximum and the final decrease which is a slow and continuous process (*Allison*, 1947; *Christianson*, 1944, 1947). All these changes are normally exhibited when the soil is under prolonged submergence in water.

All the soil samples heated to different temperatures retain the above features. But the permeability-time curve shows a lateral shift with the progressive increase in the temperature range of the soil during the heating. The soil heated to 60 °C suffers a decrease in permeability. With further increase in the

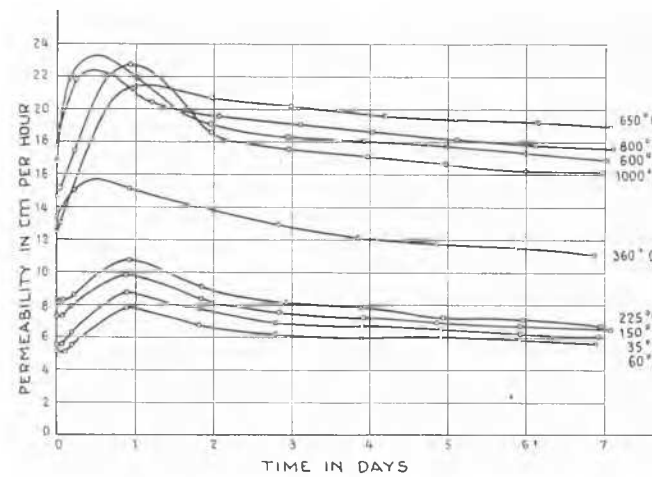

Fig. 1 Permeability of Soils heated to Different Temperatures
Perméabilité de sols portés à différentes températures

temperature up to 650 °C the permeability steadily increases. Above 650 °C, the soil suffers a decrease in permeability. Between 650 °C and 1,000 °C, the reproducivility of the permeability-time curve becomes less accurate.

The permeability of a soil to water is essentially a capillary flow phenomenon. Of the total porosity of a soil, it is the noncapillary porosity (wider porosity) that is believed to be responsible for the permeability, whereas the capillary porosity (finer porosity) determines the water holding capacity (*Baver*, 1946). The increase in permeability with rise in temperature from 60 °C to 650 °C indicates an increase in the noncapillary porosity i.e. of the wider pores. Wider pores can be produced by increase in the size of the soil particles. It follows then that higher temperatures facilitate the aggregation of the smaller soil particles into bigger particles. This mechanism is quite probable in view of the drastic condition of high temperature treatment.

When the normal soil is heated to 60 °C there is however a small decrease in permeability. This decrease indicates that the soil suffers a small shrinkage on heating. As a result of this shrinkage, the porosity decreases and consequently the permeability also decreases.

The decrease in permeability of the soil when the temperature is raised from 650 °C to 1,000 °C indicates a decrease in total porosity and this is probably due to certain amount of incipient fusion of soil particles at the high temperature, resulting in a decrease of the porosity.

The above mechanism of the changes taking place in the soil when the soil is heated to higher temperatures is very interesting indeed. Low temperatures like 60 °C bring about only the shrinkage of the soil, reducing the porosity, whereas high temperatures up to 650 °C bring about aggregation of the smaller soil particles into bigger aggregates. Above 650 °C the soil seems to suffer an incipient fusion resulting in a decrease of porosity.

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