An Asian Journal of Soil Science, **Vol. 3 No. 1 : 183-185 (June, 2008)**

A suitable method for determining hydraulic conductivity of soils of high clay content

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Accepted : *May, 2008*

ABSTRACT

A study was undertaken to determine the hydraulic conductivity (HC) after accounting for full expansion of swelling clay soils (Vertisols). Further correlation studies were made between soil texture and hydraulic- conductivity. Results indicated that, for all black soils, HC values obtained by the split core method were higher than the values obtained by the rigid core method, but for red soil the results were reverse. Silt and clay fractions showed significant negative correlation with HC of both expanded (in split core) and non-expanded (in rigid core) samples, whereas coarse sand fraction showed significant positive correlation. Fine sand fraction showed significant positive correlation only for non-expanded samples, but for expanded samples it showed non-significant correlation.

Key words : Hydraulic conductivity, Split core, Rigid core, Vertisol.

Hydraulic conductivity in black clay soils (Vertisols) is recognized as a physical parameter of major importance in water management and drainage studies. In the usual method, hydraulic conductivity determination is carried out irrespective of soil type in rigid metal cores, which do not allow the swelling clay soils to expand fully and attain natural state of water transmission capacity. This reduces the hydraulic conductivity due to blocking of natural pores. So an attempt was made to develop a new technique for determining hydraulic conductivity after accounting for full expansion of swelling clay soils.

MATERIALS AND METHODS

Four black soil profiles and a red soil profile were chosen for the study from different locations of Karnataka on the basis of parent material. Soil samples were collected depth-wise from these two pedons. The method devised for allowing the clay soil to expand fully is as follows :

Air dry soil samples were taken in polythene tubes of 6.75 cm diameter and 4 cm height, open at top and bottom and split vertically into two equal halves. Inner wall of the two halves was lined with rubber tube sheets cut to size, so that the slits were closed as shown in Fig. 1 (b). The two halves of the split polythene ring were held in position by a flexible rubber band with muslin cloth at the bottom as shown in Fig. 2.

Split core method:

Soil required for packing to a bulk density of 1.5 Mg/m^3 for the split core was calculated, weighed and filled in about three equal lots and packed to 1.5 Mg/m^3 bulk density by dropping a solid metal cylindrical block weighing 1 kg through a distance of 2.5 cm/ 25 times for every lot. Care was taken to see that the split polythene ring did not give away.

After filling the split core with soil to the desired bulk density, it was kept for saturation in water overnight or longer as the case may be. Saturation was effected from the bottom by immersing the core in deaerated water to a height of 2 mm, short from the top. After ensuring complete saturation and expansion, they were transferred to vacuum desiccator containing deaerated tap water in Neubauer's dishes. Displacement of soil air was effected by applying mild suction ten times, 5 minutes at a time at 15 minutes interval in case of black soils. In case of red soil, saturation time was reduced and suction was not applied as it failed to stand long saturation time and suction.

After complete saturation, core (metallic core of the steel permeameter) sample was taken by carefully and slowly pushing metal core (sizes 3.9 cm height and 5.6 cm diameter and 3.7 cm height and 5.7 cm diameter) into the expanded soil sample right down to the bottom. After pushing the core to the bottom, the split halves of the outer polythene core, rubber band, rubber tube sheets were removed. Soil sticking outside of the metal core was wiped off. A very slight compaction of the saturated, deaerated soil was carried out to prevent water seeping through