

FIELD MEASUREMENT OF HYDRAULIC PROPERTIES OF CAMBISOLS BY INSTRUMENTED INFILTRATION EXPERIMENT

M. Sněhota¹, D. Zumr¹, H. Pavelková², M. Sobotková¹, M. Dohnal², M. Císlarová¹

¹ CTU, Faculty of Civil Engineering, Dept. of Irrigation, Drainage and Landscape Engineering, Prague, Czech Republic

² CTU, Faculty of Civil Engineering, Dept. of Hydraulics and Hydrology, Prague, Czech Republic
michal.snehota@fsv.cvut.cz

Introduction

Transformation of extreme rain event in watershed depends largely on infiltration into soil. Infiltration during extreme rain represents the near saturated water flow in soil. It was shown in the literature that such flow may be affected by many effects, which are not conventionally considered by models nowadays. This includes slow infiltration into dry soil caused by soil repellency, the preferential flow, temporal changes of hydraulic properties due to various physical reasons (e.g. changes in volume of the entrapped air) or caused by biological processes. Relatively simple methods of measurements of effective infiltration properties of soil, accounting for the above mentioned effects, are disk tension and ring infiltration experiments.

Tension disc and pressure ring infiltrometers have become very popular devices for the in situ estimates of soil hydraulic properties (Angulo-Jaramillo *et al.*, 2000). The tension disc infiltration is usually done using infiltrometers operated either manually (Perroux, White, 1988) or automatically (Ankeny, 1992). The result of the experiments is either the set of steady state infiltration rates for series of pressure heads in the infiltration disc,

which can be interpreted as the function of hydraulic conductivity, or it is a record of the infiltration rates in time for one or several tensions. In the second case, which is referred as the transient experiment, the soil hydraulic properties are evaluated by inverse modelling (Vogel *et al.*, 1999). From the point of view of the uniqueness of parameters, Simunek and vanGenuchten, (1997) recommended the infiltration experiment with multiple tensions and measurement of final water content.

Current study is focused on measurements on near-saturated hydraulic properties of soils exhibiting the preferential flow and temporal changes of the hydraulic properties. Infiltrations using disk infiltrometer were conducted in selected sites in head-water areas of the Czech Republic.



Figure 1. Set-Up configuration for infiltration experiment

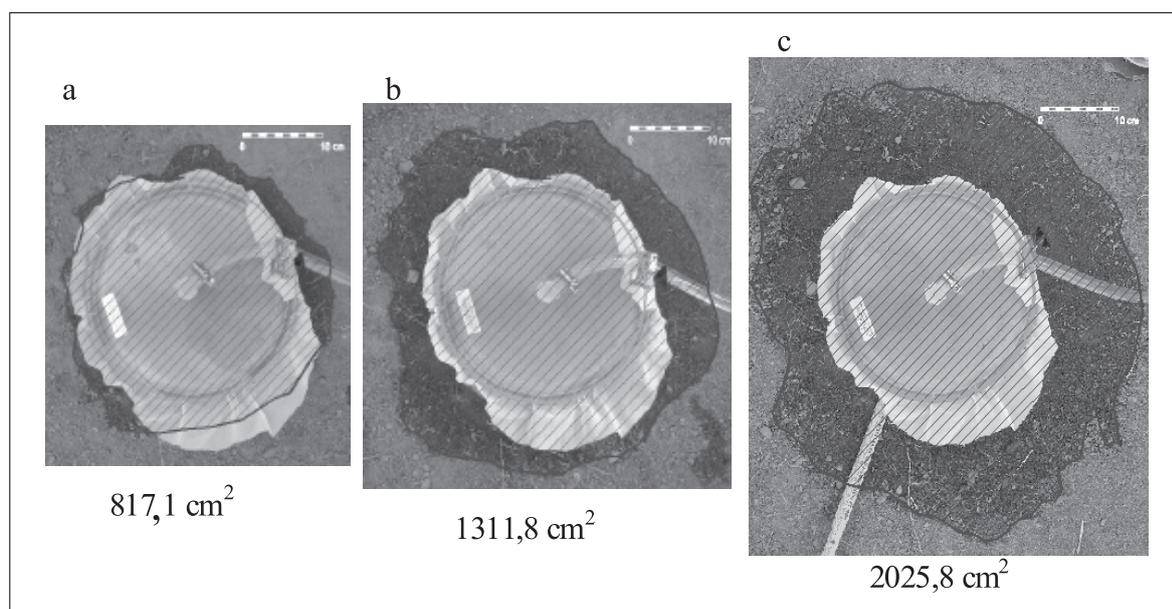


Figure 2. Photographs of the soil wetted by infiltration in various times after the beginning of infiltration a) 35 min, b) 2 h 40 min and b) 24 h 03 min. The area of wetted surface including the area of the disc for each time is given below pictures

The experiment conducted in Korkusova Hut (Šumava mountains, Czech Republic), is shown in this contribution. The soil under study is coarse sandy loam (*Dystric Cambisol*). It exhibits preferential flow, as well as dependence of saturated hydraulic conductivity on the water content at the beginning of the infiltration event (CíslEROVÁ *et al.*, 1988).

The soil profile was instrumented with two tensiometers (Irrometer Co, U.S.A.) equipped with pressure sensors (Omega PX 202, Omega Engineering, Inc., U.S.A.). Tensiometers were installed at the 45° angle to the soil surface. The holes for the tensiometers were drilled in the way that ceramic cups centre of gravity was installed below the outer rim of the disc to the depths of 20 and 40 cm, below soil surface. Tension infiltrometer was similar to the instrument proposed by Perroux and White, (1988). A double Mariotte bottle was connected to the disc by PVC tubing.

Infiltration was started with tension -4 cm and the same pressure head was maintained overnight for 24.5 hours. Then, PVC barrier was built around the disc and pressure head was raised to +2 cm creating ponded condition.

Cumulative infiltration and pressure head data are the direct output of the experiment. Additional information about the wetting front propagation in x-y plane was obtained from photographs of the disc surrounding; the wetted area was significantly darker than soil at the initial soil moisture.

From pressure heads measured by tensiometers, shown in figs. 3 and 4, it is evident that the wetting front did not reach the tensiometer cup placed in 40 cm below surface during infiltration with tension $h_0 = -4$ cm. During ponded infiltration the response was obtained from both tensiometers. The tensiometers installed to 20 cm exhibited relatively fast response and the pressure head increased to the maximum value of $h = +7$ cm. In the deeper tensiometer the pressure head increased rapidly from initial tension of -500 cm to maximum pressure head +5 cm. After both tensiometers reached the positive pressure readings, the infiltration disc was removed in time 25.5 h and redistribution started.

Soil hydraulic properties were evaluated by inverse modeling of the infiltration experiment. The numerical code S 2D Dual (Vogel *et al.*, 2000) was coupled with parameter optimizer to run inverse 2D axisymmetrical model. Preliminary results from experiments on Cambisols have shown that the dual permeability approach produces significantly better fit to the observed pressure and flow data than the single porosity model (Zumr *et al.*, 2007). The method based on tension and ponded infiltration combined with the simultaneous monitoring of pressure heads seems to be a promising method for estimating the near saturated hydraulic properties of Cambisols.

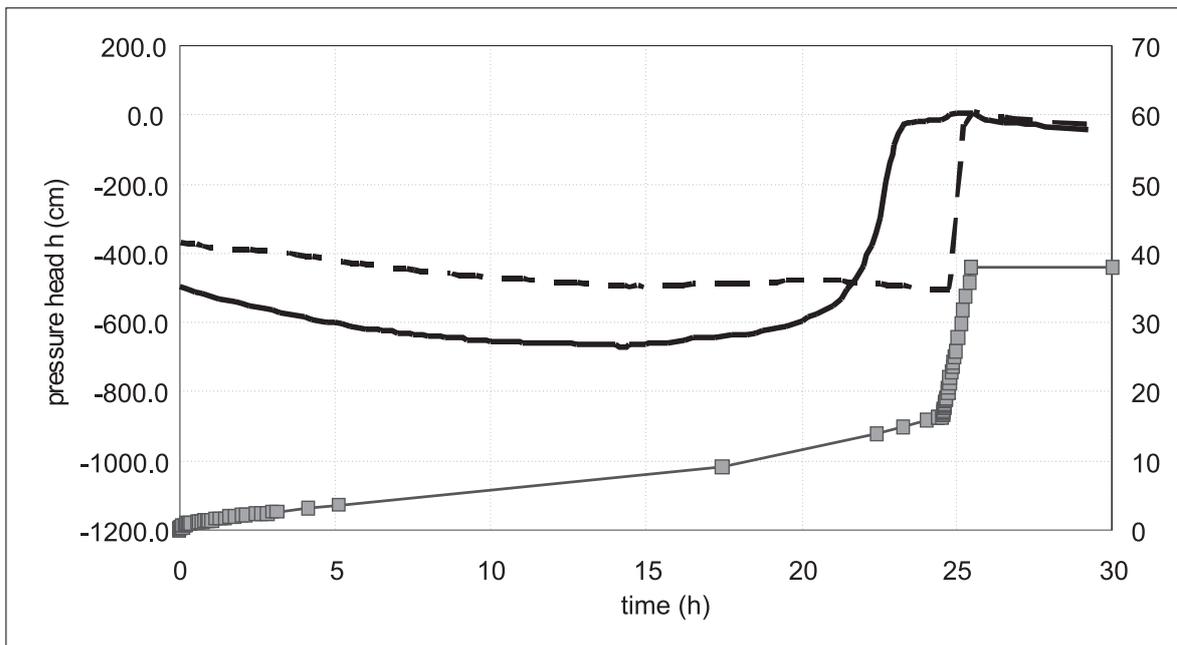


Figure 3. Infiltration experiment data for entire experiment. Cumulative infiltration water flux (gray boxes and line) and pressure heads measured by tensiometers in depths 20 cm (solid line) and 40 cm (dashed line)

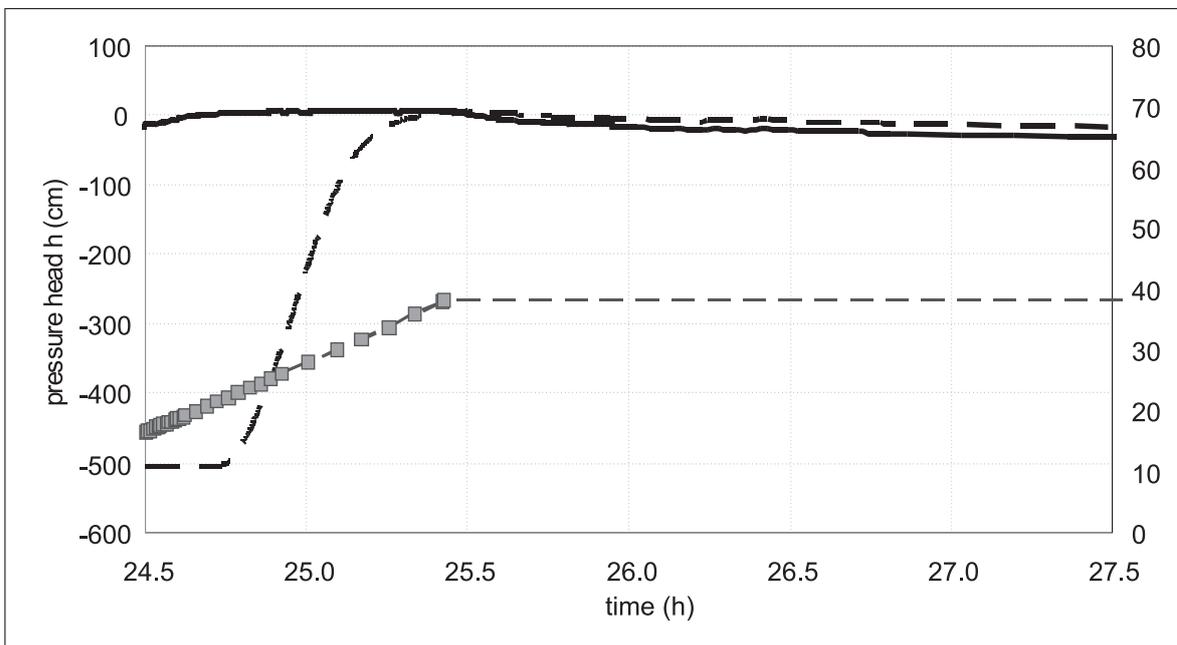


Figure 4. Detail of the infiltration experiment data focused on ponded part of the experiment. Cumulative infiltration water flux (gray boxes and line) and pressure heads measured by tensiometers in depths 20 cm (solid line) and 40 cm (dashed line)

Acknowledgements

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