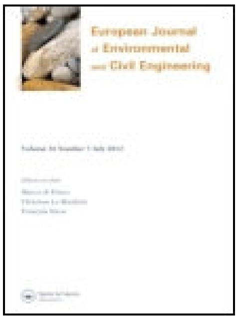

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Numerical simulation of water flow in unsaturated soils: comparative study of different forms of Richards's equation

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Modelling one-dimensional flow process in unsaturated soils is usually based on the numerical solutions of the Richards's equation. Richards's equation may be expressed in water content form, pressure or mixed form. The objective of this paper is to test the accuracy of the results and the ability of the different forms of Richards's equation to describe the water flow in unsaturated soils. Implicit finite difference scheme is used in the numerical solution of the water content form and the pressure form of Richards's equation. The solution of the mixed form is obtained using the 1-D Hydrus software. The effect of texture and the initial moisture of the soil on the equation solutions are explored. The results show a significant difference under some conditions. The choice of the empirical model to describe the hydraulic properties like retention curve and hydraulic conductivity may play an important role on the performance of each form, and can lead to remarkably different simulation results. The accuracy of the results is established by comparing numerical results to the semi-analytical solution of Philip and confronting them to the measured results.

Keywords: flow process; unsaturated soils; Richards's equation; pressure form; water content form; mixed form

1. Introduction

Water transport in unsaturated porous media has always been a major concern in several branches of hydrology, agriculture and environmental engineering. Different methods are used in order to describe soil water infiltration. Laboratory and *in situ* methods used to measure evolution in water content (e.g. TDR, neutronic moisture, capacitive sensors …) and suction (e.g. tensiometer, filter paper …) are generally tedious, costly and time consuming. In the last decades, a large number of analytical approaches have been developed (Broadbridge & White, 1988; Parlange, 1972; Philip, 1969; Ross & Parlange, 1994; Warrik, Isles, & Lomen, 1991) to provide useful tools to study simple unsaturated flow systems. Most of these analytical solutions have been tested for specific unsaturated hydraulic properties. However, they cannot provide the complete profile of water content without major simplification on soil description such as constant diffusivity. Additionally, simple initial and boundary conditions, homogenous and isotropic matrix, are commonly assumed and gravity is often disregarded. The most popular analytical methods for general descriptions of the unsaturated hydraulic properties and for the

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