Abstract

A preliminary study is presented on the use of Non Uniform B–Splines (NURBS) for the numerical analysis of one dimensional hydraulic problems in unsaturated soils. This class of problems is characterised by high degree of non linearity and by coupling between the gaseous and the liquid phases. In principle, NURBS based numerical models may present a few advantages with respect to standard Lagrange polynomial based Finite Elements. They possess useful mathematical properties, such as any desired order of continuity, variation diminishing and convex hull properties, and the ability to be refined through various techniques, including knot insertion (h-refinement), order elevation (p-refinement), and k-refinement. Higher order NURBS have been implemented in a numerical code for the analysis of problems of increasing complexity. Linear steady state and time dependent problems are tackled first, to verify the implementation procedures. Afterwards, non linear time-dependent problems are studied, including one-phase and two-phase infiltration problems. The performance of NURBS based discretisation is compared to that of the Lagrange-based finite elements, with reference to a benchmark problem suggested in the past to test such numerical algorithms (Liakopoulos' problem), and with reference to data coming from a prototype experimental soil column. Various interpolation orders and refinement techniques are analysed and compared. The influence of starting algorithm, mass-lumping technique, and initial time-step amplitude are evaluated. The work suggests that for linear and non linear standard diffusion problems NURBS may provide a valuable alternative to FEM. They do not show definite advantages over the more classical FEM in terms of solution accuracy. Nonetheless, their implementation is straightforward and allow for more flexible refinement procedures. Advantages in terms of stability of the time-stepping scheme and accuracy of the discretised solution are demonstrated for non linear degenerate parabolic problems, especially at increasing interpolation order.