Numerical Study on the Hyporheic Flow Across Bedforms of Different Type

C. Gualtieri[1]

[1]University of Napoli Federico II, Department of Civil, Architectural and Environmental Engineering (DICEA), Napoli, Italy

Abstract

Despite the traditional separation between the studies of surface water and groundwater flows, it has been long recognized that rivers and aquifers are strongly connected and that their interaction gives rise to a continuous exchange of water and solutes, which exerts a significant influence on water quality. The volume within the porous medium where groundwater and stream water mix is termed hyporheic zone, which has hydrodynamic, physiochemical and biotic characteristics different from those of both the river and the subsurface environments.
The paper presents results from a numerical study carried out to investigate the influence the geometry of a bedform on a coupled free fluid-porous medium flow. Laminar flow in the water column above three different types of periodic bedforms and Darcy flows in the underlying permeable sediments were simulated. The simulations were carried out under steady-state conditions in a range of bedform height-based Reynolds number ReH from 6 to 4448. First, numerical data confirmed the close relationship between the characteristics of the separation region in the water column downstream of the bedform crest and those of the hyporheic zone in the porous medium. Second, numerical results highlighted the influence of the geometry of the bedform on the development of the hyporheic zone. Third, the numerical data were validated by a comparison with both numerical and experimental data from the laminar backward-facing step flow. Finally, the issue of the application of these results to turbulent flows was discussed.

Figures used in the abstract

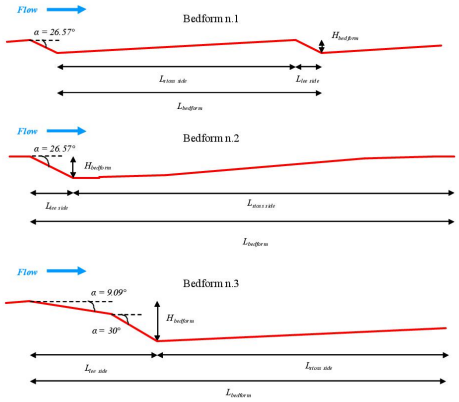

Figure 1: Detail of the investigated bedforms.

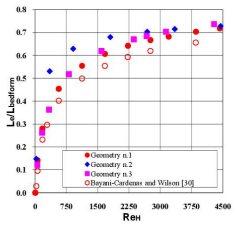

Figure 2: Nondimensional separation length Le/Lbedform vs. ReH for Runs 1–27.

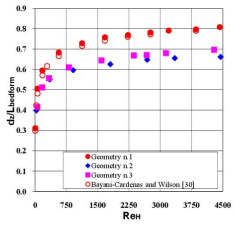

Figure 3: Nondimensional hyporheic zone depth dz/Lbedform vs ReH for Runs 1–27.