Two-dimensional hydraulic analysis of water flow over and through an anisotropic soil layer

*PingCheng Hsieh[1], PeiYuan Hsu[2]

1. National Chung Hsing University, Taichung, Taiwan, 2. Water Resources Bureau, Kaohsiung City Government, Fengshan, Taiwan

In this study, we focus on the hydraulic analysis of a 2-D water flow on a pervious ground down a hillslope. Different from the past, we not only consider the soil layer as a porous medium with an anisotropic permeability, but also consider the vertical component of the flow velocity, and then compare the results with the relevant literature including Makungo & Odiyo (2011) and Dagadu & Nimbalkar (2012). We divide the flow field into two regions (the water layer and the anisotropic soil layer) and derive horizontal component and vertical component of the flow velocity as well as other physical quantities in the two regions. Herein, by regarding the soil layer as an anisotropic and permeable porous medium, we adopt the Song’ s (1993) laminar model based on Biot’ s poroelastic theory for the momentum equations of the anisotropic soil layer, and the Navier-Stokes equations for the water layer. When considering the anisotropy of permeability in the soil layer, the hydraulic conductivity becomes a tensor, and the momentum equations of the flow in the soil layer should be derived in a new way. Finally, with appropriate boundary conditions and the velocity type set by Desseaux (1999), we derive the horizontal, vertical velocity and (pore) water pressure distributions by taking the Differential Transform Method (DTM) proposed by Arikoglu & Ozkol (2006).

Keywords: subsurface flow, anisotropic, vertical velocity

