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NUMERICAL SOLUTIONS OF STEADY FREE FLOW OVER POROUS MEDIA USING COMSOL MULTIPHYSICS

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Flow simulations in porous media have a wide range of environmental and industrial applicability. This process is a vital tool in groundwater hydrology, civil engineering, automotive industry, and textile engineering. Most research focus on modeling the physics of the flow through porous media. Recently, due to new findings in biology, blood flow in a capillary can be modeled as flow over a porous media. However, only a few studies have developed governing equations of motion for flows over porous media. Our previous work found analytical and self-similar solutions for the velocity distribution of free flow over porous media. This work presents the numerical solutions of free flow over porous media by using COMSOL Multiphysics. We consider a channel where the bottom of the channel was occupied by porous media and the top of the channel was occupied by a free flow region. The motion in the channel was governed by the coupled incompressible Navier-Stokes Equations and the Brinkman Equations. The flow between the channels was assumed to be steady-state and Newtonian. Further, the velocity profiles for the flow in the channel were examined for different values for parameters such as permeability, porosity, and input velocity. We observed that the velocity distribution in the channel depended on these parameters. Moreover, the contribution of the porous layer to the volumetric flow rate was discussed at different permeability values and input velocities. Results showed that the volumetric flux rate decreased as the permeability of the porous medium increased, and the volumetric flux rate increased as the input velocity increased. The results were validated with analytical results.

Keywords: COMSOL Multiphysics, Darcy-Brinkman equation, Navier-Stokes Equations, Porous media