

RANDOM VORTEX ELEMENT MODELLING OF GROUNDWATER FLOW

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Abstract-Exploitation of groundwater for both domestic and industrial uses has continuously been undertaken in different parts of the world. The proper harnessing of available water required adequate analysis of the flow in the aquifer. Successful attempts have been made using finite difference and finite element methods. However, the possibility of vortex element method as an alternative technique was considered in this work. A model was developed using random vortex element method to simulate groundwater flow with constant head at the aquifer boundary. This was carried out by transforming the governing equation for groundwater flow into a typical vorticity equation for vortex method. The model was then used to determine groundwater head at varying time for Lagos basement complex with transmissivity and storativity of 5.5×10^{-5} and 6.840796×10^{-2} respectively. The aquifer thickness varied from 4.0m to 7.0m. At the aquifer thickness of 4.0m the predicted groundwater heads varied from 0.0m to 0.024833690m, while at the aquifer thickness of 7.0m the predicted heads varied from 0.0m to 0.159134m for varying time step at 0.1s. The head differs only from literature value by 2.44%. Random vortex element method is therefore a viable numerical tool for predicting the groundwater flow parameters of the aquifer at any desired location.

Keywords: Groundwater, Modelling, Vortex Method, Aquifer, Diffusion

1.0 Introduction

The groundwater flow occurs in a layered soil, consisting of permeable water bearing layers bounded at their bottom and / or their top surface by layers of very low permeability. The permeable layers are called the aquifers which are more or less horizontal. Therefore, the flow in the aquifer is predominantly horizontal in nature. An

Aquifer is said to be completely confined, if the bounding layers below and above aquifer is completely impermeable. When water is percolating through one or both of the bounding layers, the aquifer is called semi-confined aquifer. When the upper boundary of the groundwater is a free surface, it is referred to as unconfined aquifer.