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# The Influence of Aperture on Flow Regimes in a Single Smooth Fracture

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Laboratory flow visualisation experiments indicate that fluid flow regimes in unsaturated fractured rock can occur in numerous forms. To name a few it may either be through regular film [4], continuous liquid rivulets [3], intermittent rivulets and sliding droplets [5]. This also includes flow regimes arising from two-phase flow systems [2]. The formation thereof is dependent on various factors such as the interaction between gravity, capillary, pressure and viscous forces which results in other complex flow phenomena in the unsaturated media i.e., episodic fluxes, intermittent fluxes and preferential flow paths [3]. Whereas, in two-phase flow, flow structures arise from combined effects of different inlet phase pressures, the physical properties thereof, interactions between different interfaces as well as the flow path geometry and flow path surface tension. Adding to the already complex system are the influences of varying joint parameters, in particular – aperture, which conditions the fracture flow tortuosity and flow channelling [6] [1]. Nonetheless, the identification of fluid flow structures continuous to be important in vadose zone hydrology, contaminant transport, groundwater contamination as well as various geotechnical applications, such as subsurface excavations and slope stability.

The aim of the research is to investigate the influence of aperture in a single smooth fracture under conditions of variable saturation and the influence on flow regimes. This was done by identifying flow regimes or flow structures associated with the varying aperture, in a smooth parallel plate model. The model makes use of two rectangular plexiglass sheets (400mm x 290mm x 10mm). These are separated by means of plexiglass strips to simulate the appropriate width (apertures) between the sheets: 0.18mm, 0.5mm, 1mm, 1.5mm, 2mm and 3mm with tests conducted under constant head.

From the inlet point source, water flows in a sinuous flow movement within the top quarter of the 400mm long fracture and thereafter bulges out to form a plume within the narrower apertures (0.18mm and 0.5mm) and much lesser in the 1mm aperture. Whereas, within the wider apertures (1.5mm, 2mm, and 3mm) water travels in a continuous thread, however, much more sinuous and in an abrupt manner with water flowing out at various points of the fracture. Compared to narrower apertures, water flows out through a wider area. The visual experiments indicate that the width and orientation of the smooth joint have a significant effect on capillary and gravitational forces. Narrower apertures provide more contact between fluid and joint surface, thus, favouring capillary forces. Whereas, wider apertures provide a lesser contact area between water and surface, favouring gravity forces.

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