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Effects of Soil Porosity on Rainwater Infiltration, Slope Stability and Debris Flow Run-out

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Modeling rainwater infiltration in slopes is vital to the analysis of slope failure induced by heavy rainfall. To analyze rainwater infiltration into soil, it is important to have an understanding of the hydraulic properties of the soil, in particular the relationship between volumetric water content θ and soil capillary pressure ψ, and the relationship between unsaturated hydraulic conductivity K and ψ. These relationships are known as the water retention curve and the hydraulic conductivity function, respectively.

Among soil hydraulic properties, the hydraulic conductivity K, a measure of the capacity for water movement in soil, has been frequently analyzed for its effects on slope stability (*e.g.,* Reid, 1997; Cai *et al.,* 1998; Cho and Lee, 2001). In contrast, few studies have been published on the effects of water retention characteristics on slope stability. In this study, a numerical model is developed to estimate the extent of rainwater infiltration into an unsaturated slope, the formation of a saturated zone, and the change in slope stability. This model is then used to analyze the effects of the soil porosity parameters (*i.e.,* saturated soil water content θ_s, residual soil water content θ_r, and effective soil porosity (ESP)) on the occurrence of slope failure, the moisture conditions of the corrupted material, and the movement of debris flow.

Analysis of the effect of ESP values on rain-water infiltration and slope stability shows when the surface soil of a slope has a relatively large ESP value, it has a greater capacity for holding rainwater, and therefore delays rainwater infiltration into the subsurface layer. Consequently, the increase in pore water pressure in the subsurface layer is also delayed. In this manner, a relatively large surface layer ESP value contributes to delaying slope failure. Under weaker storm conditions, slope failure tends not to occur when the surface soil has a relatively large ESP value. However, the greater ESP value tends to increase the water content of the corrupted matter, which resulted in faster and longer travel distances, and in a broader extent of deposition of debris flow. As a consequence, such larger ESP values may increase the risk of damage in downstream regions.

Key words: rainwater infiltration; effective soil porosity; slope stability; debris flow

References

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