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A new Correlation Between Permeability and Capillary Pressure Curve in Unconsolidated Porous Media

Yun Hwa Jung[1] · Sang Il Hwang[2*] · Dong Soo Lee[1]

[1]*Graduate School of Environmental Studies, Seoul National University*
[2]*Korea Environment Institute*
e-mail: sangilh@kei.re.kr

ABSTRACT

The transmission of fluids by porous media has widespread relevance to engineering, geological, and agricultural problems. The ability of a porous medium to transmit fluid is described quantitatively by permeability, k, which is dependent on the pore structure alone. Several approaches to predicting permeability have been taken in the past. One approach is to seek empirical relationships between permeability and properties of the medium such as porosity or grain-size distribution. However, its application to various complex geologic media is questionable. A second approach is to relate permeability to the geometric properties of porous media. The well-known Kozeny-Carman model, which is based on the concept of hydraulic radius, is one example. However, the hydraulic radius theory fails to describe structural bodies such as fissured clays. A promising approach to the prediction of permeability from basic physical properties of the porous medium is to seek a connection between permeability and pore-size distribution. Since, however, there is no direct or simple way to obtain or characterize this distribution *per se*, it is an efficient way to use the capillary pressure curve that is based indirectly on the pore-size distribution. Several researchers have developed correlations between permeability and capillary pressure curve for *consolidated* porous media such as sandstones (Swanson, 1981; Guo et al., 2004). Swanson (1981) found that permeability is linearly related to the Swanson's parameter that is defined as the maximum of the ratio of the nonwetting phase saturation to the capillary pressure. In this study, we developed a new correlation between permeability and capillary pressure curve for *unconsolidated* porous media, using parameters of capillary pressure function developed by Kosugi (1996). The Kosugi function is based on the assumption of a

lognormal pore-size distribution. To develop a new correlation using parameters of Kosugi function and to compare its results with those from Swanson's parameter, we chose 168 soil samples from the Unsaturated Soil Hydraulic Database (UNSODA). We found, for unconsolidated porous media, that correlations using parameters of Kosugi function performed slightly better than those using Swanson's parameter. This result indicates that parameters of Kosugi function may have more significant information on the effective pore-size distribution than Swanson's parameter. Also, both parameters performed better for coarse-textured soils than for fine-textured soils, showing that both parameters are applicable to unconsolidated porous media with narrow grain- or pore-size distribution.

Key words: permeability, capillary pressure curve, Swanson's parameter, Kosugi function, and unconsolidated porous media