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# Determination of fractured bedrock hydraulic conductivity on a borehole scale: An empirical development with field applications

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The determination of bedrock hydraulic conductivity is a crucial task to support evaluation of hydraulic properties of fractured bedrock aquifers. This effort enables to bring information to establish a hydrogeologic conceptual model and process the model simulation for groundwater-related engineering problems. On the basis of boring logs, borehole televiewer image data, groundwater velocity measurements, porosity measurements and double packer hydraulic test data conducted in mountainous regions of Taiwan, significant parameters affecting the hydraulic conductivity of fractured bedrock with the collected data were explored through bivariate analysis. The selected significant parameters include rock quality designation (RQD), depth index (DI), gouge content designation (GCD), lithology permeability index (LPI), groundwater vertical velocity (V), porosity (n), fracture width (FW), and fracture frequency (FF). The rating approaches for each parameter and synthetic systems (integrated multiple influential parameters together; five types of combinations) that represent the magnitude of permeability are also designed. These rating systems can be used to perform a numerical assessment of the fractured bedrock hydraulic conductivity.

This study correlated each parameter and synthetic systems with hydraulic conductivity measurements, respectively. The Spearman correlation coefficient for each parameter (the highest correlation coefficient is 0.691) is lower than those of the synthetic systems (the highest correlation coefficient is 0.896). This outcome implies the hydraulic conductivity relies on multiple potential parameters but one single potential parameter. Subsequently, five synthetic systems were utilized to develop empirical models of estimating fractured bedrock hydraulic conductivity. Regression analysis with different regression models (e.g., linear, polynomial, power law and exponential) was performed to investigate the relationship between each synthetic system and hydraulic conductivity. The overall results of the regression analysis for all five empirical models indicate that a power law relationship exists between each synthetic system and hydraulic conductivity, and the calculated R-squared value ranges from 0.715 to 0.804.

According to the above studies on the empirical development of fractured bedrock hydraulic conductivity, five empirical models can be regarded as a practical tool, which removes the expense of in-situ hydraulic testing, to predict continuous hydraulic conductivity data in a given borehole with their regression equations. The continuous data in practice help evaluate vertical variations in hydraulic conductivity. Therefore, the proposed models can provide a basis for understanding the hydraulic characteristics of fractured bedrock and quantitative information for various groundwater-related engineering design purposes.