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Development and implementation of a fluid flow code to evaluate block hydraulic behaviors of the fractured rock masses

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A computer program code was developed to estimate the hydraulic head distribution through the 2-D DFN(discrete fracture network) blocks considering hydraulic aperture of the individual fractures, and to determine flow quantity, directional block hydraulic conductivity and principal hydraulic conductivity tensor according to fracture geometry such as orientation, frequency and size of the fracture network systems. The generated stochastic DFN system is assumed to have a network structure in which the equivalent flow pipe composed linear fractures is complexly connected. DFN systems often include individual or group of sub-network that are isolated from a network that can act as fluid flow passages from one flow boundary to another, and the fluid flow is completely blocked due to lack of connectivity. Fractures that are completely or partially isolated in the DFN system do not contribute to the overall fluid flow through the DFN system and add to the burden of numerical computation. This sometimes leads to numerical instability and failure to provide a solution. In this study, geometric and mathematical routines were designed and implemented to classify and eliminate such sub-networks. The developed program code can calculate the total head at each node connected to the flow path with various aperture as well as hydraulic conductivity of the individual flow pipe using the SOR method. Numerical experiments have been carried out to explore the applicability of the developed program code. A total of 108 stochastic 2-D DFN blocks of 20 m$\times$20 m with various hydraulic aperture were prepared using two joint sets with fixed input parameters of fracture orientation, frequency and size distribution. The hydraulic anisotropy and the chance for equivalent continuum behavior of the DFN system were found to depend on the variability of fracture aperture.