Permeability tensors of three-dimensional numerically grown geomechanical discrete fracture networks

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The mechanics of fracture propagation and interaction influence the growth and permeability of developing fracture networks. A set of initial flaws grows quasi-statically in response to a remote tensile stress. A finite element, stress intensity factor-based approach grows these flaws into non-planar three-dimensional discrete fracture networks (GDFNs). Their extension and growth angle is a function of local stress intensity factors along a fracture tip. Stress concentration increase when proximal fractures are aligned, and decreases when they are sub-coplanar. These interactions can result in the reactivation of fractures that were initially inactive, and the arrest of fractures that become entrapped by proximal growing fractures. Interaction can cause growth away from an intersection front between two fractures, resulting in evolving fracture patterns that become non-uniform and non-planar, forming dense networks. These GDFNs provide representations of subsurface networks that numerically model the physical process of concurrent fracture growth. Permeability tensors of the geomechanical 3D networks are computed, assuming Darcy flow. Growth influences apertures, and in turn, the hydraulic properties of the network. GDFNs provide a promising way to model subsurface fracture networks, and their related hydro-mechanical processes, where fracture mechanics is the primary influence on the geometric and hydraulic properties of the networks.