Notes on Fracture - Cubic Law and Linear Law

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1 Cubic Law

1.1 Deduction from Navier-Stokes

This model of the fracture assumes that the flow is viscous and slow, so the inertia terms in the Navier-Stokes can be neglected. The fracture is saturated with water, and are thin.

1.2 Cubic Law for Discharge

The cubic law for discharge in the direction of the fracture is

$$Q_s(s) = -\beta^* b^3 \frac{\partial \tilde{\phi(s)}}{\partial s} \tag{1}$$

where b is the total aperture of the fracture and β^* is equal to

$$\beta^* = \frac{\rho g}{12\mu} \tag{2}$$

where ρ is the density of water, $[kg/m^3]$; g is the gravity acceleration $[m^2/s]$, and μ is the dynamic viscosity, $[Pa.s]$, $[kg/(m.s^2)]$.

1.3 Cubic Law for the Potential

$$Q_s(s) = -\frac{\beta^* b^3}{k} \frac{\partial \Phi}{\partial s} \tag{3}$$

2 Linear Law

2.1 Linear Law Approximations

The Linear Law for flow in the fractures assumes that the fracture is filled with a material of hydraulic conductivity k^*, that the flow is viscous and slow and incompressible.

2.2 Linear Law for Discharge

The discharge is equal to

$$Q_s(s) = -k^* b \frac{\partial \tilde{\phi(s)}}{\partial s} \tag{4}$$

2.3 Linear Law for Potential

$$Q_s(s) = \frac{k^* b}{k} \frac{\partial \Phi}{\partial s} \tag{5}$$