Geophysical Research Abstracts
Vol. 18, EGU2016-16487, 2016
EGU General Assembly 2016

On the closure of circular holes in nonlinear viscous media.

Jan Cornet, Marcin Dabrowski, and Daniel Schmid
UIO, PGP, Oslo, Norway (jscornet@hotmail.fr)

Many rocks exhibit viscous behaviors which have to be taken into account in applications ranging from wellbores creeping during drilling to salt caves or hard rock mine tunnels shrinking with time. We address all these different cases using a unified configuration. We consider a 2D plane strain problem where a circular hole, representing the wellbore, the cave or the mine tunnel depending on the application, is embedded in an infinite incompressible non-linear viscous material. The problem is purely mechanical. Not only the rheological model used here is well suited for real formations but it can also represent many different sorts of rocks like salts, shales, quartzite and even ice. The major difference between the applications concerns the relevant time scales and they must therefore be separated according to that. For short timescale applications like wellbore creep during drilling it is first necessary to determine whether an elastic component must or must not be taken into account. This analysis is carried out using a non-linear viscoelastic Maxwell model. If it is acknowledged that a purely viscous rheology is enough, as can be the case for salts, then we can proceed with our unified configuration.

We start by considering the case where the medium is isotropic and where pressure boundary conditions are prescribed both at the hole rim and at infinity. This problem is 1D due to axial symmetry. Analytical solutions to very similar problems have already been provided and we compare the solution we have derived to the existing ones. We show that our solution is consistent and that we recover similar results to the ones derived for comparable rheologies.

Using MILAMIN, a fast finite element code, we investigate further two cases which lead to angular dependency and stress concentrations around the hole. In the first case we add a deviatoric stress at infinity and we study the impact of this extra stress on the solution. It is important to understand this parameter because deviatoric stresses are common in reality and this issue must therefore be addressed. The other case deals with anisotropic viscosities. Rocks like shales and salts can be anisotropic so we take this into account and explore the degree to which it can modify our original solution.

We finish by investigating other constitutive laws which do not only reflect dislocation creep but diffusion creep too. This is achieved by considering the total strain as being respectively the sum of a nonlinear and of a linear law. Adding this extra term is important to accurately model the closure of the hole when the latter has a radius much smaller than the initial one.