Post-doctoral position on fracture of anisotropic media: a lattice poromechanics- based approach

Over the past decades, the lattice approach to fracture has been proven to be a powerful technique for describing the processes involved during cracking in quasi-brittle heterogeneous materials. The extension of the lattice approach to coupled phenomena, such as hydraulic fracturing or coupled diffusion – mechanical problems (e.g. corrosion of steel in concrete), has been also considered. Looking at the example of hydraulic fracturing, poromechanics can be – conceptually – rather easily introduced by considering two coupled dual sets of lattices, one for the hydraulic problem and the second one for the mechanical problem. There are, however, at least two pending issues in such an approach that need to be addressed in order to understand the mechanisms involved in such a process – when applied to real cases in rock mechanics:

1. The first issue deals with a better appraisal of the influence of damage in poromechanics. Current approaches consider that the coupled hydro-mechanical effects captured by the Biot coefficient and the Biot modulus (Biot, 1941) are simplified. These quantities do not depend on the state of mechanical damage, although classical homogenisation show that they should. In other words, the effective stress should evolve towards the Terzaghi stress upon damage and the Biot coefficient should increase.
2. The second issue deals with the anisotropy of the properties of the considered rock. In almost all existing models, the anisotropy of the elastic parameters, and above all the anisotropy of the fracture properties of the material are not considered. A rather simplistic look at a sedimentary rock shows that this assumption may not be realistic at all. It may fundamentally affect the damage zone/macro-crack propagation and it may induce some preferential directions that could not be expected in a isotropic material for instance.

The topic of the proposed study shall deal with the issue of anisotropy. Anisotropic elasticity and anisotropy of the failure properties will be considered. In each case, one needs to define the continuum model that is expected to be recovered in the limit of lattice elements of infinitely small sizes. In addition, new model parameters need to be defined, and also measured experimentally (at least two different fracture energies for transverse isotropy corresponding to a layered microstructure). Here, we shall concentrate on the modelling issue, using parameters available in the literature and we will focus on the proper description of the anisotropy of fracture from the mechanical point of view. Then, the model will be implemented and issues dealing with a proper poromechanical description shall be considered (item 1). An expected result is the comparison of crack propagation and directions on some specific small-scale structures that could be further tested in order to validate the method.

This post-doctoral work will be supervised by Prof. Gilles Pijaudier-cabot in collaboration with Alexandre Lapene at Total SA. The expected duration is one year, starting as soon as possible.

Location: the main location of the candidate will be at the Total office in Palo Alto near Stanford University but the candidate is expected to visit the Laboratoire des fluides Complexes in Anglet (France) on a regular basis.

Applications (CV, list of publications and motivation letter) should be sent by mail to Gilles Pijaudier-Cabot (Gilles.Pijaudier-Cabot@univ-pau.fr)