Thibaut Defoort

Comparison of fracture and damage mechanics approaches to simulate three-point bending and double-notch experiments on rock samples

Rock failure can be modelled using a variety of numerical methods, including Linear Elastic Fracture Mechanics, and Continuum Damage Mechanics. In the former approach, cracks are modelled explicitly, whereas in the latter approach, the effect of the cracks is represented by a smeared-out degradation of the elastic moduli. Few comparisons have been presented to contrast the predictions obtained using these two approaches. In this presentation, a comparison of the modelling of failure in three-point-bending and double-notch experiments will be presented, using LEFM and CDM. The CDM simulations are conducted using the Mazars isotropic damage model. In the explicit fracture simulations, fractures are represented as explicit surfaces within a three-dimensional unstructured mesh comprised of isoparametric quadratic tetrahedra and quarter-point tetrahedra. Heterogeneities in strength, stiffness and toughness are introduced in a random manner, within ±50% of the average values. A characteristic length is used to define the size of element clusters having uniform properties. Both approaches are used to evaluate the influence of material heterogeneity on crack propagation and interaction. It is found that both models reproduce well the experimental results for homogeneous rocks. In the three-point-bending and double-notch simulations, the damage mechanics approach is more realistic in that it leads to rougher crack surfaces. However, the fracture mechanics model predicts lower curvature of the fracture, which better corresponds to experimental observations. Both approaches
predict that the presence of heterogeneities diminishes fracture interaction.

Thibaut Defoort is a second-year PhD student, working in the rock mechanics research group under the supervision of Adriana Paluszny and Robert Zimmerman. He holds an MSc degree in Mechanics from ECAM Lyon in France.