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Comparison of mechanical and hydro-mechanical models for rough fracture closure

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Flow in fractured porous media is in part controlled by the fluid pressure within the fracture, which is typically modelled by assuming planar fracture surfaces. However, experimental data has shown that the geometry of non-planar, i.e. rough fracture surfaces impacts both permeability and its dependency on stress. Various (semi-)analytical and numerical methods have been developed to describe this stress-permeability relationship in rough fractures. This paper aims to compare two methods and analyze the suitability for a particular purpose: a) numerical contact mechanics based fracture closure using Virtual Element Method connected to Stokes flow solver and b) analytical McDermott closure connected to 3D Darcy flow solver. We investigate the mechanical and hydro-mechanical evolution of a rough fracture with synthetically created and natural mudrock surfaces. The roughness is represented by heights profiles and parametrized by the fractal dimension and by the root mean square of heights. Simulation is carried by taking 2D cross-sections from the 3D surface and compared against the McDermott model. Results of two approaches compare well for the stress-aperture and stress-permeability relationships, and McDermott model can be used for general purposes. However, the numerical method offers more flexibility for more specific modelling such as modelling exact fracture roughness, implementation of nonlinearities in the material or failure. Besides, the normalized aperture vs. the number of contacts relationships, which is related to the fracture roughness, were proposed for the use in McDermott.

Time Block Preference

Time Block A (09:00-12:00 CET)

References

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Primary author: KUBEYEV, Amanzhol

Co-authors: Dr BISDOM, Kevin (Shell Technology Centre Amsterdam); Dr KAMPMAN, Niko (Shell Technology Centre Amsterdam); DOSTER, Florian

Presenter: KUBEYEV, Amanzhol

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