EGU2020-22623
https://doi.org/10.5194/egusphere-egu2020-22623
EGU General Assembly 2020

Use of "digital core" module in SAE Fidesis to determine effective parameters of fractured porous media

Vladimir Levin
Lomonosov Moscow State University, Faculty of Mechanics and Mathematics, Department of Computational Mathematics, Moscow, Russian Federation

Development of the homogenization algorithms for the heterogeneous periodic and non-periodic materials has applications in different domains and considers different types of upscaling techniques (Fish, 2008, Bagheri, Settari, 2005, Kachanov et al. 1994, Levin et al. 2003).

The current presentation discusses an algorithm implemented in CAE Fidesys (Levin, Zingerman, Vershinin 2015, 2017) for calculating the effective mechanical characteristics of a porous-fractured medium (Myasnikov et al., 2016) at the scale of a periodicity cell dissected by a group of plane-parallel cracks modeled by elastic bonds with specified stiffnesses in the normal and tangential directions in accordance with the method of modeling cracks based on elastic bonds (Bagheri, Settari, 2005, 2006) In this case, the relationship between the components of the displacement vector and the force vector (normal stresses at the fracture's boundaries) in the normal and tangential directions will be diagonal, neglecting the effects of dilatancy and shear deformations as a result of normal stresses.
The presentation also considers the general case of the relationship between displacements and forces along the fracture's boundaries, taking into account shear deformations (which leads to an increase in the effective Young's modulus by 30%), and additionally a cell's geometrical model is generalized by the presence of pores in the matrix's material. The results of numerical studies on mesh convergence, the influence of periodicity cell sizes and fracture's thicknesses on the computed effective properties are presented. A comparison between analytical (Kachanov, Tsukrov 1994, 2000) and numerical results obtained in CAE Fidesys for the effective elastic moduli estimation for particular cases of geometrical models of the periodicity cell is shown.
The developed algorithm is used to evaluate the effective mechanical properties of a digital core model obtained by the results of CT-scan data interpretation. A comparison is made with the results of laboratory physical core tests. Additionaly an algorithm implemented in CAE Fidesys and the results for the effective thermal conductivity and the effective coefficient of thermal expansion estimation are given for the considered test rock specimen.

The reported study was funded by Russian Science Foundation project № 19-77-10062.

- Bagheri, M., Settari, A. Effects of fractures on reservoir deformation and flow modeling // Can. Geotech. J. 43: 574–586 (2006) doi:10.1139/T06-024
- Bagheri, M., Settari, A. Modeling of Geomechanics in Naturally Fractured Reservoirs – SPE-93083-MS, SPE Reservoir Simulation Symposium, Houston, USA, 2005.
- Fish J., Fan R. Mathematical homogenization of nonperiodic heterogeneous media subjected to large deformation transient loading // International Journal for Numerical Methods in Engineering. 2008. V. 76. – P. 1044–1064.
- Kachanov M., Tsukrov I., Shafiro B. Effective moduli of a solid with holes and cavities of various shapes// Appl. Mech. Reviews. 1994. V. 47, № 1, Part 2. P. S151-S174.