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BARIK: laboratory programme within the framework of the development of an extended Hoek–Brown-based anisotropic constitutive model for fractured crystalline rock

Max Friedel[1], **Fabian Weber**[1], **Heinz Konietzky**[1], **Paola Rocio León Vargas**[2], **Alireza Hassanzadegan**[2], **and Michael Rahmig**[2]

[1]Lehrstuhl für Gebirgs- und Felsmechanik/Felsbau, Institut für Geotechnik, TU Bergakademie Freiberg, Gustav-Zeuner-Str. 1, 09599 Freiberg, Germany
[2]BGE TECHNOLOGY GmbH, Eschenstr. 55, 31224 Peine, Germany

Correspondence: Max Friedel (max.friedel@ifgt-tu-freiberg.de)

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Abstract. The disposal of heat-generating radioactive waste in deep geologic formations is a global concern. Numerical methods play a key role in understanding and assessing the disposal scenarios of radioactive waste in deep geological repositories. However, the complexities of the thermal, hydrological, mechanical, chemical, and biological processes associated with the disposal of radioactive waste in porous and fractured materials constitute significant challenges. One of the most challenging issues in this field is the complex material behaviour of fractured crystalline rock. The presence of fractures makes the rock anisotropic, nonlinear, and dependent on loading paths. Additionally, the Biot coefficient cannot be considered constant throughout the critical and subcritical fracture development regions. These factors make the development of an accurate constitutive model for fractured crystalline hard rock a critical component of any deep geological disposal project. Furthermore, to demonstrate the integrity of the "containment effective rock area" in crystalline host rock, the qualitative integrity criteria must be quantified so that numerical simulation can be performed with concrete numerical values. Part of this assessment for a crystalline host rock is a dilatancy criterion, which is currently based on the Hoek–Brown constitutive model.

This contribution provides an overview and first results of the laboratory programme, which was performed as a part of the research project. The aim was to generate a fundamental and extensive dataset for an anisotropic material used for verification and validation purposes of the newly developed constitutive model. The rock material for the test programme was "Freiberger gneiss" because of its pronounced anisotropic properties regarding deformation and strength as well as the good access to obtain a larger amount of sample material. A wide range of basic tests have been performed, e.g. determination of density and porosity, measurement of ultrasonic wave velocities to get dynamic elastic properties, Brazilian tests, and uniaxial compression tests to obtain strength data. Additionally, a large number of more complex multi-stage triaxial compression tests with examination of the post-failure region and hydromechanical coupled triaxial compression tests have been conducted or are in progress. The hydromechanical part, in particular, plays an important role in examining and quantifying the evolution of the micromechanical damage process, which changes the permeability and Biot coefficient and therefore the effective stresses inside a saturated rock material. Tests were conducted with different orientations of the structural planes in relation to the loading directions.

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