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Feasibility studies of a continuum modelling approach using a ubiquitous-joint model in modelling fractured crystalline rock

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Abstract. According to the Site Selection Act, crystalline rock – in addition to rock salt and claystone – is considered a potential host rock for the disposal of high-level radioactive waste in Germany. Crystalline rock formations are inherently anisotropic and heterogeneous due to the presence of discontinuities. Therefore, it is necessary to consider discontinuities in the modelling of rock behaviour. Different numerical approaches are available to stimulate the thermo-hydro-mechanical (THM) behaviour of the crystalline rock. On the one hand, DEM approaches allow high accuracy in the modelling of single and multiple fractures generally but offer low computational efficiency the larger the models are. On the other hand, continuum-based approaches provide high computational efficiency but less accuracy. There are also different subtypes available in the literature. For example, the fracture continuum approach can be used.

We investigate the different approaches to identify the advantages and limitations of each numerical approach in simulating mechanical deformation processes in crystalline rock. To assess the integrity of the geological barrier, the fluid pressure and dilatancy criteria are defined. The fluid pressure criterion states that the expected fluid pressures do not exceed the strength of the rock within the geological barrier. The dilatancy criterion states that the induced mechanical stresses do not exceed the strength of the rock within the geological barrier. The project proposes a continuum modelling approach using a ubiquitous-joint model that enables the modelling of the rock fractures in crystalline rock explicitly. In a first step, preliminary studies were carried out on small-scale models such as cylindrical specimens and plate-like specimens with deterministic single, parallel and two orthogonal fractures under uniaxial testing conditions. The typical anisotropic compressive strength curves were reproduced and compared with both analytical and observed results from the literature. It can be shown that the influence of fracture orientations on the strength properties of the rock can be captured well. In a second step, the applicability of the model for large-scale analyses of anisotropic rock masses is tested using predefined structural–geological information. The models considered for the large-scale analyses are a model with a borehole, a model with a tunnel and a model with an underground repository. The influence of fracture orientation on the large-scale models and its impact on assessing the integrity of the geological barrier will be investigated in the context of the safe disposal of high-level radioactive waste in crystalline rock. The numerical approach and preliminary results of the numerical tests will be presented in the planned poster presentation.

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