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NUMERICAL MODELLING OF TWO-PHASE FLOW IN FRACTURED ROCK MASSES USING ZERO-THICKNESS INTERFACE ELEMENTS

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ABSTRACT

In recent years, the authors and co-workers have developed a 3D finite element model for coupled thermo-hydro-mechanical (THM) problems in fractured rock masses. Zero-thickness interface elements are used for taking into account explicitly the effect of fractures and discontinuities in the fluid flow as well as the effect of fluid pressure in the crack propagation. Furthermore, the use of zero-thickness elements as a discrete modelling approach for fractures and discontinuities makes it possible to account for the heat transport taking place within these elements, even when advection dominates over diffusion (high Peclet number) [1]. The model has been implemented in the finite element code DRAC5, which is equipped with fracture-based interface elements and MPI parallel capabilities [2].

The code was originally developed considering water-saturated porous medium and fractures. The new developments described in the present paper, include the extension of the original formulation to the case of two-phase (liquid and gas) flow within the porous medium and discontinuities. The liquid includes only liquid water species, while the gas phase includes water vapour and gas species. The formulation includes the equilibrium equation, the mass balance of water and gas species and the energy balance equation. The parameters of the retention and relative permeability curves for the interface elements, such as the gas entry value and the residual water saturation, are updated with the variation of the normal aperture. The new capabilities of the model are illustrated with some academic verification examples.

REFERENCES

[1] A. Pérez, I. Carol and P. Prat, *Heat transport with advection in fractured rock.* In Proceedings of COMPLAS 2019, pages 565-576. CIMNE (2019).

[2] D. Garolera, I. Aliguer, I. Carol, J. M. Segura, M. R. Lakshmikantha and J. Alvarellos, *Hydro-mechanical coupling in zero-thickness interface elements, formulation and applications in geomechanics.* In Proceedings of EUROCK 2014, pages 1379-1384. CRC Press (2014).