6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

MORTAR CONTACT FORMULATION USING SMOOTH ACTIVE SET STRATEGY APPLIED TO 3D CRACK PROPAGATION

Ignatios Athanasiadis[1*], Zahur Ullah[2], Łukasz Kaczmarczyk[1] and Chris J. Pearce[1]

[1] School of Engineering, University of Glasgow, Rankine Building, Oakfield Avenue, Glasgow G12 8LT, Ignatios.Athanasiadis@glasgow.ac.uk, Lukasz.Kaczmarczyk@glasgow.ac.uk, Chris.Pearce@glasgow.ac.uk

[2] School of Engineering, Ulster University, Shore Road Newtownabbey Co. Antrim BT37 0QB, z.ullah@ulster.ac.uk

Keywords: *Contact, Mortar Method, Active Set, Small Strains, Small Displacements, Brittle Fracture*

This work focuses on 3D modelling of multi-body frictionless contact of brittle materials by means of the mortar method under the assumption of small displacements and infinitesimal deformations. The aim is to understand the influence of contact on quasi-static fracture propagation in nuclear graphite bricks.

Surfaces of two bodies that are candidate to come to contact are denoted as master and slave surfaces. No self-contact is considered and body domains are discretised by tetrahedral elements. When two triangular faces of tetrahedral elements are candidate to come to contact, with one face belonging to the master and the other to the slave surface, they are used to create a special triangular prism element. Only small displacements are taken into account, hence prisms are created only at the beginning of an analysis. These elements are used to perform integration of displacements and Lagrange multipliers shape functions and mapping of the displacements shape functions from the master to the slave surface according to the mortar method [1]. At each step of the analysis, prism triangular faces can either be in contact or form a gap denoting an active or passive state, respectively. The state of a prism is determined by evaluation of the complementary function proposed by [2] that, in the present work, is modified in order to yield a smooth Newton method algorithm. This modification involves two steps, expression of max function encompassed in the complementary function by means of an absolute value and then substitution of the C^0 absolute function with a similar C^1 function. Furthermore, the focus of this work is the contact between nuclear graphite bricks, that are also subjected to fracture, where crack propagation is solved in the context of configurational mechanics for infinitesimal deformations [3].

The model will be used to investigate the influence of contact when a slice of a nuclear graphite brick, that has an initial crack, is loaded through graphite keys. The keys are subjected to displacement boundary conditions that transfer tractions to the brick resulting to propagation of the crack. Results will be compared to numerical results where keys and brick form of a continuous body and experimental results presented in [3].

REFERENCES

[1] Ullah, Z., Kaczmarczyk, Ł, and Pearce, C.J., Three-dimensional mortar contact formulation: an efficient and accurate numerical implementation. In: *25th UKACM Conference on Computational Mechanics, University of Birmingham Birmingham, United Kingdom* 4 pp.

[2] Popp, A. and Gee, M.W. and Wall, W.A. O.C. Zienkiewicz, O.C. and R.L. Taylor, A finite deformation mortar contact formulation using a primal-dual active set strategy. *Int. J. Numer. Methods Eng.*, Vol. **79**, pp. 1354–1391, 2009.

[3] Kaczmarczyk, Ł, Ullah, Z. and Pearce, C.J., Energy consistent framework for continuously evolving 3D crack propagation. *Comput. Meth. Appl. Mech. Eng.*, Vol. **324**, pp. 54–73, 2017.