Multiscale Modelling of Damage and Fracture in Discrete Materials Using a Variational Quasicontinuum Method

Ondřej Rokoš*, Ron H. J. Peerlings*, Lars A. A. Beex†, and Jan Zeman‡

* Department of Mechanical Engineering, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands

† Faculté des Sciences, de la Technologie et de la Communication, Campus Kirchberg, Université du Luxembourg 6, rue Richard Coudenhove-Kalergi, L-1359 Luxembourg

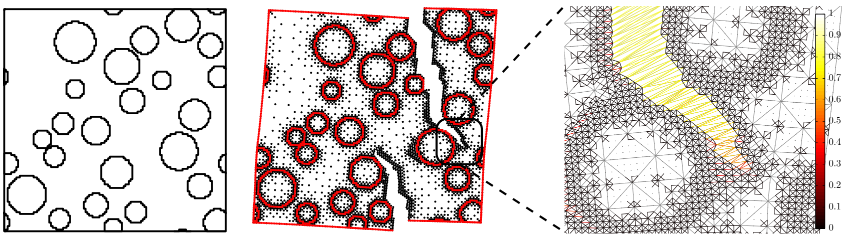
‡ Department of Mechanics, Faculty of Civil Engineering, Czech Technical University in Prague, Thákurova 7, 166 29 Prague 6, Czech Republic

Emails: o.rokos@tue.nl, r.h.j.peerlings@tue.nl, lars.beex@uni.lu, zemanj@cml.fsv.cvut.cz

ABSTRACT

Discrete materials such as 3D printed structures, paper, textiles, foams, or concrete, can be successfully modelled by lattice structures, which are especially suited for the description of non-localities, large deformations, and plasticity or damage in individual fibres. In Fig. 1, for instance, an example of a crack propagating in a concrete specimen is shown. The macro-scale fracture emerges as a result of the failure of individual interactions of the underlying lattice.

Because the application scale is in general much larger than the lattice spacing, lattice structures are often computationally too expensive when used for engineering problems. To overcome such a limitation, the QuasiContinuum (QC) methodology has been developed by Tadmor *et al.* [1] for conservative atomistic systems. Extensions to dissipative systems followed in [2, 3].



(a) application (b) deformed state (c) localized crack

Figure 1: An example application. The underlying X-braced lattice represents a concrete specimen with stiff, randomly distributed circular inclusions.

The aim of this talk is to demonstrate how crack propagation in discrete materials may be simulated using a variational QC method. A suitable marking strategy together with an adaptive algorithm will be introduced. In the case of localized cracks, coarsening in their wakes by means of the partition of unity and extended interpolation will be discussed. The proposed methodology will be demonstrated on two examples: on a concrete specimen subjected to combined tension and shear (Fig. 1), and on a concrete specimen subjected to a four-point bending test.

REFERENCES

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