Multiscale Quasicontinuum Approaches for Planar Beam Lattices

***L.A.A. Beex[1], P. Kerfriden[1], S.P.A. Bordas[1,2]**

[1]School of Engineering, Cardiff University, Queen's Buildings, The Parade, Cardiff CF24 3AA, Wales, UK.
[2]Faculté des Sciences, de la Technologie et de la Communication, Université du Luxembourg,
6 rue Richard Coudenhove-Kalergi, L-1359 Luxembourg.

*Corresponding author: L.A.A.Beex@gmail.com

The quasicontinuum (QC) method was originally developed to reduce the computational efforts of large-scale atomistic (conservative) lattice computations [1]. QC approaches have an intrinsically multiscale character, as they combine fully resolved regions in which discrete lattice events can occur, with coarse-grained regions in which the lattice model is interpolated and integrated (summed in QC terminology). In previous works [2,3], virtual-power-based QC approaches were developed for dissipative (i.e. non-conservative) lattice computations which can for instance be used for fibrous materials. The virtual-power-based QC approaches have focused on dissipative spring/truss networks, but numerous fibrous materials can more accurately be described by (planar) beam networks. In this presentation, different QC approaches for planar beam lattices are introduced [4]. In contrast to spring/truss lattices, beam networks include not only displacements but also rotations which need to be incorporated in the QC method, resulting in a mixed formulation. Furthermore, the presentation will show that QC approaches for planar beam lattices require higher-order interpolations to obtain accurate results, which also influences the numerical integration (summation in QC terminology). Results using different interpolations and types of integration will be shown for a multiscale example.

Keywords: multiscale, quasicontinuum method, beam lattice, beam network, integration, summation

References

[1] Tadmor EB, Philips R, Ortiz M, 1996, *Mixed atomistics and continuum models of deformation in solids*, Langmuir 12, 4529-4534.

[2] Beex LAA, Peerlings RHJ, Geers MGD, 2014, *A multiscale quasicontinuum methodology for lattice models with bond failure and fiber sliding*, Computer Methods in Applied Mechanics and Engineering 269, 108-122.

[3] Beex LAA, Peerlings RHJ, Geers MGD, 2014, *A multiscale quasicontinuum methodology for dissipative lattice models and discrete networks*, Journal of the Mechanics and Physics of Solids 64, 154-169.

[4] Beex LAA, Kerfriden P, Rabczuk T, Bordas SPA, *Quasicontinuum-based multiscale approaches for plate-like beam lattices experiencing in-plane and out-of-plane deformation*, Submitted to Computer Methods in Applied Mechanics and Engineering.