# LATTICE ELEMENT METHOD AND ITS APPLICATIONS

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Lattice element method (LEM) is developed as a class of discrete element method (DEM), where structure is represented as an assembly of one dimensional elements (Figure 1). Many various models for initiation and propagation of multiple fractures were constructed from this idea. The scope of the method is wide, including failure and fracturing of the various materials in statics or dynamics, multiphysics with volumetric fluid structure interaction such as porous media, thermodynamics etc. The main distinction between the solvers in lattice element method is important. Namely, one type of solvers include lattice element removal which is computed by sequentially linear analysis mimicking the nonlinear response. The other one is the true nonlinear analysis solved by incremental iterative procedures such as Newton method. The latter usually suffers from negative stiffness terms and divergence of the algorithm. The remedy for this problem lies in the technology of embedded strong discontinuities coupled with lattice elements [1]. Moreover, the mesh- independence in terms of fracture energies is preserved with such technology.

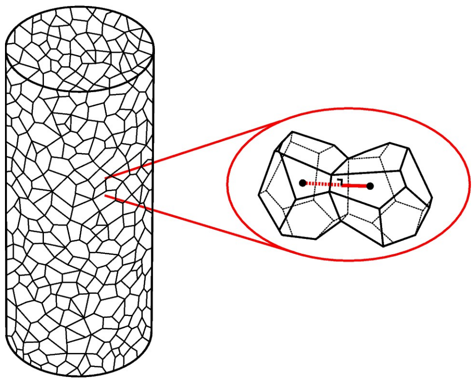

Figure 1: Lattice element representation of the domain: Voronoi cells kept together by cohesive links

In this work we cover the methodology and various applications of the method, including the complex failure mechanisms of rocks (Figure 2) [3, 4] and multiphysics problems of porous media [5]. Moreover, the crack propagation in dynamic regime will be presented as well (Figure 3) [2]. Beside the crack path, the total energy balance in dynamically driven localized failure propagation represents very important information. The full energy balance will be investigated on the well known benchmark problems where pre-notched plate is subjected to edge impulsive load causing the dynamic crack propagation until the complete failure. Namely, the input work introduced into the system by external loads should be monitored in time, while internal energy balance in damage and plasticity softening is maintained by exchanging the kinetic energy, strain energy, plastic free energy and dissipated energy in time. The role of plastic free energy is explained through the energy balance principles. The common mistake of neglecting the role of plastic free energy is also given, and its influence on fracture energy pointed out.

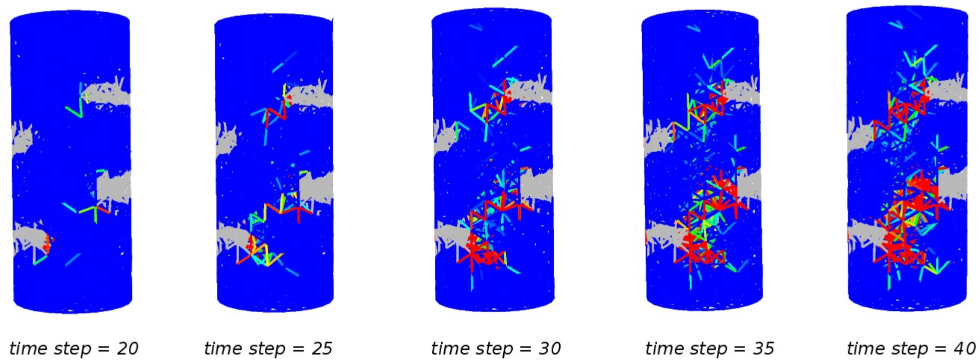


Figure 2: Fracture propagation in limestone rock specimens with initial defects

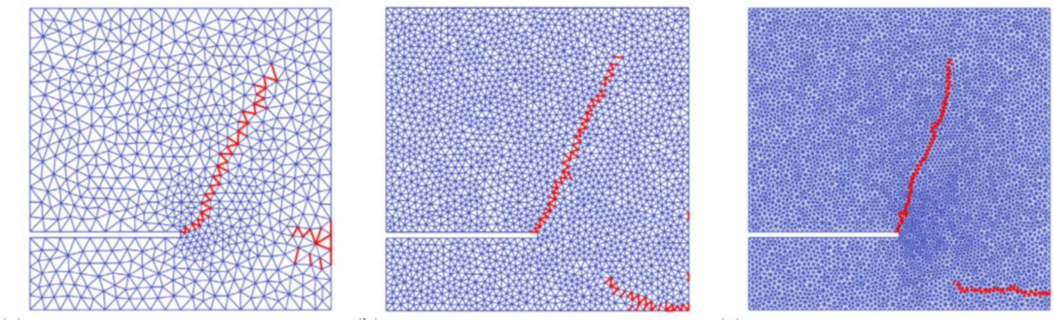

Figure 3: Impact problem on Kalthoff's test: dynamically driven fracture propagation

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