An adaptive material point method coupled with a phase field model for crack propagation– PARTICLES 2019

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ABSTRACT

As one of the extension of particle-in-cell methods, the material point method (MPM) based on the combination of Lagrangian and Eulerian material descriptions is developed by Sulsky *et al.* [1] to treat large deformation problems. Since material behavior is monitored at material particles that move within a Eulerian grid area, MPM does not need to construct a new mesh for newly created crack geometry and to consider the distortion of elements unlike the conventional finite element method. MPM is useful to analyze material damage and crack propagation in arbitrary locations and orientations.

In this study, the phase field model [2] is introduced to combine with the material point method to analyze the crack propagation efficiently. The phase field model has the advantage on crack propagation simulations, because the phase field damage evolution can predict crack initiation and fracture for materials. By combining the material point method and the phase field model, crack propagation and crack branching problem with complex geometry can be solved efficiently.

In order to simulate the damage evolution and crack propagation occurring in a damage zone with an inherent length scale [3], local refinements of material particles and grid cells are required to achieve a resolution in numerical simulations. A background grid of material particles is adaptively refined based on the material damage which is evaluated by solving a phase field model as shown in Fig. 1. Consequently, the characteristic length of material damage associated with crack propagation is considered to multiscale adaptive material point method coupling with phase field model.

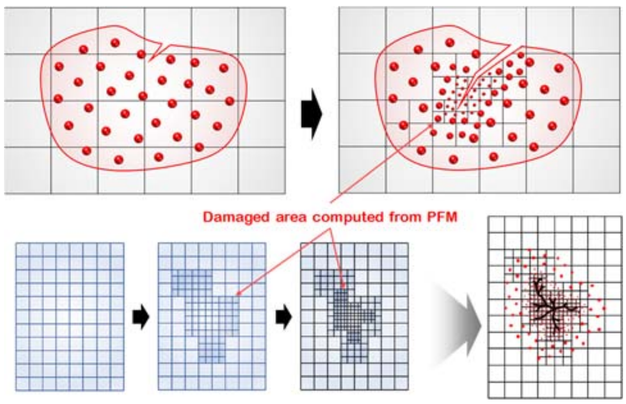

Fig. 1. Locally refined background grids and material particles

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