Phase-field modelling of crack propagation with a meshless numerical approach

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Due to the simple nature and ease of application, the phase-field modelling of cracks has gained significant attention recently as a promising method for simulating crack behaviour in various metallic materials during metallurgical thermomechanical processing. In this study, for the first time, the combined governing equations for phase-field and mechanical modelling are solved in a strong form using the meshless local radial basis function collocation method (LRBFCM) [1] to simulate crack propagation subjected to tensile loading conditions.
The cracks in the phase-field approach are defined as diffuse interfaces within the material, describing the crack by a continuous scalar field smoothly transitioning between the broken and intact material. Phase-field can capture the crack evolution without explicitly tracking the crack surface.
To validate the proposed solution procedure, we solved a benchmark test of a square geometry with a pre-defined crack in an elastic material subjected to tensile loading increments. The effects of different formulation parameters, such as length scale parameter, number of local support nodes, node density, and order of augmentation of the polyharmonic splines used for the shape functions, are analysed in this study. Our results fit the previously published data in the literature.
Since our results fit the previously published data, we demonstrate that LRBFCM combined with the phase-field approach can accurately capture the crack behaviour under tensile loading conditions. Furthermore, the meshless approach offers an advantage in efficient and straightforward coping with complex crack geometries without changing the domain discretisation during the crack growth.
The application of LRBFCM to the phase-field modelling of cracks contributes to computational fracture mechanics based on strong-form meshless methods. It complements our previous studies, using this method in various metallurgical processing.

1. B. Šarler, R. Vertnik, *Computers & Mathematics with Applications*, 2006, *51*, 1269-1282.