Phase field modelling of quasi-static brittle fracture using the scaled boundary finite element method

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Abstract

The phase field method (PFM) for fracture is in high demand due to its ability to automatically simulate crack nucleation, crack branching and coalescence without additional post-processing techniques [1]. The flexibility comes at a higher computational cost as it requires a highly refined mesh in the fracture process zone which limits its applicability. One of the possible approach is to reduce the computational cost of the PFM is by using an adaptive mesh refinement technique. In this work, we propose an adaptive phase field model to alleviate the mesh burden using the scaled boundary finite element method (SBFEM) over quadtree meshes. The quadtree decomposition retains the hierarchical mesh structure. However, this structure leads to mesh incompatibility issue due to the presence of hanging nodes. The SBFEM can treat elements with hanging nodes as *n*-sided polygon and does not require any special treatment unlike the conventional finite element method. The quadtree decomposition is driven by an error indicator directly from the SBFEM solutions proposed by Song et. al, [2] which does not require any stress recovery techniques. In addition, the key features of the proposed approach is that it can predict the fracture process zone a priori at each step and refine the elements over which the crack is likely to propagate. Several benchmark problems are solved to demonstrate the robustness and the efficiency of the proposed technique. Numerical results show improved computational efficiency in terms of the number of elements required without compromising the accuracy of the solution.

Keywords: error indicator, fracture, phase-field method for fracture, quadtree meshes, scaled boundary finite element method.

References

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