A Discontinuous Galerkin *Hp*-adaptive Finite Element Method for Accurate Brittle Crack Modelling

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Abstract

In this paper the discontinuous Galerkin symmetric interior penalty (SIPG) method is used to determine the configurational force (CF) value at the crack tip for small strain linear elastic problems. Current methods for calculating the CF are domain dependent, a novel domain independent method for calculating the CF has therefore been developed. Additionally, mesh refinement strategies for problems with cracks are naïve and are only able to achieve accuracies in the region of 0.01% for the value of the CF at the crack tip [1]. This lack of accuracy has prompted the derivation of an *a posteriori* error estimator for SIPG which drives a *hp*-adaptive scheme which is simple to incorporate into the SIPG method. Here the error estimator, which is shown to bound the error in the novel CF calculation, converges exponentially with *hp*-adaptivity, hence accuracies for the CF at the crack tip are produced which up to now have been unobtainable in literature. Further, the efficacy of the error estimator for improving the accuracy of the CF is verified against the analytical double crack problem, presented by Westergaard [2], for mode 1, 2 and mixed mode problems. The method is then used to provide benchmarks for crack tip stress intensity factors for problems with no analytical solution, additionally domain independence is demonstrated for these more complex problems.

References

1. R. Denzer and F. J. Barth and and P. Steinmann. Studies in elastic fracture mechanics based on the material force method. Int. J. Numer. Anal. Meth. 58 (2003) 1817–1835.
2. H. Westergaard. Bearing pressures and cracks. SPIE Milestone Series MS. 137 (1997) 18–22.