

AUTOMATED CODE GENERATION FOR DISCONTINUOUS GALERKIN METHODS IN STRAIN-GRADIENT PLASTICITY

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ABSTRACT

Strain-gradient plasticity models are characterised by their dependency on gradients of fields such as the plastic strain. In addition to the usual balance of momentum equation, extra differential equations are introduced. However, these extra equations are typically only defined in regions where plastic flow is occurring, and these regions evolve in time. A particular difficulty is the application of boundary conditions for the differential equations which are defined on the evolving plastic domain. A number of past efforts for modelling strain gradient plasticity have used C^1 continuous basis functions for the extra equations everywhere in a domain. This allows Neumann boundary conditions to be applied at elastic-plastic boundaries.

We examine in this work the use of discontinuous Galerkin methods for solving the equations that arise in strain gradient plasticity models on the plastic flow domains. A formulation is developed that uses functions which are discontinuous across element boundaries for the additional fields, such as the equivalent plastic strain. By allowing discontinuities in these functions, boundary conditions, either Neumann or Dirichlet, can be applied at moving elastic-plastic boundaries. A draw back of discontinuous Galerkin methods is the increase in complexity of the variational formulation compared to conventional methods. This in turn increases the time required for implementation and testing. To this end, automated code generation techniques have been developed and applied to strain-gradient plasticity problems. Recent extensions to the FEniCS Form Compiler (FFC) [1] allow the automated generation of computer code for discontinuous Galerkin forms. Both the form compiler and a number of simulations using a class of strain gradient plasticity models will be presented.

REFERENCES

- [1] K.B. Ølgaard, A. Logg and G.N. Wells. “Automated code generation for discontinuous Galerkin methods”, submitted.