The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

A spatially adaptive phase-field model for dynamic fracture

Dhananjay Phansalkar[1,2], Kerstin Weinberg[3], Michael Ortiz[4] and Sigrid Leyendecker[1]

[1] Institute of Applied Dynamics, Friedrich-Alexander-Universität Erlangen-Nürnberg, Immerwahrstrasse 1, Erlangen 91058, Germany
[2] Central Institute for Scientific Computing, Friedrich-Alexander-Universität Erlangen-Nürnberg, Martensstrasse 5a, Erlangen 91058, Germany and dhananjay.phansalkar@fau.de
[3] Chair of Solid Mechanics, Universität Siegen, Paul-Bonatz-Strasse 9-11, Siegen 57076, Germany
[4] Division of Engineering and Applied Sciences, California Institute of Technology, Pasadena, CA 91125, USA

Keywords: *Brittle Fracture, Phase Field Models, Mesh Adaptivity, Dynamic Fracture*

To be able to predict crack propagation in real-world scenarios, dynamic fracture mechanics is required. It allows to account for dynamic loads, which lead to complex fracture patterns. However, due to the singular behavior of the stress field at the crack-tip [1] and discontinuity in the displacement field, it is difficult to simulate the discontinuous nature of fracture. These challenges are mitigated by using phase-field models that approximate the discrete crack by a smeared crack [2]. This method introduces a phase-field variable to track the crack propagation and a regularisation parameter ϵ that controls the crack width. The choice of ϵ is related to that of the mesh size h to ensure a good approximate solution [3]. In our approach, we propose a generalised phase-field model in which ϵ is a field variable in the variational principle and an extra equation is derived analogously to the balance equations for the displacement and phase field. This method is further enhanced by a mesh refinement strategy, which results in reduced computational costs at the same rate of convergence as the traditional phase-field model [4]. This approach is now extended to the case of dynamic fracture.

REFERENCES

[1] M. F. Kanninen and C. H. Popelar, *Advanced fracture mechanics*. New York: Oxford University Press, 1985.

[2] B. Bourdin, G. Francfort and J.J. Marigo. *Numerical Experiments in Revisited Brittle Fracture*. Journal of the Mechanics and Physics of Solids, Vol. **48**, pp. 797-826, 2000.

[3] A. Pandolfi, K. Weinberg and M. Ortiz, *A Comparative Accuracy and Convergence Study of Eigenerosion and Phase-Field Models of Fracture*. Computer Methods in Applied Mechanics and Engineering, Vol. **386**, pp. 114078, 2021.

[4] D. Phansalkar, K. Weinberg, M. Ortiz, Michael and S. Leyendecker. *A Spatially Adaptive Phase-Field Model of Fracture*, arXiv:2109.10175 [cs, math], 2021.