An energy based peridynamic state-based failure criterion

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Keywords: Peridynamics, Failure Criterion, Numerics

The simulation of the structural behavior and particularly damage response is a key instrument for the development of lightweight structures as required in aerospace engineering or wind rotor blade development. The prediction of damage initiation and propagation in structural elements is a challenging task, even for state-of-the-art numerical procedures, such as the finite element method.

The peridynamic theory presents a promising approach for these requirements. It is a non-local theory which takes long-range forces between material points into account. Utilizing the state-based formulation arbitrary materials can be modeled and analyzed [3].

Proper failure criteria are needed for this formulation. The majority of publications use the so-called critical stretch model [2]. Therein, a "bond" between two points breaks when its stretch exceeds a critical value. However, this model reaches its limits when convergence is considered [1].

Therefore, in this paper a mode-dependent energy based failure criterion has been developed based on the work of Foster et. al [4]. The criterion has been implemented in the peridynamic code Peridigm.

In the scope of this publication, the fundamental theory of the failure criterion as well as the implementation in a massively parallel peridynamics code are explained. Based on these implementations, studies regarding the effect of probabilistic material properties to the crack initiation position are shown.

References

[1] *Rädel, M., Bednarek, A.-J., Schmidt, J. and Willberg, C., "Influence of probabilistic material distribution in peridynamics to the crack initiation" in Proceedings of 6th ECCOMAS Thematic Conference on the Mechanical Response of Composites: COMPOSITES 2017, Eindhoven, September 20-22, 2017, (2017)*

[2] *Silling, S. A. and Askari, E., A meshfree method based on the peridynamic model of solid mechanics, Computers and Structures,* **83**, *1526-1535 (2005).*

[3] *Silling, S. A., Epton, M., Weckner, O., Xu, J. and Askari, E., Peridynamic States and Constitutive Modeling, Journal of Elasticity, Engineering,* **88**, *151-184 (2007).*

[4] *Foster, J. T., Silling, S. A. and Chen, W., An Energy based Failure Criterion for use with Peridynamic States, International Journal for Multiscale Computational Engineering,* **9**, *675-688 (2011).*