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A PERIDYNAMIC APPROACH TO FATIGUE CRACK PROPAGATION: CRITICAL ANALYSIS AND COMPARISON WITH EXISTING METHODS

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Summary: Peridynamics is a nonlocal theory, alternative to classical continuum mechanics, designed from its inception to deal with discontinuities such as fracture, in an intrinsic manner. It allows cracks to naturally nucleate, develop, and propagate without any special computational treatment. Being a relatively recent avenue of research, it has attracted substantial attention from the research community, and in the last decade in particular the range of applications has widened significantly. Fatigue crack propagation is one relevant application, being one of the main root causes of material and structural failure in industrial applications in various sectors. Being able to simulate a predict accurately the crack propagation and fatigue life of critical components can be a valuable asset in the design process and peridynamics has the potential to address this issue.

In the present work, a two dimensional state-based peridynamic model for fatigue cracking, employing a energy-based failure criterion, is critically analysed. The referred model, present in the literature shows, is implemented in a Matlab code and different benchmark problems are analysed, in order to assess its accuracy in mode I and mixed mode crack propagation. The results for fatigue crack propagation are compared with experimental data, and with finite element analyses results obtained using a commercial software. The cyclic loading is considered by continuously assessing the damage index of each material point as the interactions in the horizon develop. The obtained results for the crack path and crack growth rate are compared with experimental results both for mode I and mixed mode propagation and finite element approaches.