Influence of the mesh on the crack path in phase-field fracture simulations

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Over the past 25 years, phase-field fracture models [1, 2] have become increasingly popular for modeling crack propagation. In particular, their (Γ-)convergence towards the Linear Elastic Fracture Mechanics (LEFM) provides strong theoretical foundations. Despite this popularity, limited research has been conducted on how spatial discretization (e.g., mesh size, structure, and element geometry) affects the predicted crack path. This study addresses this gap from the perspective of the mechanical engineering community. We employ a benchmark problem inspired by the Pure Shear test [3] (also called strip specimen), involving an infinite strip with an initial horizontal edge crack located above the specimen center and subjected to tensile loading. The crack path is expected to deviate towards the center of the specimen exponentially. This result has been recovered using an incremental crack propagation solver based on LEFM, which serves as our reference. Phase-field fracture simulations, performed using the Finite Element Method, are then carried out. Different meshes (varying mesh size, structured/unstructured, and element geometry) are used in the simulations to assess their influence on the crack path. The bias induced by the mesh is evaluated by comparing the phase field simulation results with the reference. The final goal of this study is to provide recommendations to avoid, or at least mitigate, any bias induced by spatial discretization.

References

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