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Proposal for a Master Thesis

Micromechanical Simulation of the Effect of Stress Triaxiality on the Fracture of Ductile Cast Iron

Due to its good machinability, cost-effective production, and excellent strength and toughness properties, ductile cast iron (spheroidal graphite cast iron; GJS; Fig. 1) is used in a wide range of applications. In many applications, a fracture-mechanical assessment is required for damage tolerant design. To understand the mechanisms in the fracture process zone at the crack tip (Fig. 1), a micromechanical model was developed at the institute. Its predictions of crack growth resistance in standard specimens, i.e., under high stress triaxiality, show very good agreement with experimental results (see Fig. 2). Experimental investigations, however, show the an assessment based on these specimens might be overconservative.

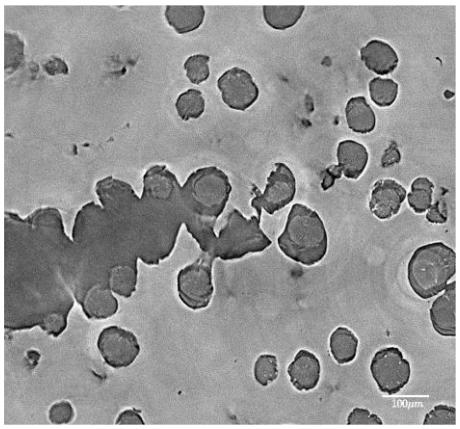

Fig. 1: Fracture process zone (from [1])

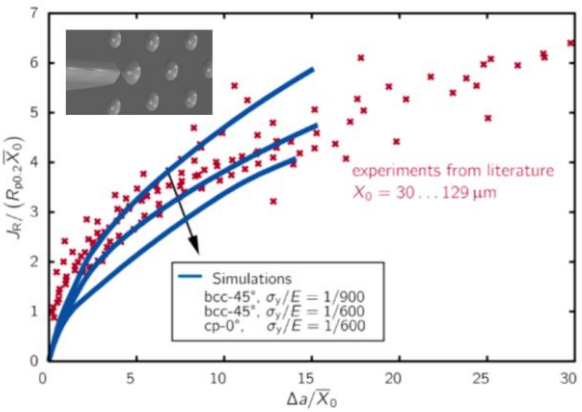

Fig. 2: Crack resistance curves (from [2])

The aim of this work is to investigate inhowfar relevant crack configurations with lower stress triaxiality can be predicted using this model. For this purpose, crack initiation and growth in specimen types with different levels of crack tip constraint and thus differing stress triaxialities are to be simulated, and the results compared with existing experimental data [1].

Subtasks:

1. Familiarization with FEM program ABAQUS, HPC-Cluster under Linux and existing models
2. Crack propagation simulations in different specimen types with and without side grooves
3. Evaluation of results

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References

[1] O. El Khatib, R.-D. Pham, G. Hütter, S. Henkel, L. Zybell, T. F. Morgeneyer, H. Biermann, B. Kiefer: *Experimental and Numerical Investigations of the Influence of Crack-Tip Constraint on the Ductile Fracture Behavior in Nodular Cast Iron*, Preprint, 2024.
[2] G. Hütter, L. Zybell, U. Mühlich, M. Kuna: *Consistent Simulation of Ductile Crack Propagation with Discrete 3D Voids*, 2013, Comp. Mater. Sci. 80, 61-70.