

A fast Neuber-type Finite Element simulator to calibrate a multi-mechanism HCF model of alloys with process-induced pores

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ABSTRACT:

The presence of process-induced meso-scale pores, typically present in a variety of cast and additively manufactured alloys, can cause elevated plasticity close to the pores, which reduces the life of components. Therefore, a new fatigue model with two mechanisms – a stochastic approach for the micro-plasticity based on a separation of scales [1], and a criteria using Chaboche-type laws for the meso-scale plasticity, is proposed. A new Neuber-type method for fast approximation of the full-field plasticity in structures with spherical pores [2] alongside a multi-fidelity correction using CNNs was implemented, and will be transferred to complex pores. The finite element method is used to take into account the complex morphology of pores. The parameters of the multi-mechanism model may be obtained via a maximum likelihood estimate on a combination of fatigue experiments and thermographic data.

KEYWORDS:

Fatigue life prediction, Machine learning, Model reduction, Infrared thermography

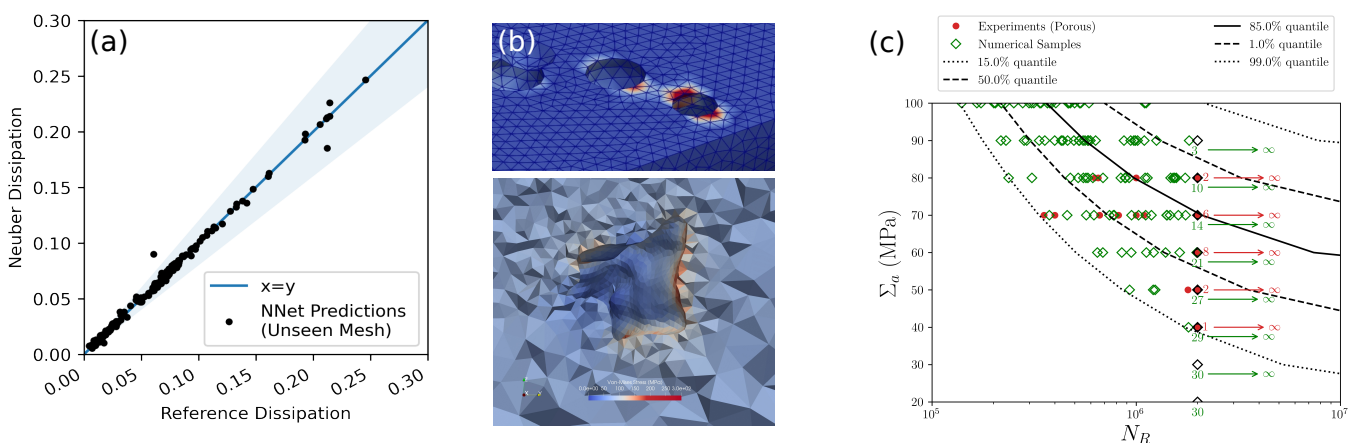


Fig. 1. (a) Results of the CNN corrected Neuber-type method for fast approximation of the dissipation in structures with spherical pores, with 96% of approximations falling in a 20% error cone (b) An example of the spherical pores corrected by the Neuber+AI approach and a complex tomographed pore meshed via FEM (c) Fatigue life predictions for specimens with complex pores, using a maximum likelihood estimate on the micro-structures for parameter identification

REFERENCES:

- [1] Rémi Munier, Cédric Doudard, Sylvain Calloch, Bastien Weber. *Determination of high cycle fatigue properties of a wide range of steel sheet grades from self-heating measurements*. International Journal of Fatigue, 2014, 63, pp.46-61.
- [2] A. Palchoudhary, C. Ovalle, V. Maurel, P. Kerfriden, *A fast Neuber-type finite element simulator to enable deep-learning-based fatigue life predictions from thermographic data*, Congrès Français de Mécanique, 2022.