Journal Pre-proofs

A probabilistic Haigh diagram based on a weakest link approach

Alexander Klawonn, Antje Hagenacker, Tilmann Beck

PII: S0142-1123(19)30523-7
DOI: https://doi.org/10.1016/j.ijfatigue.2019.105419
Reference: JIJF 105419

To appear in: *International Journal of Fatigue*

Received Date: 2 October 2019
Revised Date: 5 December 2019
Accepted Date: 6 December 2019

A probabilistic Haigh diagram based on a weakest link approach

Alexander Klawonn[a,*], Antje Hagenacker[a], Tilmann Beck[b]

[a]Siemens AG, Mellinghofer Strae 55, 45473 Mlheim an der Ruhr, Germany
[b]Institute of Materials Science and Engineering, TU Kaiserslautern, 67653 Kaiserslautern, Germany

Abstract

A statistical methodology for the assessment of high cycle fatigue failure probability is presented. Based on a probabilistic Haigh diagram for a unit volume in combination with a weakest link model, the approach allows failure probability quantification for arbitrarily shaped components. We demonstrate how the model can be calibrated using a maximum likelihood approach for censored data. In order to show its potential, the proposed methodology is applied on three different publicly available data sets containing tests for smooth and notched sheet specimens. In all considered cases the model predictions are in good agreement with the test data.

Keywords: high cycle fatigue, multiaxial fatigue, probabilistic analysis, size effects, notches

1. Introduction

Since the mid 1950s when Coffin and Manson developed a methodology to describe the fatigue behavior of metals under elasto-plastic strain amplitudes [1, 2], mechanical fatigue phenomena have roughly been classified into *low cycle fatigue* (LCF) and *high cycle fatigue* (HCF) [3]. While the first kind, low cycle fatigue, was referring to high-amplitude loadings under which failure would occur after a rather low number of cycles (typically $< 10^4$), high cycle fatigue was the terminology for most of the remaining cases where due to low stress amplitudes failure would not be expected before reaching a high number of cycles (often defined as $> 10^5$).

High cycle fatigue problems are often characterized by rather low stress amplitudes applied at high frequencies and superimposed mean stresses. A typical example

*Corresponding author
Email address: alexander.klawonn@siemens.com (Alexander Klawonn)