Effect of loading orientation on fatigue behaviour in severely notched round bars under non-zero mean stress bending-torsion

Ricardo Branco, J.D. Costa, Filippo Berto, F.V. Antunes

PII: S0167-8442(17)30185-4
DOI: http://dx.doi.org/10.1016/j.tafmec.2017.07.015
Reference: TAFMEC 1920

To appear in: *Theoretical and Applied Fracture Mechanics*

Received Date: 11 April 2017
Revised Date: 13 July 2017
Accepted Date: 14 July 2017

Please cite this article as: R. Branco, J.D. Costa, F. Berto, F.V. Antunes, Effect of loading orientation on fatigue behaviour in severely notched round bars under non-zero mean stress bending-torsion, *Theoretical and Applied Fracture Mechanics* (2017), doi: http://dx.doi.org/10.1016/j.tafmec.2017.07.015

Effect of loading orientation on fatigue behaviour in severely notched round bars under non-zero mean stress bending-torsion

Ricardo Branco [a]*, J.D. Costa[a], Filippo Berto[b], F.V. Antunes[a]

[a] CEMMPRE, Department of Mechanical Engineering, University of Coimbra, Rua Luís Reis Santos, 3030-788 Coimbra, Portugal

[b] Department of Mechanical and Industrial Engineering, Norwegian University of Science and Technology, 7491 Trondheim, Norway

Abstract

This paper studies the effect of different loading orientations on fatigue behaviour in severely notched round bars under pulsating in-phase combined bending-torsion loading. Bending moments are applied in three different planes with respect to the notch root considering two bending moment to torsion moment ratios. Complementary, beach-marking tests are also performed for different loading scenarios to evaluate the crack shape changes during the crack growth. After fatigue testing, specimen surfaces are examined by SEM to identify the main failure micro-mechanisms. Fatigue life is predicted via the Coffin-Manson model, and the notch effect is evaluated using the Equivalent Strain Energy Density (ESED) concept. Overall, experimental and predicted lives are very reasonably correlated. Furthermore, initiation sites, initiation angles and surface crack paths are successfully predicted from the principal stress field at the notch.

Keywords: bending-torsion, notch effect, initiation sites, initiation angles, crack paths, Coffin-Manson model, equivalent strain energy density, notched round bar, multi-crack initiation.

1. Introduction

Automotive and ground transportation industries, due to economic and environmental issues, are continuously looking for increased performance, weight reduction, and cost saving. These requirements are often met by using more efficient design methods and higher-strength materials.