Accepted Manuscript

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PII: S0142-1123(17)30236-0
DOI: http://dx.doi.org/10.1016/j.ijfatigue.2017.05.022
Reference: JIJF 4350

To appear in: *International Journal of Fatigue*

Received Date: 11 November 2016
Revised Date: 5 May 2017
Accepted Date: 24 May 2017

Please cite this article as: Costa, P., Vieira, M., Reis, L., Ribeiro, A., de Freitas, M., New specimen and horn design for combined tension and torsion ultrasonic fatigue testing in the very high cycle fatigue regime, *International Journal of Fatigue* (2017), doi: http://dx.doi.org/10.1016/j.ijfatigue.2017.05.022

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New specimen and horn design for combined tension and torsion ultrasonic fatigue testing in the very high cycle fatigue regime

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Abstract

Fatigue damage has special relevance on the life span of mechanical components and structures, as it takes responsibility for the majority of the registered structural failures. Although its mechanisms have been the subject of continuous research, the growing need for greater lifespans forced the understanding of the behavior of materials under the very high cycle regime, also known as Very High Cycle Fatigue. This field of research, which studies the mechanical behavior of materials for fatigue lives beyond 1E7 cycles, only recently gained notoriety, largely due to the appearance of ultrasonic fatigue testing machines, working at 20 kHz and due to the acquisition and control equipment capable of handling signals at very high frequencies. On the other hand the behavior of materials under multiaxial fatigue has been the subject of research and development, but not in the region of very high cycles, due to the inexistence of appropriate testing machine to perform these tests. The authors of this work have already a large experience on the performance of multiaxial fatigue tests under axial/torsion loading under servo-hydraulic fatigue testing machines and on very high cycle fatigue tests. In this paper, and using a new developed multiaxial fatigue testing machine operating at 20 kHz frequency, experimental results, using strain gauges and axial and shear stresses determined by finite element modelling on a new specimen design tested with biaxial loadings, tension/torsion at 20 kHz, are discussed and analyzed. Results show that it is possible to carry out multiaxial (axial/torsion loading) fatigue tests at very high frequencies which will allow to perform reliable very high cycle multiaxial fatigue tests.

Keywords: multiaxial fatigue, very high cycle fatigue, ultrasonic fatigue testing, specimen design

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