

Accepted Manuscript

Initiation and propagation of fatigue cracks in cold-drawn pearlitic steel wires

Jesús Toribio, Beatriz González, Juan-Carlos Matos

PII: S0167-8442(17)30184-2

DOI: <http://dx.doi.org/10.1016/j.tafmec.2017.08.007>

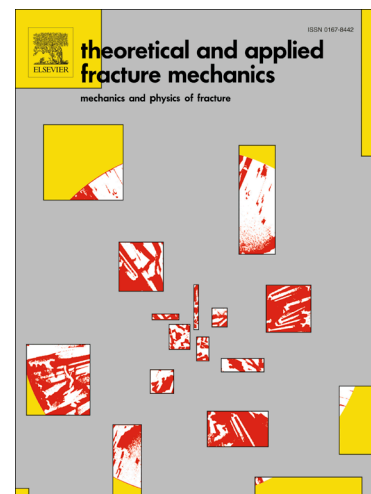
Reference: TAFMEC 1939

To appear in: *Theoretical and Applied Fracture Mechanics*

Received Date: 9 April 2017

Revised Date: 28 August 2017

Accepted Date: 28 August 2017



Please cite this article as: J. Toribio, B. González, J-C. Matos, Initiation and propagation of fatigue cracks in cold-drawn pearlitic steel wires, *Theoretical and Applied Fracture Mechanics* (2017), doi: <http://dx.doi.org/10.1016/j.tafmec.2017.08.007>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Initiation and propagation of fatigue cracks in cold-drawn pearlitic steel wires

Jesús Toribio, Beatriz González, Juan-Carlos Matos

Fracture & Structural Integrity Research Group (FSIRG), University of Salamanca (USAL),
E.P.S., Campus Viriato, Avda. Requejo 33, 49022 Zamora, Spain

Abstract

In this paper the important role of manufacturing by progressive cold drawing on initiation and propagation of fatigue cracks in cold-drawn pearlitic steel wires is addressed by analyzing the initiation (from surface defects) and propagation of fatigue cracks in two pearlitic steels with very different cold drawing degree or cumulative plastic strain (and the subsequent very distinct microstructural arrangement): a hot rolled pearlitic steel bar and a commercial high-strength cold-drawn prestressing steel wire to be used as a component of prestressed concrete in structural engineering. Experimental results show that the initiation of fatigue cracks in pearlitic steels takes place at the location of small surface defects, many of them in the form of localized damage in the area of material surface (in the case of hot rolled bar) or voids created by tearing during drawing due to the existence of particles near the wire surface (in the case of the cold drawn wire). In both materials, fatigue cracks are mostly transcollonial and tend to fracture pearlite (ferrite/cementite) lamellae, so that different micro-mechanisms of fatigue damage appear in the material such as non-uniform crack opening displacement, micro-discontinuities, branchings, bifurcations and frequent local deflections, all creating a sort of *microstructural roughness* in the *fatigue crack path* that is different in the hot rolled bar and in the cold drawn wire, thereby determining their distinct fatigue performance.

Keywords: pearlitic steel; hot rolled bar; cold drawn wire; cold drawing; fatigue crack initiation; fatigue crack propagation; surface defects; fatigue crack path; micro-roughness.

1. Introduction

The *initiation* of fatigue cracks in pearlitic microstructures [1] is strongly dependent on whether or not surface defects (scratches, voids, hard particles, inclusions, microcracks, localized damage regions...) are present in the considered material. In high-strength cold-drawn pearlitic steel wires, the fatigue damage initiation process takes place in the vicinity of surface defects [2-4], broken martensite layers (due to an overheating during cold drawing), longitudinal grooves and holes mainly caused by surface inclusions [2]. In the case of drawing-based manufacturing techniques, very often surface defects are caused by the cold drawing process itself [5].

Although surface defects (e.g. scratches) might be removed by repeated cold drawing, when a flaw appears inside the wire it remains present in the steel because of the development of an overlap of two regions of the material with a discontinuity between them, and it is thus difficult to fully remove such a flaw [6]. In the case of fatigue crack growth in aggressive environments (*corrosion-fatigue*) the harsh atmosphere surrounding any surface defect is able to blunt it due a phenomenon of damage known as material dissolution, thereby increasing the number of cycles required to initiate cracking from the afore-said blunted surface defect and increasing the corrosion-fatigue life [7]. In this framework, the beneficial effect of crack tip blunting by localized anodic dissolution (LAD) in stress corrosion cracking (SCC) of high-strength cold-drawn pearlitic steel wires has been reported elsewhere [8].

As described in the scientific literature [9], one of the main causes of engineering failure in steel wires is the presence of non-metallic inclusions in the material, because they can promote the development of surface localized damage during wire drawing or they can affect

Download English Version:

<https://daneshyari.com/en/article/7196358>

Download Persian Version:

<https://daneshyari.com/article/7196358>

[Daneshyari.com](https://daneshyari.com)