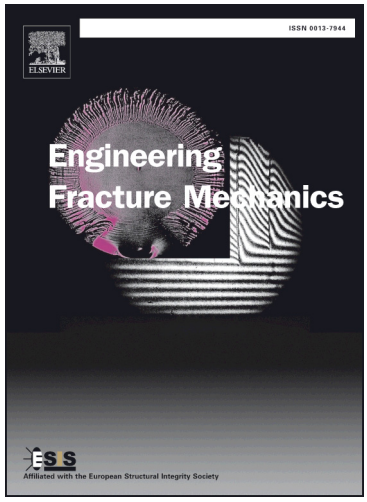

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M. Elices, M. Perez-Guerrero, M. Iordachescu, A. Valiente

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Fracture Toughness of High-Strength Steel Bars

M. Elices[1], M. Perez-Guerrero[1,2], M. Iordachescu[1], A. Valiente[1]

[1] Materials Sciences Dpt., E.T.S.I. Caminos, Universidad Politécnica de Madrid, Spain

[2] Engineering Faculty, Universidad de Los Andes, Mérida, Venezuela

Abstract

Brittle fractures caused by accidental or environmental damage of high-strength steel bars are occasionally reported in civil engineering. To analyse such ruptures, knowledge of bar plane strain fracture toughness is needed. Unfortunately, plane strain fracture toughness cannot be measured as bar diameters of commercial bars are not compatible with the thickness requirements of standardized fracture specimens according ASTM E399. The ASTM E1304 is less restrictive by using short bar specimens (SBS) but these can be ineffective with very brittle steels. This situation can be overcome, as shown in this paper, by modifying the SBS specimen.

A second aim of this paper is to provide several examples of how to analyse brittle fractures of commercial high-strength steel bars considering knowledge of its plane strain fracture toughness. Direct and indirect analyses have been carried out.

Keywords: High Strength Steel bars, Brittle fracture, Fracture toughness

Highlights:

- Novel procedure to measure fracture toughness with pre-cracked short bar specimens
- Use of standard SBS specimens for fracture testing with no stable crack growth
- A guide to analyse fracture of bars damaged with surface cracks

1. Introduction

High-strength steel bars are widely used in civil engineering. Unexpected brittle fractures caused by accidental or environmental damage are occasionally reported, among others, in the anchor rods of bridge bearings [1], in wind turbine foundations [2], in prestressing steel structures [3], in anchor bars for concrete prestressing [4], and even in structural bolts [5].

In almost all cases, fracture was triggered by small crack-like damage. This leads the engineer to suspect a low fracture toughness of bars. Regrettably, neither the designer nor