Engineering Failure Analysis 18 (2011) 148–163

Contents lists available at ScienceDirect

Engineering Failure Analysis

journal homepage: www.elsevier.com/locate/engfailanal

# Strain-life and crack propagation fatigue data from several Portuguese old metallic riveted bridges

Abílio M.P. de Jesus [a,b,*], António L.L. da Silva [b,c], Miguel V. Figueiredo [b,c], José A.F.O. Correia [a,b], Alfredo S. Ribeiro [a,b], António A. Fernandes [b,c]

[a] Engineering Department, School of Sciences and Technology, University of Trás-os-Montes and Alto Douro, Quinta de Prados, 5001-801 Vila Real, Portugal
[b] Unity of Design and Experimental Validation, IDMEC – Pólo FEUP, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal
[c] Faculty of Engineering, University of Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal

ARTICLE INFO

*Article history:*
Received 5 May 2010
Accepted 21 August 2010
Available online 26 August 2010

*Keywords:*
Old riveted bridges
Strain-life fatigue data
Fatigue crack propagation
Elastoplastic behaviour
Puddle iron

ABSTRACT

Fatigue failures are of concern for steel bridges due to the likelihood of the steel to deteriorate under variable stresses. Residual life calculations of existing bridges in operation should take into account fatigue as a progressive damaging mechanism. A consistent residual life prediction should be based on actual fatigue data from bridge members to assess. This paper presents strain-life and crack propagation fatigue data obtained using samples of original material removed from five Portuguese metallic riveted bridges. While four of the analysed bridges are centenaries, the younger bridge is little more than 50 years old which is likely one of the last metallic bridges built in Portugal using the riveting technology. Besides the fatigue properties, the monotonic and cyclic elastoplastic properties are assessed for the samples of materials. From the analysis of the results it is clear that the older materials are puddle iron, a precursor of the modern construction steels, the latter being used in the younger bridge. The generated data is essential for residual fatigue life estimations considering both crack initiation and propagation phases, respectively in the framework of Local Approaches to fatigue and Linear Elastic Fracture Mechanics.



## 1. Introduction

The maintenance and safety of existing bridges is a major concern of governmental agencies. In particular, the safety of old metallic riveted road and railway bridges fabricated and placed into service at the end of the 19th century/beginning of 20th century deserve a particular attention, since they were designed taking into account traffic conditions, both in terms of vehicle gross weight and frequency, completely different from those observed nowadays. Also, the current design procedures were not yet fully developed or even did not exist in the 19th century and design engineers were not aware of some important phenomena, such as fatigue. Fatigue was only intensively studied in the 20th century. Fatigue failures are a concern for steel bridges due to the likelihood of the steel to deteriorate under variable stresses [1–3]. Fatigue has been recognised as the major cause of failure in metallic bridges [4]. In order to assure high safety levels in old riveted metallic bridges, road and railway authorities have to invest heavily in their maintenance and retrofitting.

Residual life calculations of existing bridges in operation should take into account fatigue as a progressive damaging mechanism. A consistent residual life prediction should be based on actual fatigue data from bridge members to assess.

* Corresponding author at: Engineering Department, School of Sciences and Technology, University of Trás-os-Montes and Alto Douro, Quinta de Prados, 5001-801 Vila Real, Portugal. Tel.: +351 259 350 306; fax: +351 259 350 356.
*E-mail address:* ajesus@utad.pt (Abílio M.P. de Jesus).

1350-6307/$ - see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.engfailanal.2010.08.016