Number of tests and corresponding error in concrete fatigue

José J. Ortega, Gonzalo Ruiz, Rena C. Yu, Nelson Afanador-García, Manuel Tarifa, Elisa Poveda, Xiaoxin Zhang, Francisco Evangelista Jr.

PII: S0142-1123(18)30245-7
DOI: https://doi.org/10.1016/j.ijfatigue.2018.06.022
Reference: JIJF 4726

To appear in: *International Journal of Fatigue*

Received Date: 28 February 2018
Accepted Date: 13 June 2018

Please cite this article as: Ortega, J.J., Ruiz, G., Yu, R.C., Afanador-García, N., Tarifa, M., Poveda, E., Zhang, X., Evangelista, F. Jr., Number of tests and corresponding error in concrete fatigue, *International Journal of Fatigue* (2018), doi: https://doi.org/10.1016/j.ijfatigue.2018.06.022

Number of tests and corresponding error in concrete fatigue

José J. Ortega[a], Gonzalo Ruiz[*,a], Rena C. Yu[a], Nelson Afanador-García[b,c], Manuel Tarifa[d], Elisa Poveda[a], Xiaoxin Zhang[a], Francisco Evangelista Jr.[c]

[a] *ETSI Caminos, C. y P., Universidad de Castilla-La Mancha, Av. Camilo José Cela s/n, 13071 Ciudad Real, Spain*
[b] *Departamento de Ingeniería Civil, Universidad Francisco de Paula Santander Ocaña, Vía Acolsure, Sede el Algodonal, 546552, Ocaña N. STD, Colombia*
[c] *Departamento de Engenharia Civil e Ambiental, Universidade de Brasília, SG12, Campus Darcy Ribeiro, 70910-900, Brasília-DF, Brazil*
[d] *E. I. Minera e Industrial de Almadén, Universidad de Castilla-La Mancha, Pza. Manuel Meca 1, 13400 Almadén, Spain*

Abstract

Concrete fatigue presents probabilistic behaviour evidenced by the wide scatter of cycles to failure under the same conditions. Experimentally-fitted probabilistic distributions have an error in terms of fatigue life that depends on the number of tests. Through statistical resampling, this relationship has been obtained for the Weibull probabilistic distribution fitted to a set of 100 tests and with two additional parameter combinations. Results for low to high cycle fatigue help to obtain design fatigue probability curves or the necessary number of tests for a given admissible error. Their applicability extends to any other phenomenon that follows the Weibull distribution with similar parameters.

Key words: Sample size, Probabilistic error, Fatigue of concrete, Weibull distribution

1. Introduction

The improvement in concrete strength achieved by its continuous technological development has made it possible to use this material in some structural applications where new limiting conditions characterize the design, such as fatigue loads. This is the case, for example, with railway slab tracks [1, 2]. Therefore, fatigue resistance must be experimentally estimated for the expected working stress-range and frequency.

The main problem when testing concrete specimens under fatigue is the wide scatter of cycles to failure, which can vary by several orders of magnitude, for example from 100 to 100000 cycles [3], from one specimen to another and always under the same loading conditions. This fact also means that some of the tests may take an extended time and even without the certainty of finally reaching the failure point.

The complexity for treating and interpreting this disparity of results, together with the time necessary to carry out each test, leads to elementary approaches based on S-N curves presented in design codes such as Eurocode 2 [4] and Model Code 2010 [5, 6]. These design methods offer an expected number of cycles to failure for a certain maximum stress, which theoretically refers to a mean value. However, this is a deterministic

*Corresponding author: Gonzalo.Ruiz@uclm.es; int + 34 926 295 398