



Reliability-based structural assessment of a historical steel railway bridge

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Abstract

In this paper, a simplified probabilistic analysis approach is presented. The Barqueiro Bridge, a four-span riveted iron bridge located in Galicia, Spain, is selected as a case study. This bridge is placed in an environment with high humidity and salinity which could potentially induce severe damages to the structure. These damages introduce considerable uncertainty in the structural parameters that should be used in reliability-based assessment procedures for verifying current safety conditions. To alleviate this issue, non-destructive experimental testing is used which also helps during numerical modeling. Model uncertain parameters are described through adequate probability distributions and then grouped by using two different strategies; based on structural element type and on stress level. According to this strategy, the limit state of interest is analyzed to verify the probability of failure and the reliability index of the structure.

Keywords: Iron riveted bridge, Railway bridge, Non-destructive testing, Reliability analysis, Serviceability Limit State.

1 Introduction

During the 20th century, in Europe, the railway expansion took place so that many infrastructures such as bridges were built. As time goes by, these constructions not only acquired great importance as valuable assets of the transportation network [1] but also became in many instances pieces of significant heritage value.

Nowadays, some of these ancient structures are still in use, but limited or even no maintenance activities have been performed in many of them; this situation leads to risks regarding their functionality and security. To guarantee proper operating conditions, an adequate knowledge of the current structural performance of these bridges is mandatory.

Through the service life of these historic structures, external factors such as mechanical degradation processes due to environmental effects or damage caused by loading events might have significantly affected some of the project design parameters such as cross-section dimensions of structural elements or mechanical properties of materials. Therefore, it can be said that there is uncertainty in these parameter values. Currently, deterministic analyses are the most common analysis type when performing reassessment studies to determine mechanical performance. Nevertheless, this type of study has significant shortcomings as they use fixed values for each parameter. So, to more rigorously take into account the inherent uncertainty present on them, probabilistic analyses must be used instead [2].

The case study selected in this work, the Barqueiro Bridge, was built in 1966 and it is placed on a river