Probabilistic structural assessment of railway masonry arch bridges

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Abstract

Most of masonry arch bridges dates from ancient times, having an important historical value to society, thus requiring appropriate conservation approaches. Regarding masonry arch bridge's structural condition, considering its age, and consequently deterioration, and the fact that they are submitted to loads much higher than those existing at their construction period, it is imperative to evaluate the structural performance of these structures. This paper will expose a methodology for safety assessment of masonry arch bridges, namely in terms of ultimate load-carrying capacity, determined by limit analysis. Monitoring and material characterization are standard procedures in safety assessment and, will be shown that Bayesian techniques are a useful tool to incorporate new gathered information in structural analysis model. Safety assessment procedures described in the article will be applied to a Portuguese stone masonry arch bridge from the 19th century.

Keywords: Masonry arch bridges; Limit analysis; Safety assessment; Probabilistic assessment; Statistical uncertainty; Bayesian inference

1 Introduction

According to the European project "Sustainable Bridges" [1], 40% of European railway bridges are masonry arch bridges, being more than 60% of these bridges over 100 years old. Thereby, they are a significant linking element of transportation network nowadays. Considering the long lifetime, the masonry degradation and the ever increasing loadings and demands, it is imperative to evaluate the structural integrity and safety of this type of construction.

In the past decades, a large effort and funds have been mobilised to understand the behaviour of masonry arch bridges. Most of these studies are in the area of monotonic loadings (static, short-term effects). It has been detected that cyclic loadings (long-term effects) play a crucial role in the deterioration of masonry's constructions. Tests conducted by Clark [2] and Roberts et al. indicated that brick masonry's fatigue strength is about 50% of its quasi-static compressive strength. A complete description of environment and external influence factors, such as creep, shrinkage and saturation, can be found in [3-5]. Therefore, the lack of maintenance, degradation caused by time and the fact that they are subjected to loads higher than those employed in the respective design projects aggravate their condition. In addition, the available funds for maintenance and repairs are few, triggering a challenge for preservation in allowable condition and safety levels.

Reliability-based assessment of existing structures, such as masonry arch bridges, submitted to various actions, is a very complex issue. Lately, probabilistic approaches have been increasingly and successfully performed and

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