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Robustness-based assessment of railway masonry arch bridges

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Abstract

In the past decades, structural robustness has gained major interest due to the collapse of remarkable structures, such as the Ronan Point tower and the World Trade Center. In both situations, a local damage lead to structural collapse, triggering research to restrain progressive collapse in structures. Masonry arch bridges are important historical structures, with many of them still in service. Over their long lifetime, deterioration and damage have affected their ultimate load-carrying capacity, which must be considered when evaluating the safety condition of these structures. This paper presents a methodology for robustness-based assessment of masonry arch railway bridges, by computation of the ultimate load-carrying capacity resorting to the limit analysis method. The main damage scenarios, namely their location and extension, will be presented and discussed. The influence of such damage is discussed in detail, as well as the most influencing structural parameters, being justified the robustness capacity in such cases. The developed methodology is then applied to a Portuguese railway masonry arch bridge.

Keywords: Masonry Bridges; Reliability; Structural Robustness; Damage; Vulnerability; Redundancy.

1 Introduction

Following the collapse of large structures, associated with the progressive collapse of structural elements, for example the collapse of the World Trade Center towers, robustness has gained importance as the object of renewed interest due to the serious consequences related to the failure of structures and, mainly, due to the costs that the structural collapse can reach, exceeding the mere re-building costs. Research has confirmed that robustness is strongly related to internal structural characteristics, such as redundancy and ductility, but also depends on specific situations of events involving localized damage that can lead to collapse of the structure, namely progressive collapse. Thus, Sørensen [1] claimed that the consequences will depend not only on internal structural features, but also on passive and active measures to reduce damage and possible non-conformities with calculation hypotheses due to the quality of execution and maintenance.

Robustness is related to scenarios where exposure, by the way of non-intentional and unplanned loads and defects, results in local damage to the structural system, and in more extreme cases, lead to collapse. Robustness can be defined in different ways and at different levels of complexity/ applicability. Until today, the perception of the concept of robustness is something diffuse by part of Engineers, which causes a lack of confidence and orientation of how to incorporate this concept in the structural analysis, always remaining some uncertainty as to the vulnerability of the structures in the presence of an extreme event. Gomes [2] assumes that the exact definition of the concept of structural robustness is a necessity for a concrete materialization of the robustness in the daily

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