Investigation of the response of masonry arches using data-driven structural analysis

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Masonry arches are efficient load-bearing structures, which distribute applied loads through compression in adjacent masonry stones. The typical mode of failure for masonry arches is the formation of tension hinges in-between the masonry stones, activated when the thrust line falls outside the section of the masonry arch [1]. The change of the structural state, from equilibrium to mechanism, can be caused by settlement of supports due to earthquakes, vertical loads due to vehicles, erosion, or ground bearing failure. This hinge mechanism can result in damage and eventually partial or total collapse.

In this article an overall data-driven procedure is proposed, for the investigation of the structural response of masonry arches. The main objective of this study is to use machine learning tools in order to predict the structural response of masonry arches in a computationally efficient framework, see also [2, 3]. Heyman's assumptions are adopted for the material behaviour, incorporating contact-friction laws between adjacent blocks to capture failure. Several non-linear finite element models are developed and solved, to create corresponding databases. This procedure has been implemented using Python, Matlab and commercial finite element software. The proposed scheme can be used to predict the deformed geometry, the collapse mechanism and the ultimate, failure load of masonry arches. Cases studies demonstrate the efficiency of the proposed method, by implementing the method to random masonry arch geometries. The method can be extended towards structural health monitoring applications.

References

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