A macroscale modelling approach for non-linear analysis of masonry arches

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ABSTRACT

Masonry arches represent important structural components of numerous historical constructions, including buildings, churches and bridges. The response of masonry arches is strongly affected by material nonlinearity which is associated with masonry texture. For this reason, the use of mesoscale models [1], where individual constituents, i.e. units and mortar joints, are represented individually, enables accurate response predictions even under extreme loading. However, these detailed models are very computationally demanding and not suitable for practical assessment of large structures. In this regard, the use of continuous macro-models, based on simplified homogenised continuum representations for masonry, is preferable as it leads to a drastic reduction of the computational burden. On the other hand, the latter modelling approach requires accurate calibration of the model material parameters to correctly allow for masonry bond. An effective procedure to calibrate the mechanical parameters of masonry walls at the macroscale, has been developed in [2]. The strategy uses the results of virtual experiments represented by refined mesoscale models to identify an equivalent continuous material by inverse analysis utilising Genetic Algorithm-based optimisation procedures.

In the present paper, the previously developed procedure is extended to the study of masonry arches, considering different masonry bonds along the longitudinal and transversal directions under monotonic and cyclic loading. Distinct sets of virtual tests, associated with specific geometrical characteristics and loading conditions, are considered for the calibration of the macroscale description. The numerical results confirm the ability of the proposed methodology to calibrate a homogenised material model able to simulate the effects of the masonry bond on the arch response, with a good level of accuracy and a significant reduction of the computational cost.

REFERENCES

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