A comparison between traditional and modern modelling approaches for brick masonry vaults

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ABSTRACT

Masonry vaults are widespread and characteristic structural elements of our built heritage since many centuries, but for a very long time they were built only based upon the experience and the proportional analysis of previous positive examples. Since the Hooke's observations, in 17th century, about the shape of the catenary, and the first graphical analyses of 18th century, the tools for their "scientific" calculation has developed quickly [1], mainly to assess the stability of already existing structures rather than for the prevision of the future behaviour of new vaults. Despite the great progress in this field, ordinary programs for the static and seismic assessment of masonry buildings often disregard the vaults structural role and the professionals sometimes underestimate it, also due to the lack of attention dedicated by the technical codes. Therefore it seems now important to reconnect the elements of this modelling historical evolution, to compare the different methods and to find an equilibrium between complexity and reliability, for the common professional use.

To this aim, a pavilion vault was chosen as a reference, with given geometries and materials features, and the different methods were applied. On one side, traditional methods were chosen: the graphic Méry method [2] and the Heyman limit analysis [3] have been applied to a system of 2D arches composing the vault. On the other side, a 3D Finite Element Model and the edge cutting ChronoEngine Distinct Element Model [4] have been also tested, under the same conditions. The influence of the brick pattern on the structural behaviour have been considered, conveniently defining the arches decomposition in the traditional methods and the blocks division in the Distinct Element Method. In all cases, calculations have been made changing both values and positions of the loads.

The results are compared both in terms of stresses inside the masonry and in terms of deformation of the structural elements, evaluating the types of information and detail that the different approaches can supply. The results of the advanced numerical methods allow to assess the validity of the traditional approaches. On the other side, the possible contribution of the traditional methods to the calibration of the parameters for the numerical models is also discussed.

REFERENCES

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