

Damage interpretation in historical masonry vaults. Lessons on the structural response

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Abstract

The conservation of historical structures requires the evaluation of their stability and strength against a variety of actions such as overloads, wind or earthquake. However, the accurate analysis of curved and spatial members, such as masonry vaults and domes, faces still significant challenges due to their complex geometry and material mechanical response.

A common approach for the analysis of ancient masonry vaults and domes consists in the application of limit analysis (specifically the lower-bound theorem by means of graphic static) based on a decomposition into a set of arches. Often, several or even many alternative decompositions may be possible to describe the equilibrium condition of masonry curved spatial member. In these cases, investigating the actual structural response may be hindered by the lack of objective criteria to decide about the more accurate or realistic decomposition. In any case, the division into arches should be compatible with existing damage (such as cracks) and should even contribute to explain this damage. .

The present paper presents a discussion on the understanding of the equilibrium of curved masonry members in the light of existing damage observed in real historical structures. Real examples, corresponding to emblematic cathedrals and historical churches in Spain, will be presented and interpreted with regards to their structural performance and damage. The examples discussed include curved members such as barrel vaults, domes, apsidal half domes, cross vaults and timbered vaults.