

Assessment of structural damage and evolution in time in historical constructions using numerical models: the case of the church of Saint Bassiano in Pizzighettone, Cremona

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ABSTRACT

This paper investigates the capability of advanced numerical modelling techniques to simulate experimental observations as damage or deformations in complex masonry structures. The case of the church of Saint Bassiano in Pizzighettone, Cremona Italy, is adopted. The church comprises a nave and two aisles. The building features a particular construction history starting in the 12th century, followed by many transformations over the centuries and with, in addition, the demolition of all chapels along one side in 19th century, with consequently the later addition of iron ties to balance the lateral thrust. During the survey, significant damage was documented in the arches, vaults and the walls over them, while some of the structural elements result distorted.

A multidisciplinary research was set up to collect data as geometric survey and deformation analysis with Lidar technology, measurement of axial force in the iron tie rods of the nave, and a monitoring system of some cracks. The data was used as an input to develop and validate a finite element model to study the structural damage and the evolution of the building in time.

The finite element model features a three-dimensional geometry, which is created in part automatically, taking advantage of a parametric model for ribbed masonry vaults, proposed recently in the literature. The created model results in close adherence with the physical model, due to the fidelity of the collected data. Finally, the simulation model features a continuum plastic damage model to take into consideration the masonry behaviour under tension and compression.

The results show how the system response is closely related to the structural evolution over time, associated with the dismantling of the chapels on the south side and the addition of the ties in the nave. Besides, the numerical simulations highlight also the important effect of the soil settlements in the present crack pattern. The obtained information allows to understand the active mechanisms in the building and to optimise the technical interventions in critical parts of the structure.

REFERENCES

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