Experimental and Numerical Analysis of a FRCM Reinforced Parabolic Tuff Barrel Vault

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ABSTRACT

The integrity of barrel masonry vaults plays a crucial role in the structural behavior of construction of the architectural heritage like palaces, churches, cloisters and castles. Anyway, settlements of abutments of the vault, for example induced by foundations differential displacement often induce considerable damage [1].
This work aims at experimentally and numerically analyzing the effectiveness of strengthening interventions made of Fiber Reinforced Cementitious Matrix (FRCM) composites in reinforcing damaged barrel masonry vaults. The above is still an open research issue, since the literature lacks both experimental and modeling studies on FRCM reinforced masonry vaults [2-3].
From the experimental side, an Apulian tuff barrel vault has been first damaged by differential vertical settlements of the abutments with prevented rotations. Then, the differential settlement was blocked, and the vault has been reinforced by an FRCM system composed by a fiber-reinforced mortar embedding a basalt fiber net. Finally, the reinforced vault has been subjected to a concentrated load on a generatrix. The geometry of the vault (polycentric near parabolic shape) and the masonry material are representative of typical masonry vaults in rural constructions of Apulia, Italy.
From the numerical side, an advanced 2D heterogeneous FE Abaqus model has been calibrated starting from the experimentally determined mechanical properties of materials. In order to simulate the damage in mortar joints and cementitious matrix, Concrete Damage Plasticity, already implemented in Abaqus, has been used. The basalt fibers embedded in the matrix have been reproduced as elasto-fragile trusses and elastic behavior has been addressed to the tuff stones.
Both stages of the experimental campaign have been simulated, obtaining a good match between experimental and numerical outcomes in terms of crack pattern and load-bearing capacity.

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