Diagnosis of an unusual structural instability: the case study of the Cathedral of San Lorenzo in Viterbo

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ABSTRACT

The cathedral of San Lorenzo is a Romanesque church sited in Viterbo, Italy, founded in the XII century on a site characterized by an archaeological deep stratification[1]. Its basilica-shaped plant is divided into three aisles by two rows of marble columns connected by arches. The load-bearing walls are made of grey tuff, a volcanic local stone. The structure, that undergone many transformations during the centuries, was severely damaged during the second world war. A restore executed in 1947 brought it back to its romanesque appearance. Currently, peculiar crack pattern can be observed in the structures, which is mainly characterized by recurring subvertical fissures appearing on the keystone of the arches that run along the central nave. Lesions and deformations also affect the fine cosmatesque pavements of the monumental building. The purpose of this paper is to show the analysis path and the investigation campaign that disregards recurrent damage mechanisms[2] as the main cause of the damage in the masonry structures and identify a more realistic cause for the instabilities.
A critical reading of the geometry of the cracks and several static verifications have resulted in the exclusion of mechanisms associated to the thrust action in the arches or the compressive stress in the walls. The hypothesis of soil settlements was rejected by the outcomes of both these investigations and the calculations done by the authors. Due to the localization of the fissures and exclusion of other causes, it is concluded that thermal variations is the main cause of the traction cracks.
In particular, the cracks mainly affect the lower part of the walls along the central nave, which is not exposed to radiation from the sun due to the side naves roofs. The increased propagation of the cracks on the south oriented wall, where the exposition of the external surface to the sun radiation is considerable, provides strong support for this hypothesis.
The analysis on the sun radiation and the results of the thermographic analysis are presented. Such analysis shows significant thermal variation in the walls that is compatible with the thermal damage hypothesis.

REFERENCES

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