Methodologic evolution assessment of large deformations on Romanesque masonry in Val d'Aran (XII-XIII centuries), Spain

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ABSTRACT

There are twenty-four Romanesque churches at Val d'Aran built between the eleventh and thirteenth centuries, where large deformations and geometrical displacements have been found, which, in some cases, exceed the 3% of the structure. One of the most deformed buildings is the church of Santa Maria de Arties (XII-XIII), where some arches and vaults of which have anti-funicular shapes.

The assessment is based on a point cloud obtained with a terrestrial laser scanner (TLS). The scanner used is a Leica ScanStation P20, with a bandwidth of 808/658, class 1. It is a contactless, non-invasive surveying technique that allows for the massive capture of geometric and radiometric data of a given surface [1].

In the study of built heritage, the use of direct measurement techniques for architectural surveying requires a large number of resources. These deformations have caused, in some cases, convex shapes, in relation to the guideline of the vaults, which have the inverted profile of an arch. Some cracks have appeared in these vaults due to active and passive thrusts in order to keep the structures in equilibrium. Geometrical assessment of the least rigid elements, the pillars, makes it possible to analyse the displacements, which have been the cause of anti-funicular shapes on some vaults. It is possible to deduce the regression plane of the displacements of the pillars of the central nave and to define the deformation vectors over it. Thus, these data for the directions of the deformations of the vaults can be determined [2].

The methodology of this study focuses on the assessment of the geometrical characteristics of the 6 pillars [P1…P6] in order to study the displacements that they have sustained. The point cloud is processed with the software and plug-in:

a) Cyclone, and the program 3DReshaper (2016) is used to obtain the three-dimensional mesh with an average distance of points of 0.05 m as well as a measure of the triangle for detecting 0.100 m holes.

b) Undet for Google SketchUp (2019) to obtain the three-dimensional mesh with an average distance of points of 0.03 m, and the automatic union of points in a section of 0.002 m.

The study allows to analyse the evolution of the treatment of the points with the software Cyclone (2016) and the Plug-in Undet for Google SketchUp (2019).

Deformations of pillars are not perpendicular to the guideline of the central vault, so the methodology and results can be very useful to understand the nature of the displacements and to preserve these masonry Romanesque structures.

REFERENCES

[1] Bonali, E., Pesci, A., Casula, G., & Boschi, E. (2014). Deformation of Ancient Buildings inferred by Terrestrial Laser Scanning methodology: The Cantalovo church case study (Northern Italy). Archaeometry, 56(4), 703–716. http://doi.org/10.1111/arcm.12028-

[2] Lluis i Ginovart, J. Coll-Pla, S., Costa-Jover, A., López-Piquer (2017). Evaluation of large deformations on Romanesque masonry pillars: The case of Santa Maria de Arties http://dx.doi.org/10.7764/rdlc.16.3.468