Archaeological documentation during a securing and restoration project: an example of successful approach.

The case of the castle of Larciano (Pistoia – Italy)

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Larciano castle

Larciano, in the province of Pistoia, is on the western slope of Montalbano, a chain of hills that separates the plains of Florence, Prato and Pistoia from the Lower Valdarno, territories controlled by the cities of Lucca and Pisa. In the Middle Ages it was a strategic frontier area: for this reason, numerous castles and fortified villages were built throughout the territory. The castle of Larciano, with its walls and fortress, is one of the best-preserved examples of a fortified village of the Middle Ages. Its current conformation is the result of various construction phases between the 10th and 14th centuries. In this period, it passed from the control of the Conti Guidi to the city of Pistoia and finally to Florence. Each authority made changes to the structure of the castle, enlarging the walls, and fortifying the fortress, the result of which is still visible today (Milanese, Patera and Pieri, 1997).

The research and restoration project

The restoration and securing of the city walls are the result of a virtuous collaboration between the Municipality of Larciano, the Soprintendenza Archeologia, Belle Arti e Paesaggio of Florence, Pistoia and Prato and the University of Florence and its professional spin-off, Laboratori Archeologici San Gallo. All the institutions involved decided to plan the work by trying to conciliate safety requirements with the unrepeatable opportunity to conduct archaeological analyses during the operations (Valacchi, Leonini, Cheli, Somigli and Martini, 2020). After an initial phase of intervention in 2019, focused on the three access gates to the castle, in 2020 the project moved near the fortress; works began on securing the eastern section of the walls, which was threatened by a real risk of collapse, also due to the difference in height between the inside and outside of the walls (over 10 metres). On both occasions, the decision was made to conciliate the need for restoration and safety measures with the carrying out of archaeological analyses that would allow us to deepen our knowledge of the construction techniques present and the construction phases that have taken place over the centuries.

Fig. 1. The fortress of Larciano (a), and part of the eastern wall (b). Vegetation, collapses, safety precautions and the steepness of the ground are visible.

Work planning and workflow definition

The restoration work also included the insertion of mortar between the stones of the walls and in some cases the partial dismantling of the precarious walls for their vertical reconstruction. It was therefore decided to proceed immediately with archaeological survey and stratigraphic analyses before the restoration changed the original appearance of the walls. Thus, in the first phase of the work, the succession of operations to be carried out was planned, to optimise the timing of the interventions and guarantee the best possible result, both from a scientific and executive point of view. The first operation was the removal of the infesting vegetation from the structures; then the survey and stratigraphic analyses were carried out; finally, the scaffolding was erected, and the restoration work began.

As for the archaeological survey, it was decided to make a three-dimensional photogrammetric model; considering the height of the artefacts, a camera mounted on a telescopic monopod was used to reach even the top parts. A Leica total station was used for accurate measurement of control points. This workflow proved to be effective in all interventions on the three gates, allowing a complete archaeological documentation to be obtained and the restoration to be carried out on time.

Restoration of eastern walls: new answers to new problems

In the second phase of the work, at the eastern wall, it was planned to operate according to the same scheme: cleaning of the vegetation, archaeological analysis and photogrammetric survey, erection of the scaffolding and execution of the work. However, it soon became clear that this workflow could not be valid in this case: the height of the wall, the cliff below and the trees did not allow for a complete cleaning without first erecting the scaffolding. The problem was that the scaffolding would make it impossible to see the walls. It was therefore decided to carry out an initial photographic campaign before the scaffolding, as well as the measurement of a series of control points with the total station. In the same way, the archaeological analyses were started, at least for the portions free of vegetation.

After cleaning the walls, it was still necessary to document the object, but the scaffolding represented a major obstacle for the photogrammetric survey: it was possible to shoot from no more than one metre away, on 7 different floors, with difficulty in overlapping the various floors due to the scaffolding

floors. On the other hand, not only the entire elevation was visible, but also the crest of the wall, the inner limit, and even a lacuna which, once cleaned, allowed the nucleus of the wall to be seen.

Fig. 2. The scaffolding of the wall: the floors made hard to obtain vertical overlap and it forced to take very close images

The photogrammetric survey was a real challenge, in order to be able to model the entire stretch under restoration: about 35 metres for a height of up to 10 metres. Comparing the preliminary photographic campaign, without scaffolding, and the final one, with scaffolding, some data emerge that allow us to evaluate the differences: in the first case, with photos taken from the ground and with the telescopic monopod, keeping about 3-4 metres from the wall (depending on the steepness of the ground), 259 photos were sufficient to cover the entire stretch. In the second case, 2335 photos were needed to model the same wall portion. For both campaigns we used the same camera, a Nikon D7100 SLR, 24.1-megapixel DX-format CMOS sensor and Nikkor 18-105 f/3.5-5.6 VR lens. To minimise the preparation phase of the images, the photos were taken on a cloudy but bright day, to avoid shadows from the scaffolding and to have a naturally uniform brightness.

The sheer volume of images not only led to hardware problems with processing, but also with the orientation of the images, due to the poor overlap, especially vertically, because of the presence of the scaffolding floors. The positioning of the control points was also a challenging processing step, as each picture covered a few squared metres. To facilitate the orientation of all images, some panoramic photos of the preliminary campaign were used, which were then excluded from the processing of the dense point cloud. Metashape by Agisoft was used for the entire process; the open-source software Meshlab and CloudCompare were used to intervene on the dense cloud (cloud cleaning, comparison with the preliminary one, subsampling to decimate the points).

At the end of the processing, the accuracy of the survey proved to be more than acceptable, with a verified average error of approximately 0.02 m[1].

To confirm the effective coordination between the archaeological operations and the restoration site, the survey was finally integrated as the work progressed: the top portion, which was only brought to light in greater depth at a later date, was documented and included in the general survey. On the other hand, the three-dimensional survey made it possible to evaluate the profile of the wall at every point, to better calibrate the safety intervention.

[1] To verify the error, two parameters were evaluated: the values calculated by the Metashape software for the individual CPs, and the use of some markers measured with the total station as check points instead of control points. Finally, 2 external control measurements, not included in the Metashape process, were used to verify the accuracy.

Conclusions

The project is still ongoing and will hopefully see further work carried out to restore and enhance this valuable but still little-known site. The completed phases have already fulfilled the objectives of conciliating archaeological research with safety and restoration. It has also been an interesting case study for developing ad hoc operational methods for each intervention. The context in which the work was carried out represented a rather extreme and experimental case: the same operation of photogrammetric documentation, nowadays consolidated and widely used, was a challenge that required specific shrewdness and tricks. In fact, it was possible to test peculiar shooting and processing methods. Finally, this case study has confirmed that 3D surveying is not only a way of documenting and presenting data, but a methodology that acts directly in the research phase (Drap et alii, 2012).

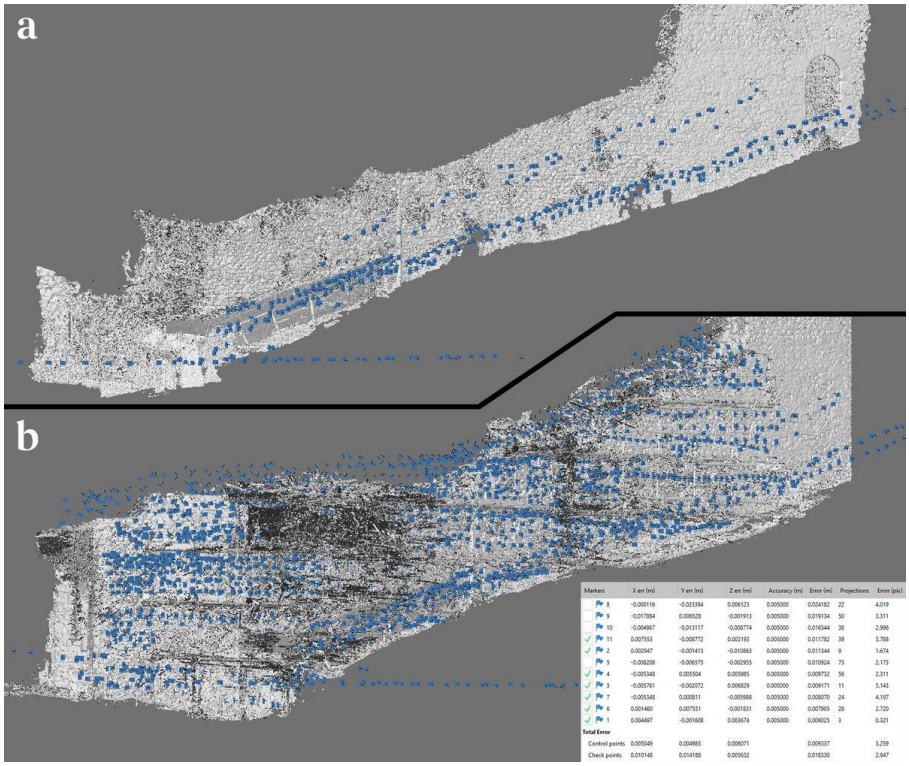

Fig. 3. 3d models of the eastern wall:the result of the preliminary photographic campaign (a) and the result of final surveys (b), realized from the scaffolding. The different distribution of cameras (the blue points) to cover the same wall is obvious. Bottom right, the table of control and check points used

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