THE CASTLE OF CERRETACCIO STUDIES FOR THE MATERIAL HISTORY AND CONSERVATION

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ABSTRACT

The present study analyzes one of the many castles of the Chianti area, the Cerretaccio Castle (Fig.1). The importance of the site is linked to historical and architectural features that distinguished it in the Middle Ages in the context of the clashes between Siena and Florence. The collapse of the tower, which today appears as a series of fragments scattered on the ground, contributes to the interest of the place. The goal of our study is to analyze the ruins of the building and hypothesize its original state, in order to understand the causes of degeneration and collapse and suggest interventions or protection measures. The study consisted of an overall investigation of the area and a specific study on the tower. The digital survey allowed the planimetric and 3D reconstruction of the site. All the fragments resulting from the collapse of the building have been acquired and this has allowed a virtual reconstruction that could return a credible hypothesis of the configuration of the structure before its collapse. The result made it possible to proceed according to the methods of building archaeology, using tools to deepen the typological investigation of the building, allowing to know its materials and construction techniques, typological variations and to hypothesize a placement with respect to the walls. Thanks to the support of structural modelling, it was possible to clarify the possible options related to the collapse of the tower. Issues related to the state of conservation of the entire site were also examined in depth. From these investigations we started an overall analysis for the protection of the site,

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by the identification of the main threats and the assessment of the vulnerability of the involved portions, suggesting some guidelines to hinder its decay.

Methodology

Given the complexity of the site, it was necessary, from the very first approach to the artefact, to formulate a rigorous method for the in-depth study of the aspects to be treated.
The aim was, from the beginning, to contribute to its material history, to the deepening of the construction history and therefore to conservation.
Given the almost total absence of graphic documentation, the first step was a survey, which could outline the morphology of the fortified complex and its architectural elements.
Historical research was carried out in order to understand and clarify the historical events that had led to the birth of the castle, its development and finally its complete abandonment.
Both the survey and the historical research have brought attention to a substantial element of the construction: the tower. Fragmented on the ground, in addition to occupying the main scene of the site, the tower seems to have also determined the events that conduced to the decline of the settlement.
For these reasons, the data collection focused both on the fortified complex in general, and more specifically on the tower through specific analyzes and a rigorous filing of all the fragments.
After all this information has been collected, we have moved on to the data processing phase.

Fig 1. View of the Castle from the Cerreto road..

The first step was the virtual reconstruction of the body of the tower, with an inverse process to the one that caused its collapse. Once the single facades of the tower had been reconstructed, it has been possible to proceed with their analysis using the methods and tools of architectural archaeology. It was in fact possible to combine different kinds of investigations (es. typological analysis) with historical-architectural insights, inevitable in the approach to existing buildings.
After the analysis of materials, building techniques and masonry features we have hypothesized the presence of construction phases and their specific chatacteristics.
The reconstruction of the body of the tower also provided a valid starting point for investigating the dynamics linked to its collapse through a structural modelling.
After these phases the study conducted to following results: the original configuration of the tower; credible hypotheses on the original location; answers on its construction phases and on the destructive methods and dynamics.
Finally, it was possible to draw up an intervention framework with proposals aimed at the conservation of the complex, according to the priorities identified by the risk analysis.

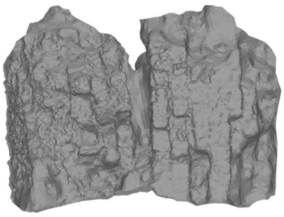
The History of the castle through the historical sources
From the historical point of view, the birth of the Castle is perfectly connected with that phenomenon of primo incastellamento that took place in the passage between the 10th and 11th centuries and which saw the birth of most of the fortified sites in Tuscany. In many cases, the castle organization comes from the structural and institutional consolidation of the sites established up to the entire 10th century (Francovich, 2000).
The castle of Cerreto was founded in 1090 as evidenced by a seal of the Cerretani family (owner of the whole area called Cerreto and therefore of the fortification) (Fusai, 2010). The organization of the settlement seems rather structured to be a rural coterie. In this regard is significant for the Castle the drafting of a breve, a sort of constitution, typically attributed to urban contexts, which was to govern behaviour within the settlement (Prunai, 1958).
The fortification becomes a strategic role especially in the main phases of the clash between Siena and Florence, becoming a strategic border place together with the castles of Selvole and Querciagrossa. The Castle will be the only one of the axis to resist the Florentine advance, attracting the enmities of the city of Florence which attempted (without results) to include its destruction in the peace negotiations with Siena.
But relationships between Siena and the settlement were not

always peaceful, in fact, in 1368 a noble delegation organized a resistance against the new power that had settled in the city at the Castle of Cerreto (Fusai, 2010).
However, these conflicts were resolved in a short time and in 1438 the Castle was placed in the countryside of the city of Siena (Fusai, 2010).
There is no definite news regarding the end of the settlement. There are three different versions about this episode: one associates the destruction of the building in 1496 identifying it as the result of a punitive operation by the Sienese, with the aim of preventing the organization of a possible revolt by the exiles of the Sienese prisons that must have occupied the place. A second version traces the destruction of the settlement and therefore of the tower to the conflicts related to the last war between Siena and Florence in 1555 (Pellegrini, 2016). The third hypothesis traces the collapse to a completely natural event: the earthquake of 1558. This caused extensive damage in Chianti area and in many of the settlements surrounding the fortification.

The digital survey and the current state of documentation
The goals of the complete survey of the area were two: the deepening of the morphological knowledge of the artefact; the documentation of the current state of conservation to facilitate future investigations, before any further collapses due to the progress of structural failures. This was possible thanks to the combination of direct, digital and photogrammetric survey.
The digital survey was carried out with FARO Focus M tool of the Faro Company. The scanner produced a total of 200 scans which, with the help of Autodesk ReCap software, made it possible to recreate a point cloud of the entire fortification. At this point it was possible to virtually remove all the vegetation and easily view the ruins of the castle.
Once this procedure was carried out, in view of the necessary deepening on the tower, every single fragment of the tower was extracted from the cloud and transformed into a 3D mesh (Fig. 2). For each fragment, the rendering of texturized 2D photoplanes was produced using digital photogrammetry and processing

Fig 2. View of the Castle from the Cerreto road..

1. Dense cloud



2. Polygonal mesh

3. Textured model

with the Agisoft Photoscan software.
The results of the survey highlighted a draw of the boundary wall modelled on the design of the promontory on which it is located. Inside it develops an area of about 3000 square meters (Fig. 3). The area is largely occupied by the remains of the tower that involve the northern portion of the complex and are positioned parallel to the long side of the wall (Fig. 4). This seems to be surrounded by a second development of walls that suggest a second building circuit following the first one. Outside of both we find the Church of Santo Stefano to the south-west and the source to the south (Fig. 5).
Access to the complex had to take place through an opening in the door located to the north-east.
Outside the wall circuit there is, in addition to the church, also a fountain located south of the complex whose access had to be guaranteed by a primitive staircase (Fig. 6).

The virtual reconstruction of the tower
Reconstructing the exact aspect that the tower must have had at the time of its collapse is a difficult operation. Probably, during the main phase of collapse, others occurred on the

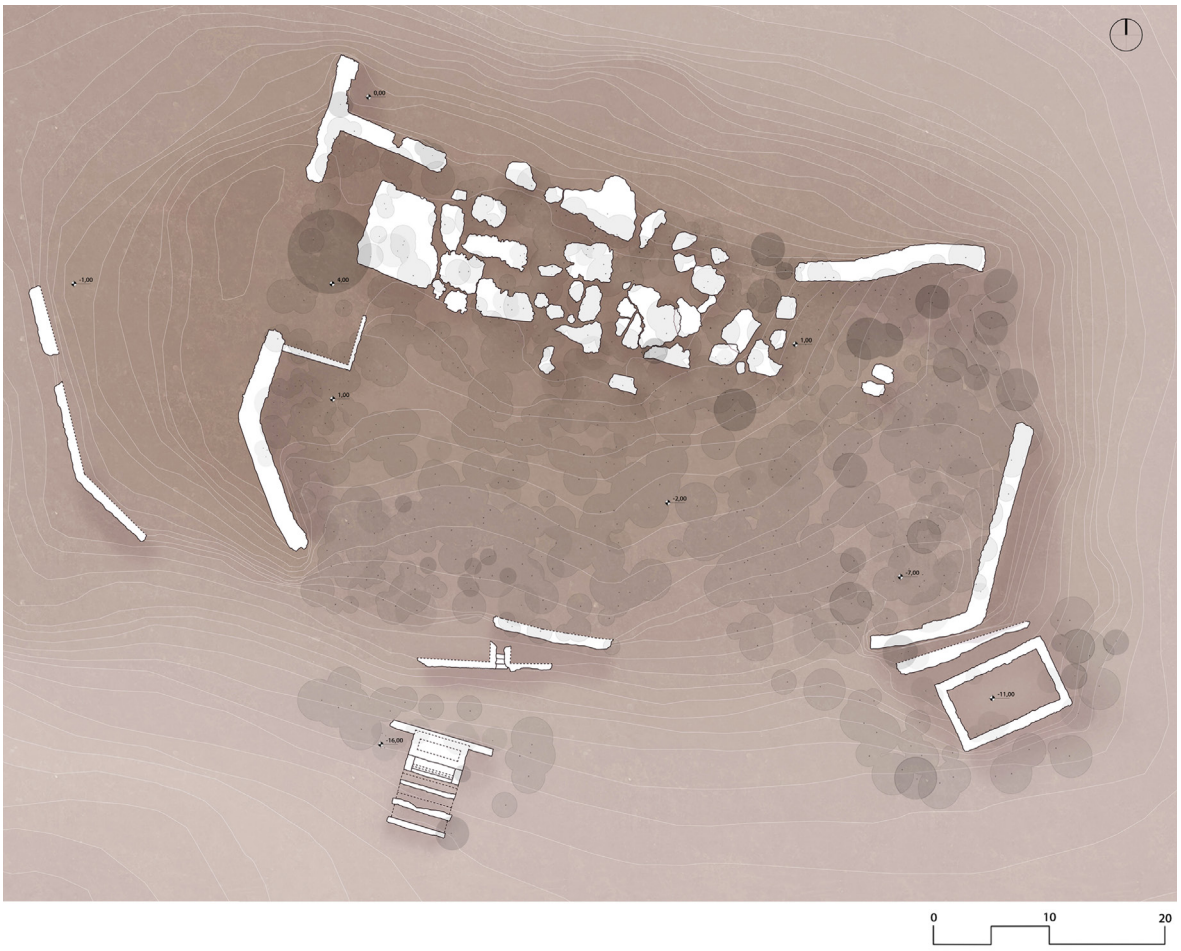


Fig 3. Planimetric asset of the fortification.

tower already lying on the ground making the identification of the fragments very complex.
The process is conceptually simple: reassemble the various fragments on top of each other to reconstruct the appearance of the tower before it collapsed.
In order to connect one fragment to another, several parameters have been considered (Brogiolo, 2012).
The first aspect considered is the identification of each fragment on the plan.
This first aspect provides us to identify macro-areas that contain fragments belonging to the corresponding elevation bands of the tower.
Following this phase each fragment was deepened in its characterizing aspects through the filing operations.
The filing phase was followed by a study of the scanning of the rows, conducted through dimensional analysis of the same. This made it possible, for each front, to prepare a grid that would make the assembly phase easier.
Once the characteristics of each fragment have been deepened, it is necessary to approach the real phase of virtual reconstruction.

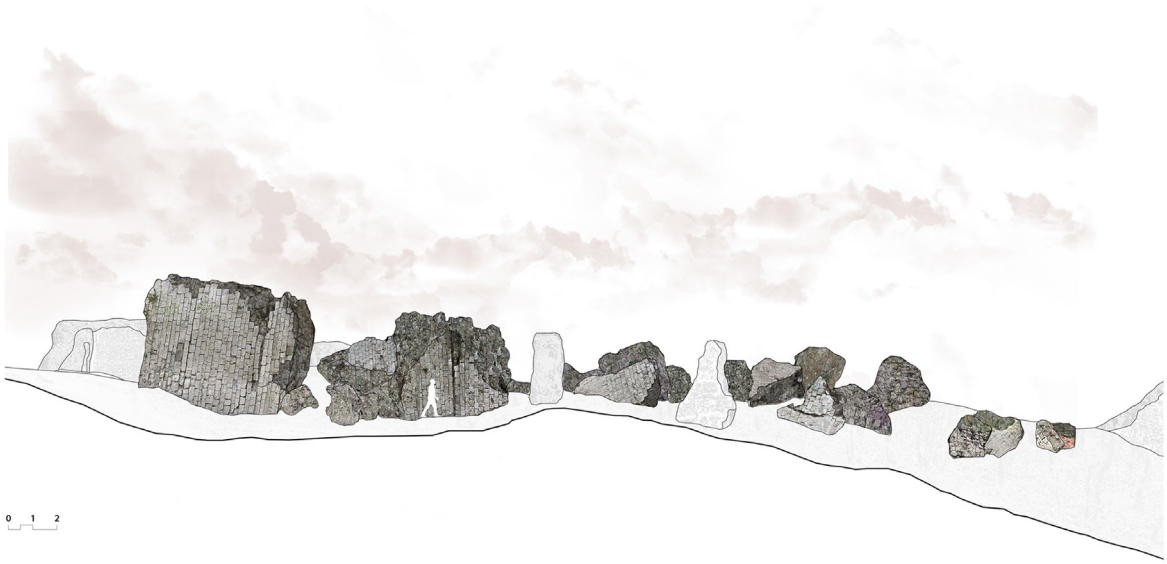


Fig 4. Section about the tower collapse area.

Superimposed on the results, the assembly of the fragments began according to the parameters that emerged from the layout, from the formal analysis and from the continuous visual support that the rendered elevations was able to offer. All the data collected in the previous investigations were

Fig 5. Views of the boundary wall and the church.

Fig 6. Views of the tower and the fountain.

useful in this phase in order to develop a credible hypothesis for the reconstruction of the tower body.
The procedure turned out to be rather complex as it was not possible to identify at first their unequivocal position for all the fragments. The absence of facing in some of them has made it difficult to relocate them, since the reference to the warping of the rows is no longer valid.
From the results emerged the recomposition of three of the four fronts of the building (A, B, and C) and a section (E). The fourth front, D front, cannot be reconstructed as it appears to be against the ground (Fig. 7).
The three brick fragments can be traced back to the top, leading to the hypothesis of a later crowning built with the influence of Siena.
The reconstruction produced a volume of 34.5 m in height, with a plan base of 7.5 m x 7 m.
The tower must have been built for its first 33 m of blocks in alberese (with sporadic elements in sandstone) and have a brick crowning (about 1.5 m).
On the main front, the one overlooking the wall circuit, is present a central opening, as reported the seal of the Cerretani family. The position of this opening is also highlighted by the angular conformation of some blocks that were to form the base and side of the opening. On the front C of the tower, the morphology of a fragment identifies another small opening. This, about 7m from the ground, guaranteed access to the volume by temporary device (retractable ladder) or by an accessory masonry volume, against the walls and the tower.
The section highlights a double reduction of the wall thickness which occurs through two 20 cm deep wall recesses. The shelves and waiting blocks suggest the presence of three floors set at regular height intervals.
The curved section of a fragment attributable to the top of the building could suggest the presence of a vault on the crowning rooms (Fig. 8).

Materials and building techniques
The tower is characterized by a certain homogeneity, both by observing the texture and construction techniques used, and by observing the materials that compose it.
With the exception of the brick crowning, the wall faces seem to maintain a homogeneous prevalence of a lithotype, called alberese. In fact, the area of the Cerreto Castle falls within the Dominio Ligure, in particular in the Monte Morello Formation. This Formation consists mainly of limestone, light gray or hazel, in layers of variable thickness (Comune Castelnuovo Berardenga, 2014).

Even so in the masonry of the tower there are some drafts of another nature, especially in the fragments that can be placed on the top of the tower and in the core of the masonry. In fact, the nucleus seems to consist mainly of sandstone, with a good probability of macigno del Chianti which, as can be

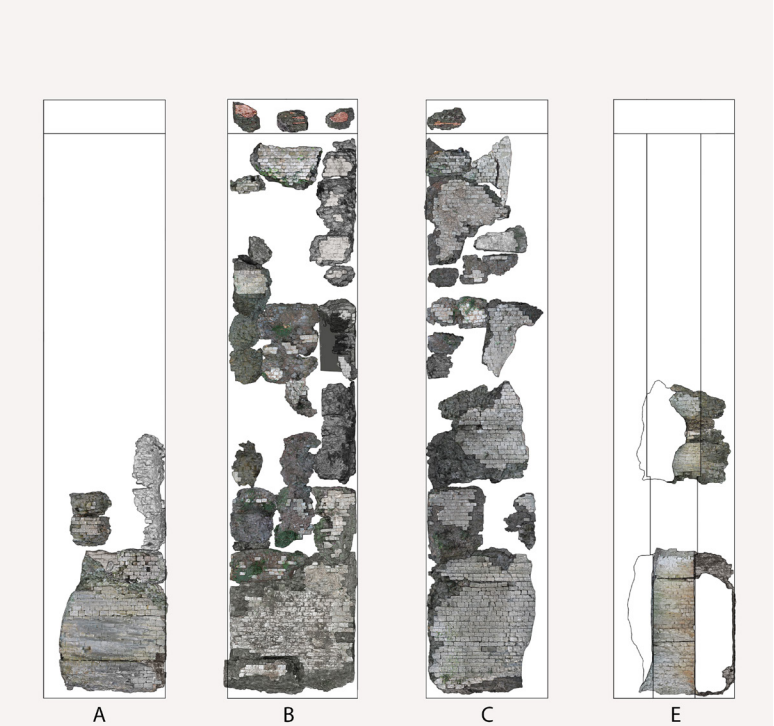


Fig 7. Results of tower reconstruction.

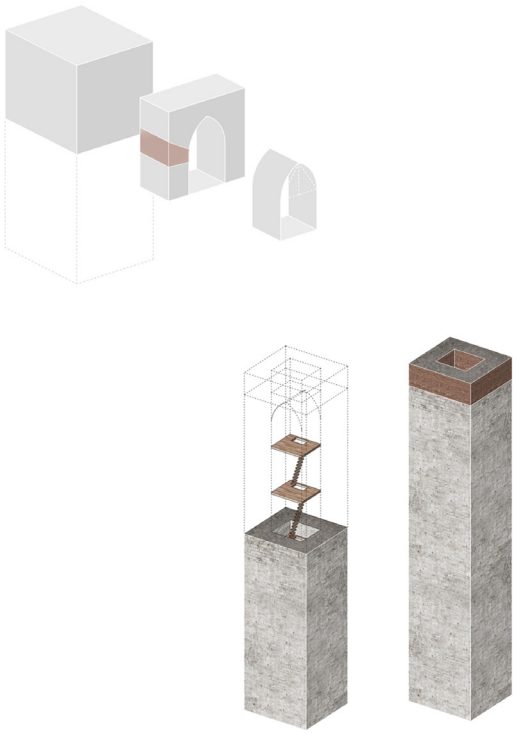


Fig 8. Hypothesis of tower elevation.

seen from the Regional Geological Map (ISPRA), emerges a few hundred meters away from the site of the castle. It is possible that the good performance of limestone was already known to builders as well as the characteristics related to sandstone. The latter, in fact, given its porosity, lent itself better than the other to its use in the core, given its good adhesion with the mortar.

Observing the fragments of the tower lying on the ground, it is evident that many of them have separated according to rather sharp cutting lines, near the horizontals of the wall. Proceeding by horizontals was common in rubble masonry constructions of this period. This method facilitated the warping of the rows and the regular progress of the construction site. However, in the event of stress and consequent collapse of the masonry, it could happen that these horizontal planes favoured the cracking near them.

The mortar used is made up of a lime-based binder and a predominantly sandy aggregate. As far as lime is concerned, its highly hydraulic nature emerges which can be associated with the firing of marly limestone or marl. In fact, based on the analysis of the composition, the initial hypothesis that provided for the use of Alberese stone also in the production of lime is certainly confirmed (Columbo, 2020).

As for the brick used in the crowning fragments of the tower, it was useful to consult the mensiocrological curves. These represent real graphs that show how the standard dimensions of the bricks produced in the Sienese area have undergone variations (Causarano, 2017). This allows us to establish the belonging of the modules used in the tower to a period long after its erection. In fact, they seem to be traced back to the mid-13th century.

It is possible to think that the castle in a first phase consisted exclusively of a tower, a wall circuit and a masonry source, a primitive church could be added to these elements. In this first phase, therefore, the remaining structures were probably built in wood, as was the tendency of the 11th-12th century. Later, however, the tower was raised with a brick crown, the ancillary buildings were replaced and integrated with mixed stone and brick structures and the church was integrated with the use of brick. These interventions could be attributable to the repair operations that the city of Siena had carried out on the Castle.

As regards the construction technique in particular, we can observe that throughout the 11th century there was a slow improvement in the techniques of working the stones to be used in the masonry. In fact, it went from roughly squared drafts up to regular segments well squared by the skilled hands of stonemasons.

The filaretto, used in the erection of the tower, had to be placed exactly at the center of the evolution in the processing of the stones, in fact it is made up of elements, drafts, in horizontal and parallel courses with rather well squared drafts but still with a certain margin of imperfection. The exposed surface of the facings in fact does not show a specific surface processing, other than that of the crack, and the corners of the drafts are not perfectly square. The comparison faced with similar contemporary constructions has brought out the valuable constructive characteristics of the same.

Typological analysis of the masonry

Given the homogeneity found in the observation of the tower walls, the typological method proved to be the only useful tool in the search for any construction variations.

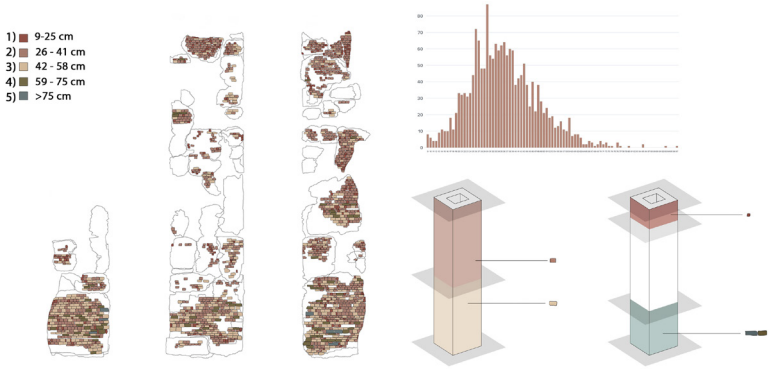


Fig 9. Typological study of segments in width.

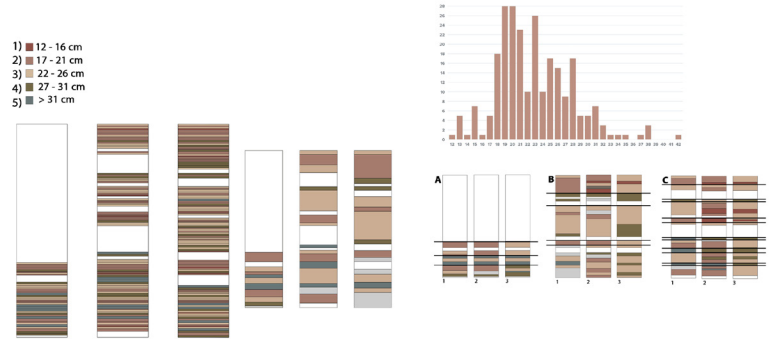


Fig 10. Typological study of rows in height.

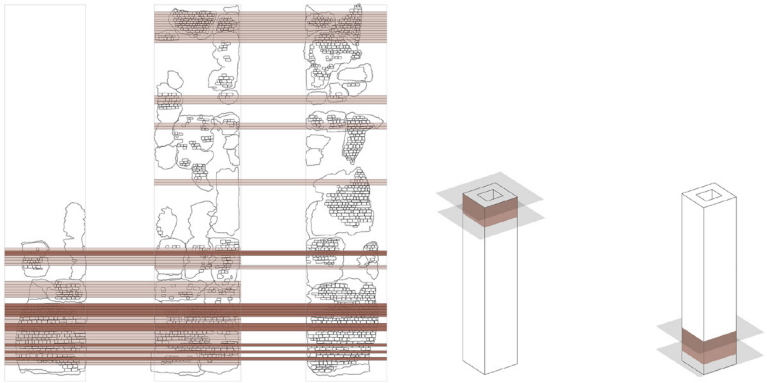


Fig 11. Typological study of horizontals.

The parameters taken into consideration in this phase concerned a rather large population, as they refer to the entire face of the three fronts investigated (Coppola, 2018).
The work focuses on three aspects: study of the dimensions of all the segments of the masonry in width (Fig. 9), dimensional study of rows in height (Fig. 10), study of horizontals (Fig. 11).
As regards the first two phases of the study, a scrupulous measurement of width and height was carried out for all individuals in the population. After data collection, it was necessary to report the same in diagrams to view the distribution trend. Dimensional classes are set on the diagram to simplify the reading on the high side. The address, both as regards the dimensioning in width of the segments and as regards the height of the rows, is to use dimensional classes with regular pitch and check how the elements are distributed within them. Once the classes had been established and identified with a colour, it was advisable to fill in the elements belonging to the specific class with the reference colour.
It is clear that the data that emerged cannot lead either to an absolute dating of the masonry or to a specific identification of circumscribed USM.
It is well known that what emerges from the typological analysis is not a certain and unequivocal fact but represents the possibility of identifying even minimal variations on it.
In light of this, the results obtained can be said to be satisfactory. It was possible to identify homogeneous and diversified characters and proceed with an investigation on the latter. The variables found are attributable to the

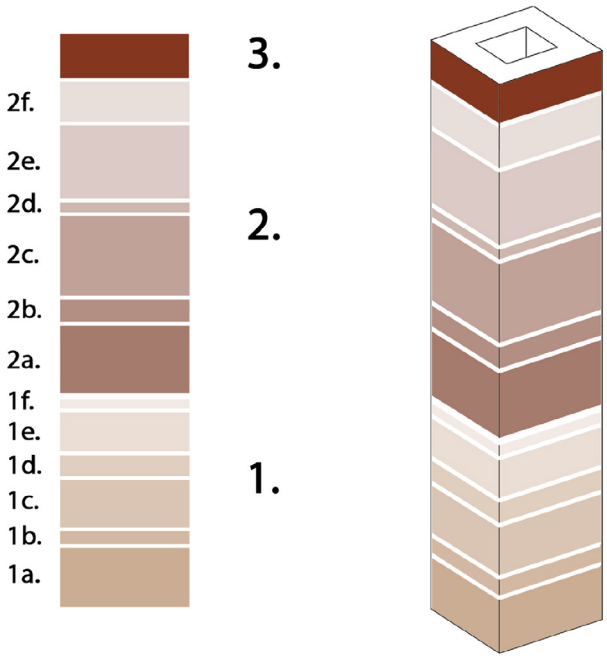


Fig 12. Results of typological analysis.

dimensional aspects of the stones and rows and their texture. Among the parameters investigated there is an occasional continuity of rows on contiguous fronts. This is found mainly in the lower part of the structure, probably as a consequence of the presence of the third front limited to this elevation. The good correspondence, however, maintained between fronts A and B suggests a significant collaboration between the manpower employed on site for the erection of the tower. In particular, the top part of the tower finds a total correspondence in the horizontality of the rows, due to the improvement of the masonry technique during construction, to the reduction of workers employed and therefore to a certain construction uniformity.
As for the dimensional analysis, what emerges is that once again the construction of the tower had to proceed in a unitary way because the fronts seem to respect the same trend and are rather comparable to each other. The presence of these variations is most likely to be traced back to the type of material that was to arrive on site. It is therefore possible that the extraction from the various outcrops took place on several rocky banks and therefore the matches reached the construction site on several occasions.
In general, however, it is proven that there is an almost continuous variation determined by evolving ways of building, changes in the course of construction, suspension and resumption of the construction site and changes in the intervention. It cannot therefore always be established whether all variations correspond to distinct USM or not, but what is important for research purposes is to observe them and record them as variations (Fig. 12).

Hypothesis on the location and collapse of the tower
Before being able to make any considerations relating to the dynamics of collapse, it was necessary to question the location of the tower .
It is typical, following medieval mine operations, to find traces of the base of the structure on the ground.
For these reasons, initially the hypotheses on the placement of the tower were based on the research of this trace. A volume leaning against the surrounding wall, some fragments in a vertical position have contributed to make us think that the tower was originally located in that point. However, the dimensional analyzes carried out on the fragments (which highlighted a reduction in the section through the presence of wall recesses) and the in-depth analysis of the dynamics of the collapse made it possible to arrive at a more credible hypothesis. It is in fact highly probable that the original

position of the tower was not located on the layout of the wall circuit. Rather, it seems that it stood apart from this, in a more central and structurally autonomous position.
Once the most credible location of the tower was identified, a study was conducted to identify the reasons for its collapse. A modal analysis was conducted starting from a simplified 3D model, subjected to stresses through the use of Diana 10.4 software from the Diana FEA group.
This made it possible to compare the hypothesis of the collapse caused by a mine and the collapse caused by a seismic event. Going to analyze the hypothesis linked to the earthquake, the self-frequency analysis shows us how ways of vibrating higher than the first may have aroused a rather articulated response in the structure.
However, with regard to this reflection it is necessary to observe that the main damage due to the earthquake should have occurred on the upper third of the tower, where the displacements seem to be more consistent. It is likely that if the collapse had occurred due to the earthquake, the configuration today would be different. The collapse, in fact, appears extremely directional, which is difficult to trust from a seismic event which, on the other hand, tends to produce debris in every direction, for the crumbling of the masonry caused by vibrations. Moreover, it seems inconsistent to think that the base trunk of the body of the tower shows such a clear separation lesion from the base. In fact, according to what the modal analysis has shown, such a directional collapse could have occurred due to the first modes of vibrating. Only very slow oscillations in fact would have led to such a concentrated cut at the base. However, for such long periods of oscillation,

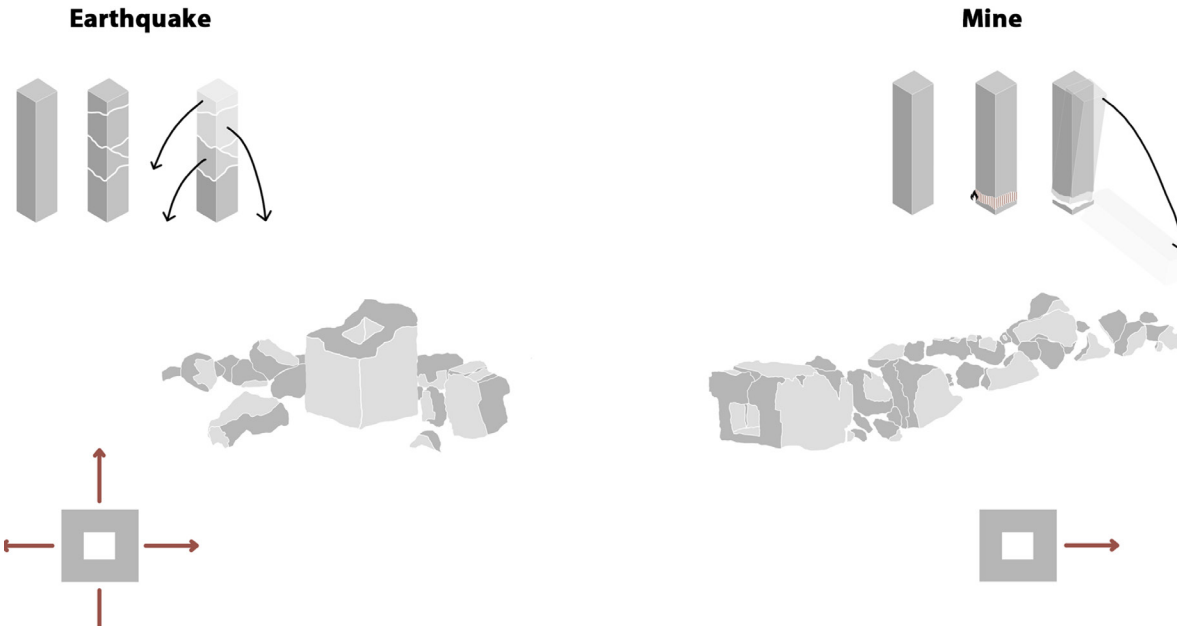
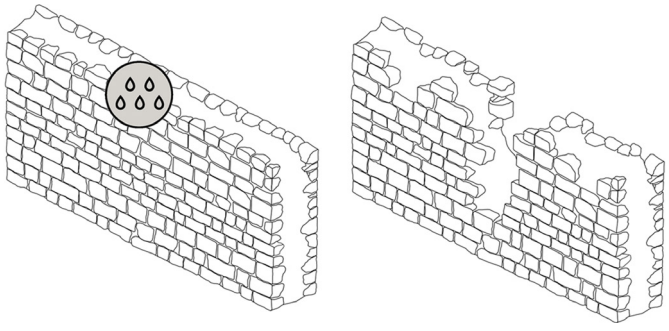


Fig 13. Comparison between the two possibility of collapse.

the expected acceleration at the site (and the consequently induced shear forces at the base) is very low, and in any case not such as to determine a similar level of damage. Thus, the kind of acceleration that may have led to this form of ("slow") collapse is actually not intense enough to cause it.
Conversely, for an earthquake, it is reasonable to think that it is the modes of vibration higher than the first ("serpentine") that would cause the higher portion to be more damaged, and the lower portion, which instead turns out to be overturned, would be due stay upright.
Therefore, excluding that the collapse occurred for the seismic action alone, it seems reasonable that the collapse could have been caused by the mine action in the foundation. Finally, the hypothesis should not be excluded that if for some reason the mine did not have the desired effect, the earthquake, finding itself urging a tower already undermined at the base, could have caused its consequent collapse (Fig. 13).

State of conservation
The macroscopic phenomena common to the whole area are generally linked to the evident state of neglect of the property. In more significant phenomena are linked to two aspects: the presence of vegetation and the infiltration of rainwater (Fig. 14). The lack of material on the wall crests would have exposed the masonry more to degenerative phenomena. The loss of

Fig 14. Main degenerative phenomena of the fortification.



the crown must have allowed the infiltration of rainwater into the inner core and the rooting of the vegetation. It is probably for these reasons that most of the injuries were created. In many cases the crack pattern has produced a more or less consistent loss of material. In the south-eastern section of the boundary wall, the phenomenon caused an important fracture in the thickness of the entire wall section which seems to have caused the detachment of the two contact fronts. One of the two portions into which this section of the boundary wall is divided, is progressively losing its original position, assuming a position outside the vertical plane.

As for the tower, it owes its state of decay to the unusual position it occupies today. A masonry that is designed to remain in a vertical position, free on all four sides suddenly finds itself in contact with the ground. All those phenomena linked to the rising damp from the ground (stains, biological organisms) that affect the portion of the fragments adhering to the ground are connected to this accidental location.

We can generally affirm that the phenomena of decay linked to the Castle seem to differ according to the artefact they involve and seem to connect mainly to problems relating to the action of phenomena external to the construction, therefore not to be sought in the poor quality of the materials or construction techniques.

Following the analysis relating to the state of conservation of the complex, it was useful to ask some questions. What do you face if the artifact is not preserved? How soon could the artifact disappear and together with it its intrinsic value? To answer these questions it was useful to use the practice of risk management. This method has been developed over several years through international courses offered by ICCROM (International Center of Studies for the Conservation and Restoration of Cultural Heritage) and by the CCI (Canadian Conservation Institute) and through its application in many cases of study conducted around the world.

Comparing the results with the manual's priority scale gives a rather worrying picture.

Although there are no phenomena attributable to the highest level, therefore identifiable with catastrophic priority, all the external phenomena analyzed seem to fall into the second and third category extreme and high priority.

In particular, what stands out most is the great extent of the phenomena related to the presence of vegetation which, associated with poor conservation of the property, could lead to the loss of 30% of the building in the next 100 years.

Guidelines for conservation strategies

The framework provided by the risk analysis drawn up on the guidelines of the ABC Method together with the study of the phenomena of deterioration in progress made it possible to draw up a risk assessment that has highlighted some extreme situations. The risk assessment has produced these worrying results especially in relation to the masonry works and the consistent state of decay.

The vulnerability of buildings reduced to the state of ruin is different from that of buildings which, although affected by important degradation phenomena, maintain their original characteristics.

It is necessary to relate to the Castle with targeted interventions that can save the surviving ruins.

The indications drawn up can refer to three phases of intervention. The first is certainly the cognitive nature. The investigations carried out on the tower deserve to be extended to the whole complex and, where possible, related to further investigations. Cognitive research is to be considered essential before proceeding with any conservation intervention.

Further guidelines are highlighted below referring to the practical interventions of consolidation of the asset drawn up on. For simplicity, the phases that affect this aspect are separate: on the one hand guidelines linked to specific or widespread interventions on the materials involved, on the other hypothesis on the maintenance and structural consolidation of the artifacts. To these is added a further third, strictly connected to the others, which refers to the operations on the vegetation that so insistently involves the site. Finally, intervention strategies are presented for the enhancement of the asset.

Conclusions

The work presents the cognitive investigations on a fortified Chianti complex, the Cerretaccio Castle, central to the medieval events of the territory and today almost disappeared from common memory.

The research was able to frame the artifact in its complexity and offer more specific insights.

The deepening of the demolished tower lying on the ground allowed, through techniques of digital survey and architectural archaeology methods, to reconstruct its body, allowing each fragment to be positioned with respect to the others up to a credible hypothesis. It was possible, directly on the individual fragments and then on the entire rebuilt tower, to investigate the masonry, the materials used and their technology. The typological analysis of the recomposed elevations allowed the identification of significant variations

on the construction such as to allow the formulation of hypotheses on the dynamics of the construction site.
With the support of similar examples of architecture it was possible to reconstruct the volume of the elevations and the section of the tower, its dimensions and its position with respect to the wall circuit.
The structural investigations made it possible to evaluate the reasons for the collapse and to clarify the versions reported in the literature.
Finally, the study of the state of conservation highlighted the problems related to the building in general and specifically to the tower and to assess the risk in terms of time and loss of value, so as to be able to draw up guidelines for the conservation of the asset and the possible use by the population.
For the future we hope that the work can be completed and integrated according to the guidelines drawn up in order to preserve its exclusive testimonial value.

References

Brogiolo, G.P. and Cagnana, A. (2012) *Archeologia dell'architettura. Firenze: All'Insegna del Giglio*.
Causarano, M.A. (2017) *Mensiocronologia e produzione dei laterizi a Siena in età medievale e moderna* (XII-XIX secolo), in "Archeologia dell'Architettura" n. 22.
Francovich, R. and Ginatempo, M. (2000), C*astelli. Storia e archeologia del potere nella Toscana Medievale*. Vol.1. Firenze: All'Insegna del Giglio.
Columbu, S.; Gabbrielli, F.; Giamello, M.; Mugnaini, S. and Scala, A. (2020) *Le tenaci malte della torre del castello di Cerreto Ciampoli* (Siena, Italia). In "Defensive Architecture of the Mediterranean", vol. XII.
Comune Castelnuovo Berardenga (SI), R.U. – *Relazione geologico- tecnica Marzo 2014*
Fusai, L.(2010) *Mille anni di storia attraverso le vicende della famiglia Cerretani Bandinelli Paparoni.* Pisa: Edizioni Ets.
Coppola, M. (2018) *Le indagini tipologiche in architettura. Leggere il costruito con metodi non strumentali.* Roma: Carocci Editore.
ISPRA, *Note illustrative della Carta Geologica d'Italia – foglio 297* Asciano
Pellegrini, E. (2016), *Fortificare con arte. Torri, casseri e fortezze nel Chianti.* Siena: Betti Editrice.
Prunai, G. (1958), *Il "Breve dominorum de Cerreto"* del 1216. Archivio storico Italiano 116.