Measurement xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Measurement

journal homepage: www.elsevier.com/locate/measurement

The Cluny Priory of Castelletto Cervo (Biella, Italy): Archaeometric study of mortars

Elena Basso[a,*], Gabriele Ardizio[b], Eleonora Destefanis[b]

[a] Dipartimento di Scienze della Terra e dell'Ambiente, Università degli Studi di Pavia, via Ferrata 1, 27100 Pavia, Italy
[b] Dipartimento di Studi Umanistici, Università del Piemonte Orientale, p.zza S. Eusebio 5, 13100 Vercelli, Italy

ARTICLE INFO

Keywords:
Mortars
Petrography
SEM-EDS
Cluny Priory
Building phases
Building archaeology

ABSTRACT

The Cluny Priory of Castelletto Cervo (Biella, Piedmont) was deeply investigated from 2006 to 2014, in a multidisciplinary project. This contribution deals with the methodological approach followed for the archaeometric study of mortars, and the results in term of material knowledge and reading of the building phases in a time interval of about a millennium.

Petrographic observations combined with microchemical data showed that the local raw materials were exploited during a very long time span: the aggregates are polygenic sands, with a high percentage of volcanic rock grains, coming from the hydric basins of the Cervo River, and its tributary Ostola; the binders are mainly Mg-bearing lime, with a strong hydraulic component due to the reaction between the binder and the volcanic grains of the aggregate. A good match between mortars composition and building phases was determined only for some of the earliest phases of the monastery.

1. Introduction

Mortars and plasters are complex artificial stones, realized from three essential components: binder, aggregate, and water. The compound thus obtained is highly plastic, and the irreversible transformations that occur during hardening strongly depend on the raw materials used and on the "know-how" in a specific historical period. Therefore, the material culture strongly influences physical, chemical, and mechanical features of mortars [1]. For this reason, mortar characterization represents an essential tool in the study of building techniques and construction phases of historical buildings, as well as in provenancing raw materials, which is interesting in terms of both production techniques and materials trade in a specific time [1–10].

The goal of this work concerns the interpretation of the stratigraphic analysis of the Cluny Priory of Castelletto Cervo (Biella, Piedmont) through the material study of mortars, carried out through petrographic and micro-chemical analyses. This study is part of a complex archaeometric project, which included also analyses on bricks (in the framework of the international research Project *Terres cuites architecturales et nouvelle méthodes de datation*), stones, plasters, and pigments.

1.1. Historical framework

The Cluny Priory of Castelletto Cervo (Biella, Piedmont) has been the object of a long-term multidisciplinary research Project (2006–2014), leaded by the Humanities Department of the Eastern Piedmont University (under the direction of Eleonora Destefanis). Results have been recently published in a monography [11], where the research is illustrated under many aspects. In this contribution, some of them are highlighted, notably concerning the archaeometric study of mortars.

The complex is located at around 25 km north of Vercelli, on the edge of a relief a few meters higher than the surrounding plain; the landscape is still characterized by extended moorland areas, as it was in the past. Not so far, and just beneath the Priory, the water stream Ostola joins the river Cervo, that flows at the foot of the relief.

Firstly mentioned in 1092 as already established (likely founded in the last quarter of the 11th century), the St. Peter and Paul monastery developed and implemented his ownership at least until the first half of the 13th century, with an economic strategy that facilitated the acquisition of properties in complementary territories, not only from the agricultural point of view.

Then, the whole region was marked by a long period of troubles and wars involving the monastery too, which the written sources attest as abandoned by monks, who left for the safer dependency in Carpignano (Sesia Valley), in a territory east of the monastery.

Only from the end of the 14th and above all in the 15th century, the monastery's development recovered, but this lasted very shortly: in fact,

* Corresponding author at: via Giacomo Leopardi 2, 13048 Santhià, Italy.
E-mail addresses: elebasso75@gmail.com (E. Basso), gabrieleardizio@tiscali.it (G. Ardizio), eleonora.destefanis@uniupo.it (E. Destefanis).

http://dx.doi.org/10.1016/j.measurement.2017.08.022
Received 14 March 2017; Received in revised form 20 July 2017; Accepted 12 August 2017

Fig. 1. Overview of the complex (left) and plan with the excavated areas (right) (after [11]).

over the 16th century, it was permanently abandoned by the religious community, and, at the end of the same century, converted into a parish church, a function that the site has been keeping up until the present days. This transformation process caused the gradual demolition of some parts of the monastery complex, particularly of the cloister and other areas that did not meet the new requirements.

The complex counts several buildings (Fig. 1), which, according to the stratigraphic analysis carried out on the masonries in the framework of the research project, belong to different phases, dating from the Middle Ages to the Modern Age [12]. A quite wide archaeological excavation, alongside the work on the existing structures, has allowed archaeologists to identify the main construction periods and to find out the most important steps in the development of the complex.

The site was occupied and dwelled at least since the Early Middle Ages (Period I), as documented by a group of graves, dating from the late 9th-10th century (according to the stratigraphy and the radiocarbon dating), and a possibly more ancient workshop for metal production.

In the monastic period, from the second half of the 11th century, the first building built was the main church, which displays two main phases (Period I, phases 1a and 1b).

The most ancient part of this three-aisled and three apses building is the eastern one, while the western one belongs to a later period, likely some decades after: it not necessarily deals with a different phase, but rather with a recovery in the framework of a long-time constructing work, which is very common in the architectural medieval practice.

The façade, belonging to this latter phase, displays decorated single-lancet windows and an originally painted single portal placed at the center. A bell-tower rises on the last bay of the southern aisle.

In the area south of the main church, in the first half of the 12th century, a cloister was built (Period II, phase 2), whose eastern and western walks are known: the former is still preserved, although deeply transformed, while the foundation walls of the latter were brought to the light during the excavation.

A further development of the monastery took place in the second half/final decades of the same century, when a second single-aisle church, whose apse was found in the excavation, was built against the cloister's eastern building (Period II, phase 3). This church, documented by later written sources as consecrated to St. Mary, represents an important moment in the monastery's history, bearing witness to a characteristic and widespread architectural feature in the Cluniac world, associated to specific liturgical functions, as recent studies are highlighting [12].

Finally, at the very end of the 12th century or at the beginning of the 13th century, the last special building dating to the Middle Ages was added to the complex: in fact, a westblock was built against to the Priory church's façade (Period II, phase 4). It is originally a one-stored building, provided with vaults. Two doors allowed the access to the complex, respectively, on the south, towards the cloister (reserved to the monastic community); on the west, towards the outer space, accessible to the layman who possibly could approach to the Priory church in specific liturgical occasions. In the second half of the 14th century a new two-stored room was constructed on top of the westblock, providing the church with a new, monumental façade (Period III, phase 1).

The original functions of this building are so far unknown, even tough, again, the inclusion of this site in the Cluny milieu might suggest its use as location for liturgical station and an in-between space, placed between the religious and secular world.

Furthermore, in the same first construction phase (Period II, phase 4), at the beginning of Duecento, another still preserved store was added to the bell-tower, having three-mullioned windows per each side, which open on the surrounding landscape.

The oldest construction phases (Priory Church, lower part of the bell tower, cloister) show a consistent use of pebbles as main component in the masonry, bound by abundant mortar [13]. The squared stonework was used in a very careful and selective way, limited to the molding elements (such as arches and pillars) as well as, generally speaking, to the most important structures from the statics point of view (Fig. 2). The construction technique in the more ancient phase is also characterized by the use of large pebbles, broken and roughly hewn. The most ancient masonries, apart from a very few exceptions, are rarely enhanced by the insertion of bricks, usually of re-use.

Only with the construction of the second church and notably the westblock, the building technique changes significantly, and the association brick-squared stone becomes more and more evident. The petrographic analysis carried out on stones, combined with some written documents dating from the Modern Age [14], have demonstrated, moreover, that squared stones come from different sources: in the first phases of the complex (Priory Church and bell tower) a widespread use of green cornubianite and gray limestone is attested, which come, in the first case from a nearby area, in the Biellese territory (Villa del Bosco) or the lower Sesia Valley. The green cornubianite was likewise quarried in the latter area, where some traces of a quite recent exploitation of the