Abstract The Herculaneum Conservation Project is a public-private initiative to conserve and enhance the Roman city of Herculaneum, Italy. Emphasis is placed on simplifying and reducing costs of archaeological site management by reinstating site infrastructure, promoting rolling programmes of maintenance, and research and trials to improve conservation methods. After preliminary research in the site archives, the 100 Mortars Project is now underway and aims to study the wide range of mortars present in the archaeological site – both original Roman mortars and those used in twentieth-century restoration campaigns. More than one hundred mortars have been sampled for analysis so far and it is hoped that in a few years almost a complete range of ancient and modern mortars from Herculaneum will be available. This will not only increase knowledge about the site but will also contribute to the conservation of Herculaneum and other open-air archaeological sites, thanks to the development of works strategies that consider quality, cost and time parameters when working with each type of mortar identified. This paper reviews the results obtained so far.

1 Introduction

The Herculaneum Conservation Project (HCP) is a Packard Humanities Institute project, in partnership with the Soprintendenza Speciale per i Beni Archeologici di Napoli e Pompei (SANP; the heritage authority) and the British School at Rome, which has been active in Herculaneum since 2001. The partnership was formalized by a sponsorship contract through which the private partner can undertake works in the archaeological site of Herculaneum under its own management and at its own expense with a multidisciplinary team working in very close partnership with colleagues from the public authority [1, 2].

The 100 Mortars initiative was launched by the HCP team in order to carry out an extensive sampling campaign across the site of both original and restoration
mortars. Mortars from Herculaneum have never been systematically sampled and consequently there is little knowledge about the quality and the behaviour of the ancient mortars and those used during the nineteenth- and twentieth-century excavation and restoration campaigns. This research is providing important data on the different mortar typologies present (see below), their state of conservation and the composition of the modern restoration mortars used at Herculaneum in the nineteenth- and twentieth-century excavation/restoration onwards.

The primary focus of the initiative is on wall mortars (mortars in wall cores and joint mortars); however, research is being extended to include mortars related to decorative features (plastered surfaces and their preparatory layers, bedding mortars for mosaics and mortar pavements).

The result of this sampling campaign will be of great importance in providing additional data on the building techniques used in the Roman town, but also in understanding the effect of the AD 79 eruption on the ancient mortars and their condition after 80 years (and in some case of more than a century) of exposure to the elements as the result of archaeological excavation. As HCP is a project focused on advancing conservation methodologies and techniques, this research is also considered as the first step in a broader study which aims to understand how to manage the conservation of mortars in open-air conditions and how to conserve them where cement-based mortars were applied during modern restoration works. These results will also inform the rolling programme of maintenance that is being launched at Herculaneum, and could also be useful for other sites in the Vesuvian and Naples area.

2 Understanding mortars to consolidate Herculaneum’s walls

Since 2007 the HCP team has carried out extensive mapping of Herculaneum’s walls, aimed at identifying structural problems and intrinsic characteristics that could affect its survival. Since 2005 a campaign focused on structural consolidation has been one of HCP’s main activities and the mapping, along with other studies on materials and construction techniques, has provided support for programming works [3, 4].

In Herculaneum the nature of the site’s burial means that wall structures often survive at a significant height (32% of the walls in the archaeological site are higher than 3 m) and the buildings may have more than two floors still in place (unlike Pompeii). However, these heights are not properly supported by thick consistent walls (more than 50% of the walls are no wider than 50 cm). These structures are similar in height to those found in modern towns, but are as fragile as archaeological ruins. In addition, violent site formation processes and progressive decay have caused many walls to be in conditions at the limit of resistance to failure: bowing and leaning, erosion of lower portions, etc. are common phenomena.
The characteristics of the mortars that sealed the joints are crucial in cases of rising damp, a very common condition at Herculaneum. Erosion is also a characteristic of half-excavated structures, in areas close to the edge of site, as ground water coming from the modern town above is continual. In reality the decay by erosion in Herculaneum surprisingly affects the tuff blocks that make up the wall facing more than the mortar holding them together. This demonstrates the strong resistance of the ancient mortars used in Herculaneum (indeed, there is wide evidence for use of pozzolana in mortars at Herculaneum and Pompeii).

3 Ancient and modern wall mortars in Herculaneum

The composition and quality of the original construction mortars used in Herculaneum’s walls do not only have archaeological value, but are also fundamental for understanding the structural capacity of the wall itself. In the case of Herculaneum, the masonry fabric has been exposed to violent natural events and slow decay processes: the archaeological site which we deal with today is the result of the AD 62 earthquake and AD 79 eruption, as well as the trauma of excavation, extensive restoration inventions (including reconstructions with a variety of modern and often incompatible materials) and gradual decay due to exposure to the elements since excavation.

Today understanding the structural capacity of an archaeological wall is of great importance in order to better carry out its restoration, and is even more so when, as in the case of Herculaneum, it is in a seismic area.

The decision to core sample the walls was made so as to gain the most information with the least invasive option possible: the core drill can extract bedding mortar from the wall facing and core filling.

3.1 Rubble core masonry walls at Herculaneum

The most widespread typology of masonry in the Roman world – and therefore at Herculaneum – are faced walls with a rubble core where the external facings functioned as formwork into which the core mixture was poured. Roman constructions vary considerably according to geographical location, construction period, wall thickness and decay suffered [5]. In Herculaneum the external facings are usually made up of geometrically arranged tuff blocks and sometimes are brick-faced walls. Instead the reconstruction of wall facings during and after excavation were carried out using an alternative arrangement of tuff blocks, which was used as a visual language for distinguishing original from restored sections.

Before the 100 Mortars sampling campaign began, knowledge of the wall cores was limited and came from direct observation of the few unconsolidated wall crests. On the basis of this data, the core seems to be made up of large quantities of mortar containing tuff and/or brick fragments. The wall cores reconstructed
after the nineteenth- and twentieth-century excavations are instead distinguished by the use of lapilli as an aggregate, a clear sign that the restoration work was carried out in the modern period (as lapilli were a product of the AD 79 eruption).

4 Methodology

As the 100 Mortars project is not a global sampling campaign but one for a limited number of samples, choosing areas to sample was crucial for obtaining comparable results. This is a summary of the strategy adopted:

- Building typology (public/private, bath building, house, etc.);
- Architectural typology (pilaster, colonnade, elevations, etc.);
- Construction technique (opus reticulatum, incertum, vittatum, mixtum, craticium) [5];
- Restoration techniques (1800s, 1927-1939, Second World War period, post-war period, after 1961).

These categories were agreed with the HCP archaeologists [6] using research that had already been acquired on the Roman period and the post-excavation restoration techniques (using the excavation diaries and photographs held in the heritage authority’s archive). The main objective is to create a database of comparable information on various levels, so as to obtain results that connect the conservation risk to construction typology, construction period or restoration characteristic. In this way, using HCP’s GIS database as a tool it is possible to establish works priorities using data gathered from decay mapping cross-referenced with the 100 Mortars results.

For the internal samples a diamond-tipped core drill was used with a diameter of 2 cm, while pieces of the joint mortars were often easier to extract using a small hammer and chisel. The bored hole was also investigated using an endoscope. The location of the samples is recorded on a geo-referenced map and all the relevant data are entered into HCP’s GIS database (Fig. 1) [7].
During the first sampling campaign on wall cores, 44 core samples were taken, of which only 4 remained intact during extraction (Fig. 2). This is already a result in itself, as it can be deduced that the decohesion of the core’s component material is tied to the presence of clayey material mixed with lime. This clay component has been preliminarily identified as volcanic material (a mixture of pumice) dating to 3800 years ago (the so-called Avellino pumice) which is widely present in the geology of the Herculaneum area. The characteristic of disaggregating in water was also true for samples taken from the walls that had been entirely reconstructed during the 1800s restorations and those carried out by Amedeo Maiuri (1927-1961), probably because they used material from the eruption of AD 79 in the mix.

All samples were taken with the aim of creating thin sections to be examined under an optical microscope in order to evaluate:

- the ratio between binder and aggregate;
- the petrographic components of the aggregates;
- the presence of salts;
- the microscopic decay conditions.

Further investigation is planned in order to characterise the various types of mortar including X-Ray Diffraction (XRD) and Thermogravimetric Analyses (TGA/DTA).
5 Sampling decorated wall plasters and restoration mortars

Outdoor and indoor decorative plasters at Herculaneum are composed of different kinds of aggregate with varied granulometry. The use of local materials such as pyroclastic sands or sand taken from the two rivers which ran alongside Herculaneum was common. In many cases a mixture of inert sands was used, though a single aggregate is found in some cases. The lower areas of outdoor plasters were usually made with the addition of ground brick dust to give the mortars hydraulic properties and longer durability.

After a careful examination of the weathered areas around site, twenty samples of decorative plasters were taken from lacunae in the painted layer. Pre-selection was also carried out using macro-photography (Figs. 3-4).

Large quantities of cement were used during the excavation and restoration campaign led by Amedeo Maiuri from 1927 to 1962 [8]. Apart from the cement used to surround fresco fragments, Maiuri used to fill in gaps with a mortar on which an outline of the decoration was sketched. Restoration mortars will also be sampled and examined. The period in which these interventions were carried out can be identified by consulting the heritage authority’s archives.

6 Sampling floor mortars

Herculaneum has various types of mortar floors including cocciopesto (ground terracotta fragments mixed with mortar, often with tesserae or polychrome marble fragments inserted as decoration), mosaics; opus sectile (marble pieces bedded in mortar and arranged in geometric patterns).
Most of these floors have been restored in the past and so the selection of original mortars was determined by a team including an archaeologist and a conservator. Forty-one samples of mortars used in these types of floors have been taken from lacunae.

Fig. 3 Detail of plaster in the peristyle of the House of Argos where the primary aggregate can be seen. Scale marker: units of 1 cm. (Image: Alessandra De Vita/HCP)

Fig. 4 Detail of plaster from the facade of the House of the Genius showing brick fragments and black volcanic sand grains (the latter are indicated with arrows). (Image: Alessandra De Vita/HCP)
7 Preliminary results

Although we are still waiting for the results of the scientific analyses on the samples taken from this first campaign at Herculaneum, it is already possible to say that the sampling methodology and 100 Mortars Project aims are a significant step forward both for our understanding of ancient Herculaneum and for improving conservation techniques and methodologies.

After several years of activities focused on the ancient city’s structures and decorative features, thanks to a continual campaign of emergency interventions and maintenance, the HCP team has entered into a new phase where it is handing over information, conservation approaches and methodologies to SANP. Through research, experimentation and pilot projects, but in particular through a long process of co-programming (where the public partner and the private partners commission consultancy and works in unison), the HCP team is attempting to launch a long-term conservation programme for the entire archaeological site sustainable with the resources of the public partner alone. Maintenance campaigns are being organised by typology, both on structures and decorative features. These are accompanied by interventions that focus on specific problems and also by more complete conservation projects. In this context, the 100 Mortars project will constitute a particularly important contribution as an attempt to identify the best techniques for the maintenance and conservation of construction mortars and those for floors and wall plasters.

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9 References


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