

# **Title: Study and definition of standards for the formulation of restoration mortars compatible with historical mortars**

**Tutor: Alberto De Bonis**

## **Research program**

The formulation of restoration mortars for applications in the architectural - archaeological - historical - artistic fields is a complex operation. In Italy, the standard "UNI 11488: 2013, Guidelines for the classification, definition of the composition and evaluation of the performance characteristics of restoration mortars" establishes that the choice of a restoration mortar cannot be separated from the compatibility with the materials composing the artifact, from its suitability with respect to the function and from the environmental conditions where the artifact is located.

Compatibility with the original materials is one of the fundamental principles for the formulation of a restoration mortar. This kind of material is defined as "compatible" when does not create chemical, physical, mechanical and aesthetic damage to the object on which it is applied. This requires a diagnostic study and a detailed characterization of the ancient mortars, object of restoration, via an analytical approach suitable for this type of geomaterial.

The compositional characteristics of the ancient mortars should be investigated by means of mineralogical-petrographic methods commonly used for archaeometric investigations. This will allow for the identification of the raw materials and the mix-design used to produce the mortars, as well as the minerogenetic secondary processes influencing their technological features. The latter are closely related to the physical-mechanical properties of the materials and will be investigated via laboratory tests, also to assess their susceptibility to weathering agents. Useful information on the compositional characteristics of the ancient mortars can also be investigated in situ, where it is not possible to take material, with instruments used for non-destructive diagnostics, which will also allow for a valuable data collection on the types of decay, any previous restoration and on aesthetic features.

The data collected on ancient mortars will allow for the formulation of "recipes" for the restoration mortars by means of an experimental approach implemented for evaluating the interactions between the two materials. The mix-design of the restoration mortars will be based on criteria and parameters as similar as possible to the original ones, in order to obtain optimal performances, both in the fresh state and in the hardened state of the mortar.

The multidisciplinary approach of the project will therefore allow for the definition of criteria for the formulation of restoration mortars compatible with ancient mortars. Historical mortars are strongly related to the territory of production, therefore it is essential to go back to the "original recipes" and identify the areas of supply of raw materials. By using the latter consciously, it is therefore possible to make eco-friendly restoration mortars with the use of local materials produced with traditional methods with a low environmental impact. The materials thus obtained will be fully compatible from a compositional, behavioral and aesthetic point of view and will represent a continuity with the ancient materials.

## **Proposal for a PhD position**

The doctoral program has a multidisciplinary approach in archaeometric, diagnostic, petrographic, historical-artistic and conservative fields. During the PhD course, the methodologies for the study of ancient mortars will be applied via different analytical techniques such as polarized light microscopy (PLM), scanning electron microscopy with microanalysis (SEM-EDS), X-ray diffractometry (XRD), thermal analysis (DTA-TGA), and physical-mechanical characterization.

The work program will include the study of the available literature and a selection of samples of ancient mortars following a strategy carefully planned with the expert archaeologist(s) responsible for the materials.

Non-destructive diagnostic techniques will also be applied *in situ* through infrared (FT-IR), Raman, and portable X-ray fluorescence (pXRF) spectroscopy. By means of an experimental approach, restoration mortars compatible with the ancient ones will be replicated in the laboratory. For this reason, the PhD student must demonstrate a good practical predisposition for the formulation and preparation of restoration mortars.

The candidate must also have a good knowledge of English, such as to allow a period of stay at a foreign institution of at least five months, for collaborating with local researchers in the development of specific aspects of the research plan.

Training courses of the “Scuola di Dottorato” will be also available for the student at the host University for improving her/his knowledge on different topics.

The research programme is supported by funds Overheads SINAPSI