



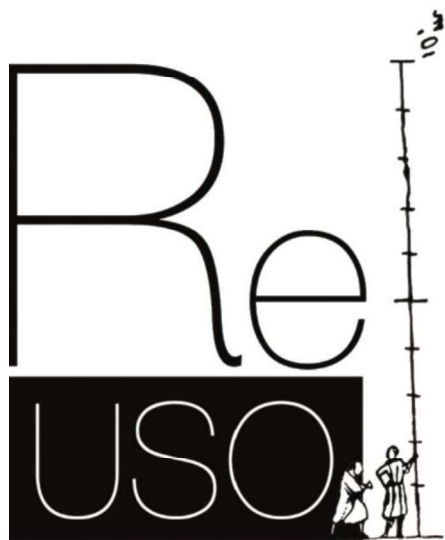
## Documentation, Restoration and Reuse of Heritage

2-4 November 2022  
Porto, Portugal

# BOOK OF EXTENDED ABSTRACTS







**Documentation, Restoration  
and Reuse of Heritage**

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## Natural hydraulic mortars for rehabilitation of historic buildings: review of the state of the art

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**Abstract:** The growing concern with environmental issues has enabled the insertion of new solutions for waste management in various fields of knowledge, including civil construction. The evolution of construction techniques and the option for materials with less impact on the environment have been increasingly topics of study in this regard. Among the most significant residues, we can mention the ceramic residues that come both from the production of this material and from the demolition and execution of new construction sites. Inserting ceramics in the mixture of natural binder mortars has been a construction technique used for centuries to obtain a material with hydraulic properties. Many of the historical buildings were built with this type of mortar, since Portland cement is a binder considered recent, having started its commercialization only at the end of the 19th century. To assist in the research of new compositions, this paper proposes a review of the state of the art on the use of natural mortars in historic buildings and the insertion of ceramic waste in these mixtures.

**Keywords:** Mortars, Natural hydraulic binder, Ceramic residues, Rehabilitation

### 1. Introduction

Developing the rehabilitation of historic buildings with the insertion of materials that would potentially be waste sent to landfill sites, is an effective way to bring together the already known use and function of mortars produced with natural binders. This paper aims to review the available literature on the production of this type of natural mortar with hydraulic properties, cataloguing information about the ceramic waste, the properties of the mixture, and possible uses in on-site case studies.

### 2. Materials and methods

The main purpose of this study is to gather information that can support the development of mortars with natural binders, with hydraulic behaviour, that have good performance for the rehabilitation of facades of historic buildings. The method used to reach this goal is based on three important research topics: ceramic residues and their processing, production of natural mortars, and rehabilitation of historic buildings. Through the catalogued information, it will be possible to seek answers to the following questions: Is there technical and environmental feasibility for the development of these mortar mixtures? What are the benefits of using natural mortars in this context? Are ceramic residues materials with pozzolanic potential to favour the function of the proposed mortars?

In order to conduct scientific research on the development of material mixtures and application of mortars in situ and in laboratory tests, a typical systematic review of the literature was conducted in major databases such as Scopus, Web of Science, and Springer. In this study, the search was programmed to find the keywords in the titles and abstracts of

the articles. The keywords "ceramic waste" and "mortar" were restricted by the following filters: (i) type of article (research, reviews, and book chapters); (ii) publication between the years 2012 to 2022; (iii) text written in English. All results were reviewed and selected with support from the "Mendeley" literature review software. Duplicate sources were removed, as well as those that did not contain in the title, abstract or keywords the list of words: mortar, natural mortar, lime mortar, alkali-activated mortar, ceramic waste, historic building. The final selection was made by analysing the title and the abstract. This search methodology led to the enumeration of the latest publications related to the development of natural mortars with insertion of ceramic material in their composition.

#### 4. Final remarks

The presented review aimed to demonstrate the available investigations about the production of natural binder mortars with addition of waste for the rehabilitation of historic buildings. As observed in several studies, the properties of ancient mortars have similarities with this type of mixture.

The results obtained from the research point to an amount of studies of ceramic waste as a substitute for natural aggregates and binders in mortars, most of which refer to investigations related to Portland cement products. However, for the use intended here, this material should be avoided, for not generally presenting a behaviour compatible with historic buildings.

In order to better research the proposed theme, it is recommended that the years of publications searched be extended. One can also alter the keywords searched, so as to possibly include more articles that study the type of mixture that obligatorily includes a natural binder (lime) and ceramic residues of various types. Another limitation imposed was the language in which the article was published, with only English being used, which despite being the language of most publications, there were still some exceptions in other original languages.

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