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Brick masonry identification in a complex historic building, the Main College of the University of Alcalá, Madrid (Spain)

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HIGHLIGHTS

- Interdisciplinary analysis of masonry historic buildings.
- Six historical periods and four morphologies were identified.
- Five types of mortars and four types of bricks were characterized.
- Combination of morphology and materials, double-checked by historical data.
- Six brick masonry typologies were found in the 16th century building.

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ABSTRACT

The aim of the paper is to study the brick masonry walls of a complex historic building, the first College of the University of Alcalá (Madrid, Spain), founded in 1495 and declared World Heritage Site by the UNESCO in 1998. An interdisciplinary procedure for brick masonry identification has been defined, in order to enhance documentation, conservation and restoration issues, then putting into value the architectural heritage. The methodology integrates experimental data obtained through on site sampling and measuring together with historical information. The results were used to correlate stratigraphic units, fabric morphology and materials. The differences identified through morphological analysis and experimental results were cross referenced with historical data, allowing a scientific interpretation, supported by experimental results and contrasted to historical information.

An integrated constructive analysis based upon available historical data allowed the identification of six brick masonry types based on their period of construction, fabric morphology and building materials. The results provide a scientific support for decision making in future conservation and restoration strategies.

1. Introduction

The identification of building materials and constructive techniques is essential for conservation and restoration of historic buildings and is of great help to put into value their heritage importance. As a general rule, the walls of complex historic buildings are characterized by the overlapping of different masonry types, due to the addition of constructive elements and refurbishment works along time. As a consequence, their current appearance is the result of multiple interventions which are often difficult to identify. It is therefore necessary to develop strategies for the study of these buildings.

The investigation of historic buildings must combine on site observations and measurements, along with laboratory tests. The main aspects to consider may also include the history of the building, its chronology and the history of constructive techniques [1].

Some information concerning historical constructive issues could be obtained from documentary sources, such as ancient drawings and descriptions or historical studies [1]. In the case of buildings with a high historic or artistic value, there are usually many historical studies, although the constructive information is scarce and usually concerns to very specific decorative elements. While some assumptions can be made, mainly based on analogy to nearby buildings, actually the existing materials are often unknown. Therefore, studies on the current building materials

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must be conducted as a first step before taking any conservation or restoration decision [1].

The study of masonry walls in complex historic buildings can be conducted on the basis of two different approaches: the masonry morphology [2,3] or materials characterization [4,5].

Morphological analyses are based upon stratigraphic studies and are essential for architectural archaeology [6]. The aim is to find out the constructive units existing in a building considering the shape and size of bricks and the brickwork. This approach does not take into account the constitutive materials in themselves, further than their external appearance, which limits the extent of this type of analysis.

Materials characterization of masonry walls involves the study of both the binder material and the brick/block. The binder material is usually a mortar and the pieces are mainly bricks, as it is the case of the present study. Mortars can be characterized by the physical–chemical composition of the binder and the physical–chemical and mineralogical composition of the aggregates. Bricks can be characterized through the physical–chemical composition of the raw materials and the manufacturing techniques, as the grinding techniques or the firing temperature.

However, the usefulness of these tests alone is sometimes questioned [1]. The study of materials, without considering other aspects such as the masonry morphology or the historic period, has also limitations [1]. Depending on the historic and the geographical context, as far as raw materials and manufacturing techniques availability are concerned, the physical–chemical characterization results can be unable to identify significant dissimilarities. This can be the case of the composition and firing temperature of bricks and the composition and mineralogical aspects of the binder and aggregates used for mortar manufacturing.

One of those complex buildings is the Saint Ildephonse's College, the first building of the University of Alcalá that was built up in early 16th century. Fig. 1 shows the main plan of the building, characterized by a large central arcaded courtyard (Saint Thomas' Patio courtyard) surrounded by rooms devoted to different uses. The complexity derives from the history of the building and the multiple additions and rehabilitation works undertaken during the last 500 years. The building has been the subject of many studies [7–10], even though no architectural studies have been accomplished to identified materials and constructive techniques, further than the use of brick masonry and rammed earth.

Regarding the history of the College, the original two-story building was erected between 1499 and 1508 using brick masonry and rammed earth. In 1537, the outstanding three-story stone façade was built [11]. Accordingly, the north side of the College was raised one storey more (Fig. 2a). During the next century, the original building completely changed its appearance. In early 17th century, a new clock tower was erected on the south side (Fig. 2c) and, between 1656 and 1670; a granite cloister was built

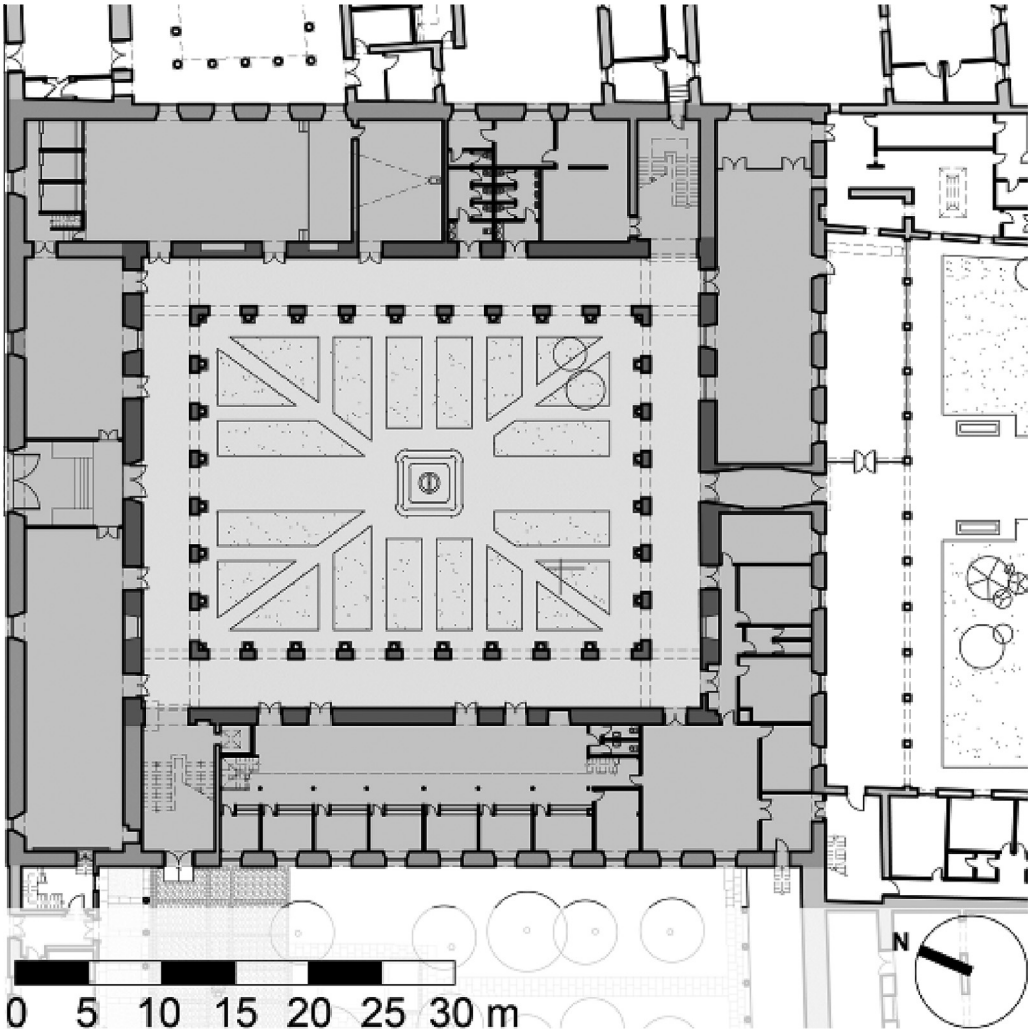

Fig. 1. Ground floor plan of the Patio of the Saint Ildephonse's College, University of Alcalá (Madrid, Spain).