Journal of Archaeological Science: Reports 7 (2016) 269–279

Contents lists available at ScienceDirect

Journal of Archaeological Science: Reports

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

Studies for the restoration of the Islamic Bofilla Tower as an example of wood use in rammed earth structures

C. Mileto [a,*], F. Vegas [a], V. Cristini [a], N. Macchioni [b], L. Sozzi [b], S. Lazzeri [b]

[a] Universitat Politècnica de Valencia, Cno. Vera s/n, 46022 Valencia, Spain
[b] CNR – IVALSA, Via Madonna del Piano, 10, 50019 Sesto Fiorentino, Italy

ARTICLE INFO

Article history:
Received 14 July 2015
Received in revised form 12 April 2016
Accepted 3 May 2016
Available online xxxx

Keywords:
Rammed earth
Wood
Restoration
Islamic tower
Olive
Maritime pine
Mulberry
Ash

ABSTRACT

This paper deals with the analysis of traces of wood technology in the Bofilla Tower, a medieval rammed earth Islamic watchtower close to Valencia. Although the principal material constituting the tower is earth, wood played a basic role in the construction and use. Indeed, wooden elements were used to execute the formwork, as reinforcement for the earthen structure and as structural material for the floors. At the time of restoration, the tower had completely lost its floors, ceilings and stairs, although traces of the original structure and small pieces of woodwork remained. Samples of various elements were extracted and anatomically examined in order to identify the timber. Only four types of timber were identified: olive, maritime pine, mulberry, and ash. Based on the few wooden remains found and the tests carried out, this paper analyses the use of different timbers found within the structure of the tower and tries to identify the provenance of the wood according to the organisation of the rural community living around the building. The paper concludes with a description of the restoration of the tower.

1. Foreword

Earthen architecture presents many structural and taxonomic studies, especially linked to the monumental character of traditional and historical artefacts (Graciani García and Tabales Rodríguez, 2008; Jaquin et al., 2008; Romero and López Osorio, 2012), and their sustainable and potential ecological value (Vázquez Espí, 2001; Carvalho and Lopes, 2012). There are numerous applications and hybrid versions of walls that rely on the combined use of earth and other components and supports, such as wood (Mileto et al., 2011a; Mileto et al., 2012). For instance the half-timber or wattle-and-daub techniques are two construction systems where timber frames or wooden trellises are associated with earth filling, the first for load-bearing structures and the second for non-structural walls. This is not the only historical and traditional application of this material to earthen walls. Less frequently, but just as effectively, timber has been used as a reinforcing element in rammed earth walls, as indicated in the presentation of this case study (an Islamic watchtower in the Province of Valencia, Spain).

At the time of study and restoration, the Bofilla Tower in Bétera (Valencia) had lost its wooden floors, ceilings and stairs, although imprints could still be observed in the rammed earth walls and in some of the beam ends. In addition, these walls still preserved thin putlogs from the formwork and remnants of sleepers and lintels. Therefore, the work aimed to study a miscellaneous repertoire of constructive footprints bound to wood technology and legible thanks to the plasticity of the clay used in the walls, in order to guarantee that the restoration and conservation project for the Bofilla Tower would preserve the original walls and all the wooden remains and the construction elements which were of great historical and cultural value. At the same time, the identification of these imprints in the walls (Warren, 1999; Mileto, 2010), together with the analysis of wooden fragments identified in situ, have helped to improve the knowledge of the construction of earthen structures and have ensured the reconstruction of the history of the building location (GPS: lat. 39.580124, long. −0.429165), inextricably linked to the life and history of the rural community that lived around the tower, through the materials found.

2. The tower

The Bofilla Tower in Bétera (Valencia) (Fig. 1), near the Spanish Mediterranean coast, is a defensive rammed earth structure erected in the Moorish era in the early 13th century (Bazzana and Guichard, 1978). Together with about forty similar structures, associated with farms, it is part of the protection and sighting system around the city of Valencia during the years of the Christian re-conquest (Rodriguez, 2008). Progressively abandoned in the 15th century, due to wars with the kingdom of Castile, famine and plague epidemics (López Elum,

* Corresponding author.
E-mail addresses: cami2@cpa.upv.es (C. Mileto), fvegas@cpa.upv.es (F. Vegas), vacri@cpa.upv.es (V. Cristini), macchioni@ivalsa.cnr.it (N. Macchioni), sozzi@ivalsa.cnr.it (L. Sozzi), lazzeri@ivalsa.cnr.it (S. Lazzeri).

http://dx.doi.org/10.1016/j.jasrep.2016.05.007
2352-409X/

Fig. 1. Bofilla Tower before the conservation work (C. Mileto and F. Vegas).

Fig. 3. Putlogs of the formwork inside the walls of Bofilla Tower (C. Mileto and F. Vegas).

1994), the Bofilla Tower suffered about five hundred years of neglect and looting. At the time of study, the tower presented material degradation linked to environmental agents (microvegetation and dirt on the surface; erosion and loss of volume on the crowning; erosion due to increased capillary action on the base; washing-off, especially on the upper section of the south façade, etc.) as well as to human action (the removal of the voussoirs from the main door resulted in the major collapse of the north façade and the upper northwest corner) (Fig. 2). Degradation and pathologies, both human and natural, have not erased the information still found on the surface and in the walls which the 2009–2010 restoration project was able to bring to light (Mileto et al., 2011b). In addition, these centuries of abandonment bear witness to the strength of the original building. The Carbon-14 test carried out in 2010 (Villafranca Sánchez, 2010) on samples of wood from the putlogs of the formwork of the rammed earth revealed that these elements were approximately 750 ± 60 years old, indicating that the Tower could have been built between 1200 and 1320. These dates were cross-referenced with the historical data on the Christian conquest of these territories in 1238, as this would have been the last possible date of construction for an Islamic tower, as well as with the ceramic fragments found in the course of the excavation (Burriel and Ruiz, 2009). This suggests that the tower was built between 1210 and 1220 CE.

The sides of the square tower are 6.15 m, reduced to 5.20 m at the crown, so that the profile is that of a truncated pyramid. The walls are up to 1.20 m thick at the base of the tower but the external tapering and the internal staggering of the wall reduce this to 56 cm in the upper part. The survey suggests that the tower was probably built by

Fig. 2. Bofilla Tower, inner sections, before the conservation work (C. Mileto and F. Vegas).