

# FORT



The international journal  
of fortification and  
military architecture

Volume 43 • 2015

Fortress Study Group

ISSN 0261-586X





## Fortress Study Group

Founded in 1975 to represent the interests of those actively involved in the study of all aspects of fortifications and their armaments, especially works constructed to mount and resist artillery

Front cover: *Cleared concrete communication trenches.* (Photo Trevor Davenport)

Back cover: *A recent high level walkway and lift in Pamplona. Simple build detailing in Cor-Ten steel, a robust insertion in keeping with the nature of fortifications. See article on p.135.* (photo John Harris)

### *Patron*

His Royal Highness the Duke of Gloucester KG GCVO RIBA

### *Honorary Fellows*

Dr Christopher Duffy

Anthony Kemp

Margaret Pinsent

### **Officers and Committee Members**

*Chairman:* David Page (in succession to Bill Clements)

*Honorary Secretary:* John Cartwright (in succession to Alastair Fyfe)

*Honorary Treasurer:* Alan Fyson

*Honorary Editor of FORT:* John Harris

*Honorary Editor of Casemate:* Norman Clark

*Honorary Picture Editor:* Charles Blackwood

### *Executive Committee:*

Richard Ashmore

Simon Barrass (Webmaster)

Dave Bassett (IFC Representative)

Paul Beckmann

Alistair Graham Kerr (Conference Administrator)

Professor Jim Storr

Roger J C Thomas

### *Officers not serving on the Committee:*

Gil Dowdall-Brown (Reviews Editor)

Phil Magrath (Honorary Librarian)

### *Editorial Board for Fort 43*

John Harris

Stephen Dent

David Lakin

Charles Blackwood

Miriam Harris

This issue of FORT designed and produced by Stephen Dent.  
e-mail: [sfdent@dircon.co.uk](mailto:sfdent@dircon.co.uk)

Printed by Hobbs the Printers Ltd, Totton, Hampshire.

Tel: 023 8066 4800 Fax: 023 8066 4801

Web: [www.hobbs.uk.com](http://www.hobbs.uk.com)

*FORT: the international journal of fortification and military architecture.* is a refereed, peer-reviewed academic journal and is generally published once a year.

ISSN 0261-586X © Fortress Study Group, 2015

**Fortress Study Group is a registered charity: No. 288790**

*Website:* [www.fsgfort.com](http://www.fsgfort.com)

**Review copies of books and all other recent publications/material should be sent to the Honorary Reviews Editor:** Gil Dowdall-Brown, Langdale, 1 Pelican Lane, Newbury, Berkshire, RG1 4NU, e-mail: [reviews@fsgfort.com](mailto:reviews@fsgfort.com)

**Membership enquires and all other correspondence concerning the Fortress Study Group should be addressed to the Honorary Secretary:** John Cartwright, 49 Hartscroft, Linton Glade, Croydon CR0 9LB  
e-mail: [secretary@fsgfort.com](mailto:secretary@fsgfort.com)

**New material for future publication in FORT should be addressed to:**

John Harris BArch RIBA, 22 Crane Grove, London, N7 8LE  
e-mail: [editor@fsgfort.com](mailto:editor@fsgfort.com)

To purchase further copies of this edition of FORT, and for details of availability and contents of back issues please contact Alistair Graham Kerr, 7 Burgh Castle Marina, Butt Lane, Burgh Castle, NR31 9PZ.

# Contents

<b>Editorial</b>	2
<b>The Prussian artillery battery at Mały Garc in the fortification system of the line of the Lower Vistula (1901-1914)</b>	4
Paweł Nastrożny	
<b>Polish Casemates of Strongpoint "Nowogród"</b>	20
Piotr Popławski, MA	
<b>Historical earthworks in Prussian permanent fortifications from the turn of the twentieth century: the example of Fortress Wrocław (Festung Breslau), Poland</b>	62
Lukasz Pardela	
<b>The Prince-Bishopric of Liège: how a small state survived the campaigns of Louis XIV, William III and the first Duke of Marlborough</b>	75
Roeland Goorts	
<b>Recording Twentieth-century Wartime Landscapes in Scotland: a Summary of Progress</b>	104
Geoffrey Stell	
<b>Burj al Kiffan, Sea Fort in the Bay of Algiers. - Ottoman Coastal Defence Against European Navies (XVI-XVIIIth centuries)</b>	109
Safia Benselama-Messikh	
<b>One of the Best Preserved Medieval Fortification Systems on the Frontier of al-Āndalus: <i>Segura de la Sierra</i> (Spain)</b>	122
Santiago Quesada-García	
Luis José García-Pulido	
<b>FORTIUS Pamplona - Bayonne, a European Project for a Living Fortified Heritage</b>	135
José-Vicente Valdenebro García , PhD Architect	
<b>The Legacy of the Geometry of Dürer: the Fort of San Jorge (c.1724)</b>	156
Josep Lluís i Ginovart, Agustí Costa-Jover, Sergio Coll-Plà and Roger Mirales Jori	
<b>Reviving Alderney's Fortifications</b>	168
Trevor Davenport	
<b>Further Thoughts on Dürer's Second Bastion</b>	197
John Tomkinson	
<b>Book reviews</b>	199

# One of the Best Preserved Medieval Fortification Systems on the Frontier of al-Andalus: Segura de la Sierra (Spain)

Santiago Quesada-García  
Luis José García-Pulido

## Introduction

This paper covers the study of a set of military structures preserved in what was a unique border area between Christians and Muslims in south-west Europe during the twelfth and thirteenth centuries. They are situated in a wide mountainous and wooded territory located in *Segura de la Sierra* valley<sup>1</sup>, in the south-east of the Iberian Peninsula (province of Jaen, north-east of Andalusia). This area formed the frontier for 280 years between the Christian kingdom of Castile and the last territories of al-Andalus after the collapse of the Almohad military power, due to their defeat in 1212 in the *Navas de Tolosa* battle (see figure 1).

## Overview

This collection of well-preserved fortresses, distributed

over less than 5,000 hectares, makes up and defines a Cultural Landscape. They consist of a system of defensive structures composed of more than sixteen towers often linked to a walled enclosure (see figure 2). They provide information on the territorial organization, morphology, constructive technologies, and use of this border zone during the Late Middle Ages. They allow us to expand our current knowledge of the walls built in rammed-earth, which was widely used in the Mediterranean basin for more than two millennia, from the *qsur* (fortified settlement) and *tighrematin* (fortified familiar dwellings in between four corner towers) settled in the pre-Sahara oases, to the *taddart* or traditional houses of the Middle Atlas; from the humblest dwellings and fortifications of al-Andalus to the most refined and sophisticated construction of all of them, the

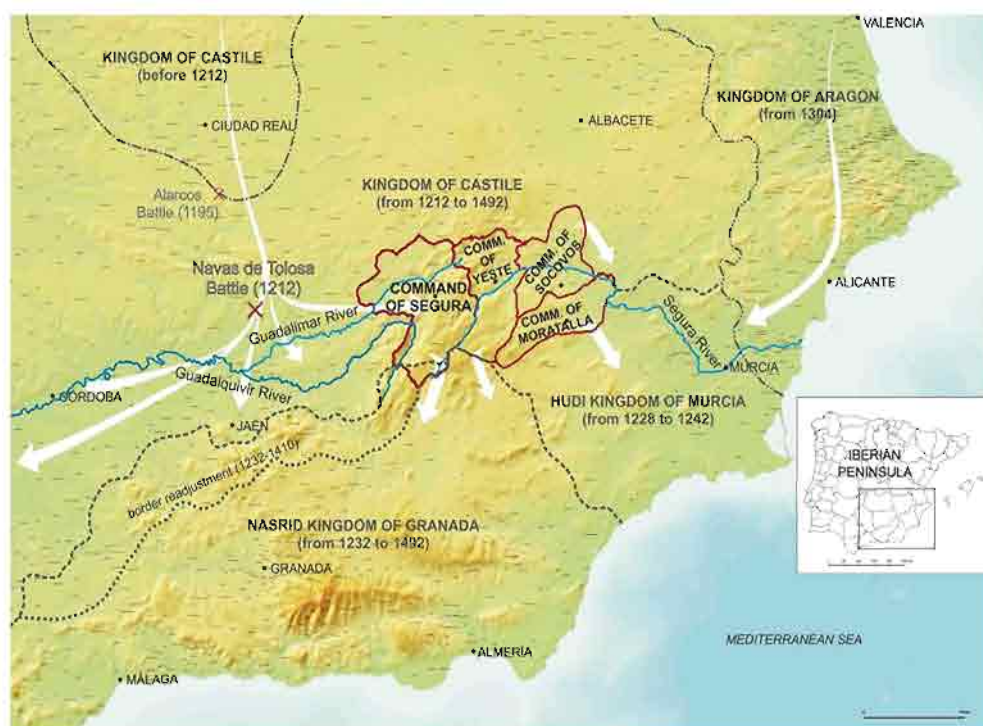


Figure 1. Borders between the Christian kingdoms of Castile and Aragon with the Islamic kingdoms of Murcia and Granada between the twelfth and fifteenth centuries.

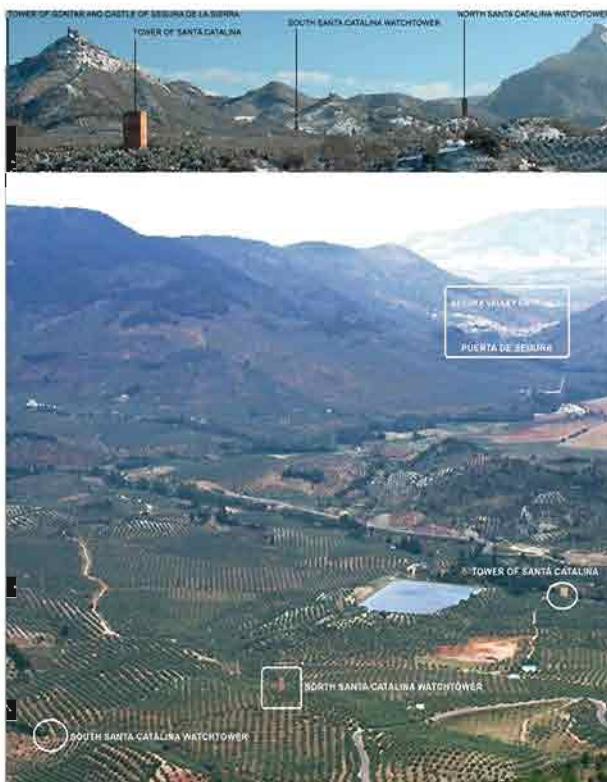


Figure 3. Santa Catalina Plains with the situation of the three towers. Above: View towards Segura town. Below: View towards Puerta de Segura village, the natural entrance to this valley from the north and west.

Figure 2. The south and north Santa Catalina watchtowers in the Segura valley.

Alhambra of Granada (thirteenth to fifteenth centuries).

The study and understanding of the main military structures of the *Segura* valley has been made from an exhaustive and rigorous stratigraphic and material analysis of the walls. It has enabled the understanding of its taxonomy and comparison with other similar examples inside and outside the Iberian Peninsula, allowing us to know and advance the knowledge of such common features as the constructional technologies, shape, typology, functional use and establishment in the territory.

This research has been carried out on the remains of the towers of *La Puerta de Segura*, *Santa Catalina*, *Fuente de la Torre*, *Gutamarta*, *Altamira*, *Espinareda* y *La Torre*, and an in-depth study made with a morphologic, stratigraphic, functional and constructive analysis of the Castle of *Góntar*, the north and south *Santa Catalina* watchtowers, the Tower of the Water (*Torre del Agua*) and the castle of *Cardete* (see figure 3).

This study has enabled the discovery and demonstration of the arrangement of the access system to the watchtowers and illustrates it graphically. The extended

knowledge obtained of these early medieval rammed-earth architectures is the main contribution of this paper.

### The territorial organization and the landscape in the Segura valley

After the official foundation of Almeria and its castle in the tenth century, a line of fortresses was built in al-Andalus in a short period of time, between the end of Abd al-Rahmān III's (912-961) and the beginning of al-Ḥakam II's (961-976) reigns<sup>ii</sup>. Amongst them were the castles of Tarifa (Cadiz)<sup>iii</sup>, Gormaz (Soria)<sup>iv</sup>, *El Vacar* (Cordoba)<sup>v</sup> and *Burý al-Ḥamma* (*Burgalimar*, in *Baños de la Encina*, Jaen)<sup>vi</sup>. The last two walled enclosures were built using rammed-earth and the others using stone. The most advanced of these fortresses (*Burý al-Ḥamma*) has an ovoid shape and consists of fifteen hollow towers, with similar constructive features to those of the *Segura* valley. During the eleventh and twelfth centuries, the constant Christian pressure across the frontier made urgent fortification works a priority. The Almoravid carried out fortification works in Almeria, Cordoba, Seville, Ecija, Jerez and Niebla<sup>vii</sup>, the ramparts of this last city being the best preserved in modern times. They were built circa 1130, with a perimeter of two kilometres including fifty rectangular towers and two more octagonal ones.

In the rural areas the *husún*<sup>viii</sup> consisted of fortified enclosures that were used as community refuges for the surrounding population in case of danger. In its interior was a watchtower and final defensive redoubt, which could be also used as a store and/or cistern.

In the *Segura* valley these small castles were always situated on a slope but never at the top of a hill. They were used to control an area of influence of between 250 and 350 hectares, with a relatively gentle topography that allowed for farming potentially irrigated lands (see figure 4). This is the most common settlement pattern in the area defined in the examples of *Cardete*, *Góntar*, *Altamira* and *La Torre*. These towers usually have a ground plan size of over 10 x 6 *varas* (7-8 x 4-5m), with the access relatively close to the ground as they are linked to a walled enclosure.

As will be analysed later, there is also another type identified in the research, the watchtowers, which correspond to the twin towers of *Santa Catalina*. They are similar to the other structures but of slightly smaller size, with the peculiarity that their access is at a considerable height from the ground, which leads to the conclusion that

they did not have a fence nor formed part of a farmstead.

The last existing type corresponds to the Tower of the Water, which would have worked as a fortified structure to protect a spring, a well or a water tank. It was linked to the Castle of *Segura* by means of a protected wall.

Most of these towers belong to the *husún* type. Almost all of them are single stage constructions and have a truncated pyramidal shape, as in the examples of the north and south *Santa Catalina* watchtowers and the towers of *Cardete* and *Peñolite*, probably influenced by the military architecture of the east coast of the Iberian Peninsula, with certain similarities to the towers of *Buñilla*, *Muza*, *Espioca* or *Godolleta*<sup>ix</sup>, all of these in the province of Valencia.

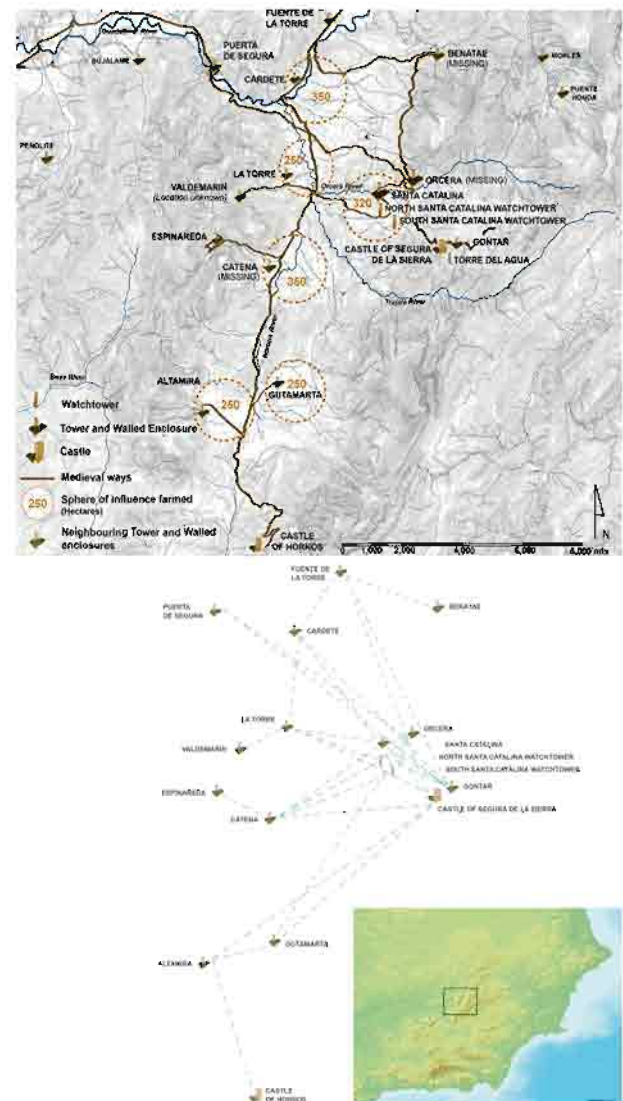


Figure 4. Above: Segura valley with its mountainous and fluvial system. Situation of the castles, towers, walled enclosures and watchtowers in relation to the topography and the principal roads. Agricultural areas controlled by the fortified enclosures of this valley. Below: Views between the different towers and defensive enclosures of the Segura valley.

Some scholars have discussed the original attribution of the fortifications of Segura valley. Up to now, their erection has been linked to Almoravid and Almohad times (twelfth to thirteenth centuries), due to the comparison and similarity to other fortresses built by these Berber dynasties when they ruled al-Andalus. The constructional technology of these fortresses comes clearly from a constructional knowledge well diffused in al-Andalus in Almohad times. Nevertheless, there are some Castilian accounts from the fourteenth century, which show that Christian fortifications were built using rammed-earth technologies similar to those used in Islamic times.

### Constructional nature of the rammed-earth structures preserved

The study of these fortresses permits the understanding of the building techniques used in these structures, allowing comparison with other contemporary examples in the

Maghrib and in the Iberian Peninsula. Almost all the Segura valley towers and walled enclosures have similar construction features using *tabiya* (from *tabia* in Arabic), a building process that consisted of the construction of walls with tamped earth and lime using a refined technology that in Spanish was referred as *tapia calicostrada*, *calicostrada*, *acerada* or *calicareada*.

There is a generally held belief that this technology was spread in al-Andalus and the Maghrib by the Arabs, but rammed-earth walls were built previously in these places<sup>xi</sup>. Pliny (AD 23/24 - 79) recounted in the 35th book of his Natural History the existence of rammed-earth structures in Iberia and in Africa before the Romans arrived. The material remains shows that the use of this technology in the Mediterranean basin goes back to at least the third century BC. Its origin can be traced to the Near East civilizations and its diffusion in western Mediterranean has been attributed to the Phoenicians<sup>xii</sup>. In the Fertile

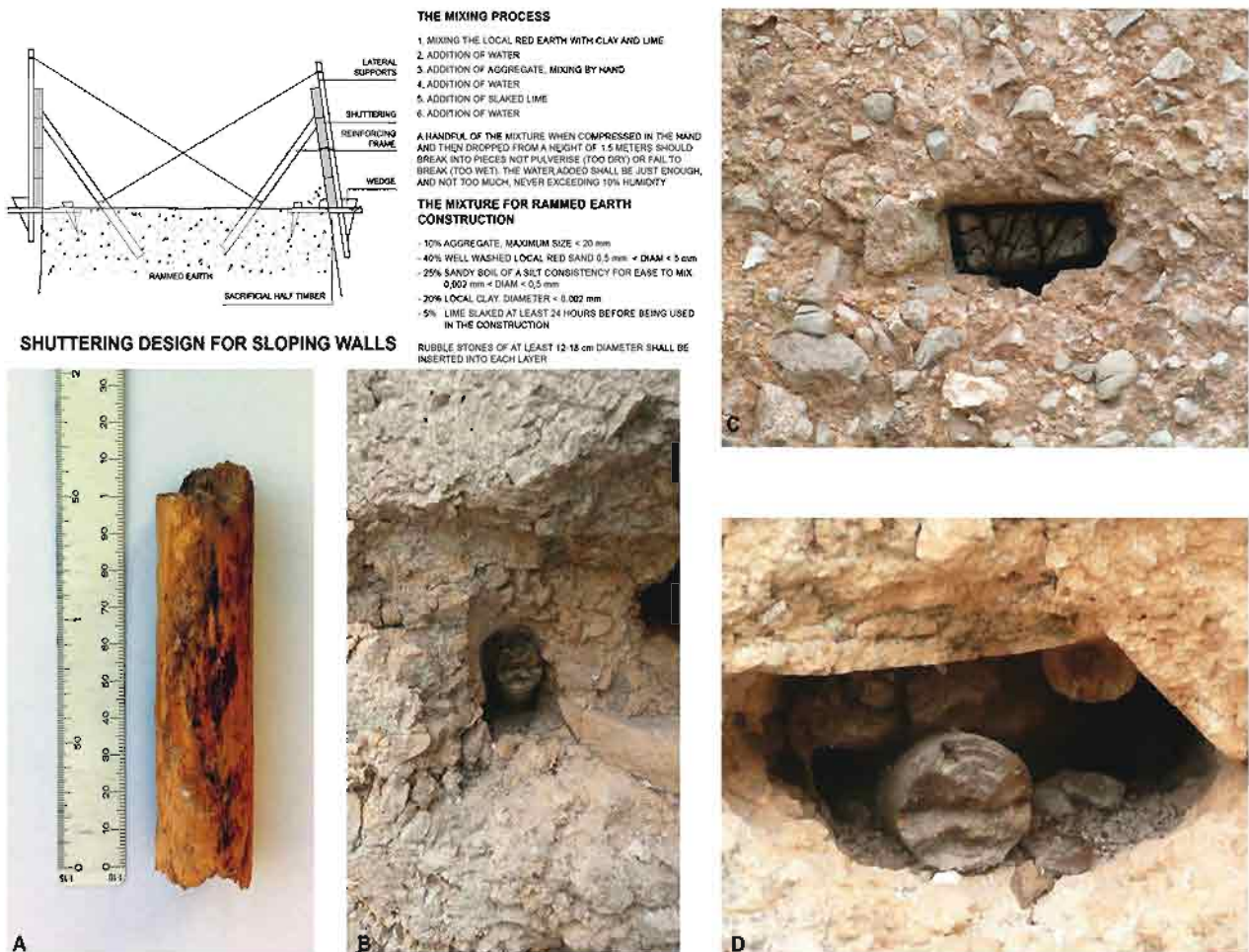


Figure 5. Shuttering design for sloping the walls of the towers of Segura. A/ Sample of a reinforcing frame inside the rammed-earth wall. B/ Original position of a reinforcing frame inside the rammed-earth wall. C/ Non re-usable horizontal timber (70 x 30mm) inside the rammed-earth wall. D/ Cylindrical timber and other timber remains inside the low parts of the rammed-earth lifts in the changes of section in the wall, found in each of the floors of the tower of Góntar. These timbers work as hoops to tie the walls together.

Crescent (between the Oriental Mediterranean, the Red Sea and the valleys of the Tigris and Euphrates Rivers) there are structures built with earth, but they are usually made of adobe and piled up-earth with a rammed-earth appearance. Some of the most ancient sections of the Great Wall of China, placed in arid zones where other constructive materials were in short supply, are also built with this technique<sup>xiii</sup>.

These types of rammed-earth constructions are generally modular, determined by the size of the timber formworks. They used to be between 2.00 to 3.00m long and 0.75 to 0.90m height, such as can be easily handled. This variation is considered to be determined by different local carpentry traditions during different periods of time<sup>xiv</sup>. They were also related to the systems of measurement of Islamic construction systems, where the basic unit of measure was the cubit, deriving from the classical *cubitus*. The Islamic cubit was divided in two basic types: *Rasasi* and *Maamuni*. The first one was used mainly during the Emirate and the Caliphate in al-Andalus. In some places it measured up to 0.70m, but it was normally slightly over 0.50m. The *Maamuni* cubit had a maximum of 0.47m. The submultiples of both types were the foot, the handspan and the inch. The multiples were the *vara* (yard), also referred to in medieval Spanish as *caña*, *tapia* or *qala*. A *vara* had two cubits and a cubit six handspans. In al-Andalus, the measure unit or module referred to as a *vara* was between 0.70 and 0.90m width<sup>xv</sup>. This measure in the defensive elements of the *Segura* valley is around 0.75m, being slightly different according to each tower.

The archaeological interpretation of these shuttering elements contributes important and conclusive information on the construction of the rammed-earth walls. The

retaining force of this shuttering was implemented by holding it in place with whole or half transversal timbers called *agujas* in Spanish. The half timbers did not cross the whole width of the wall. As a result, they remained inside the wall after the rammed-earth mixture was poured over them and tamped down. After removing the shuttering, the external part of these half horizontal timbers was cut off with an adze and their cut surfaces were covered with lime mortar. On the other hand, the complete horizontal timbers were re-usable (see figure 5). They were bigger and usually placed in the lower parts of the walls, because of the higher pressure in those areas during the building process. In addition, they were seated inside holes made for that purpose, formed with two or three stones. After finishing the rammed-earth wall, the formwork sides were removed, as well as the transverse timber and the putlog hole was also covered with lime mortar. Lime-encrusted rammed-earth wall construction is done by compacting layers of different width and spreading a layer of lime prior to the filling of gravel and earth. This process causes the lime mortar to expand from under the rammed-earth layer, and rise up the interior face of the side shuttering to create a protective crust. This lime crust can be placed on both faces of the wall or only on the exterior one. Its thickness can change, usually being thicker in walls used for defensive purposes (see figure 6).

In the *Segura* valley military buildings, the lower parts of the walls are built with rows of perfectly rounded stones with a diameter of between 150 and 180mm and laid with a mortar very rich in lime and gravel. These stones disappear progressively as the height of the wall increases to be replaced with a concrete made of gravel, sand and lime.

The walls of all of these towers have different sections.

Height ( <i>varas</i> )	Rammed-earth height (m)	Ground plan size metres = 1 <i>vara</i> ( <i>varas</i> )	Ground plan size	Height (m)	(m, lift
Tower of <i>Altamira</i>	0.8900m	10 x 7	8.80 x 6.45	—	—
Tower of <i>Santa Catalina</i>	—	—	8.60 x 5.65	—	—
<i>La Torre</i>	0.7700m	10 x 6	7.70 x 4.62	—	—
Tower of <i>Góntar</i>	0.7984m	10 x 6	7.40 x 4.80	15	12.00
Tower of <i>Cardete</i>	0.8120m	8 x 5	6.70 x 4.20	16	12.99
South <i>Santa Catalina</i> watchtower	0.7575m	7 x 5	5.30 x 3.80	20	15.15
North <i>Santa Catalina</i> watchtower	0.7620m	7 x 5	5.00 x 3.96	19	14.50
<i>Fuente de la Torre</i>	0.7142m	7 x 5	5.00 x 3.57	—	—



They are usually stepped internally and they start in their lower part about a *vara* and a half (approximately 1.10m) wide, reducing progressively to the thickness of one *vara*.

### Typology, shape, use and function of the preserved remains of these towers

The remains above ground of this set of towers can be analyzed from the discipline of the ‘standing buildings archaeology’. The morphological and typological features of the defensive elements of the *Segura* valley are different, depending on their situation and function. They are described in the next paragraphs:

#### *A small castle with walled enclosure*

To this typology belong the remains of the castle and

tower of *Góntar* (see figure 7) that were studied, cleaned, stabilized and consolidated during the restoration process carried out in 2009. It is a fortified enclosure that would have been linked to the defensive system of the Castle of *Segura*, but is independent of the castle ramparts. *Góntar* was a fortress with its own walls, some of them still remaining in the north and east, with several niches carved in the rock in this part, maybe used by the soldiers on guard duty as seats. There are no remains of the battlements but the total height of the tower would have been around 15 *varas* (around 12m). This tower and walled enclosure was possibly situated on this spot to defend this weak flank from attackers on *Góntar* hill which faces it, as orientation of the loopholes of the tower shows.



Figure 6. Shuttering design for the walls of the towers of Segura. A/ A rammed-earth wall made in Morocco. B/ A shuttered putlog hole in the towers of the Segura valley with a stone support which allowed the reuse of the horizontal timber of the rammed-earth lifts. C/ A sample of the remains of a horizontal timber and the exterior lime-encrusting of the rammed-earth wall, clearly showing its thickness. D/ Marks and geometrical designs over bands of lime applied on the rammed-earth lifts and the rows of putlog holes of the horizontal timber in the tower of *Góntar*.



Figure 7. The remains of the tower and walled enclosure of Góntar after its scientific restoration.

Prior to the restoration process, an archaeological analysis of all the walls was carried out, obtaining the chronological sequence. The vertical hollow with a small arch in the third storey, lacking any type of lintel or structural shape, shows that it was not an opening made when the tower was constructed but at a later time, to allow the access to an exterior timber sentry box attached to the east façade or to the tower, as the holes of the beams in the wall seemed to show. This kind of wooden cabin would more directly control the ancient road that passes near the tower. The holes, preserved in the wall, show the placing and anchoring of this element.

The wall analysis also has enabled the understanding of the constructive technology of the *tapial* carried out in this tower. Some additional timber (with a diameter between 120 and 150mm) was introduced inside the walls, usually placed in the low parts of each separate floor, where there was a change in the width of the walls. This timber reinforcement works like a wooden hoop, improving the structure of the rammed-earth walls and preventing their collapse (see figure 5).

The eastern exterior of the tower of Góntar is faced with lime made to look like ashlar work, covering the rammed-earth lifts and the rows of putlog holes of the horizontal

timber. This technique was commonly used in the rammed-earth towers in the Valencia region and, in general, in the principal fortresses of al-Andalus<sup>vi</sup> (see figure 6).

Other archaeological remains that belong to this typology are those of the castle of *Cardete*, which is the only fortress in this valley that has both the tower and the original walled enclosure practically intact (see figure 8). That has enabled the calculation of the average size and layout of this kind of fortified enclosures. This castle of *Cardete* is placed in a hillside and would have controlled the exit of the *Segura* valley towards the Iberian Levant, because it was built in place with a good range of visibility over the castle of *Segura* and other fortresses of the surroundings.

The walled enclosure has a huge rammed-earth tower with a truncated pyramidal cross section, and has preserved the lime crust on one of its façades. The perimeter walls, attached to the tower without jointing, have been almost entirely preserved. It was built with the same features as the other defensive structures of *Segura* valley, but with their rammed-earth lifts being slightly bigger.

This type might establish a link on a small scale between the *qasabat* (kasbah) built in rammed-earth until

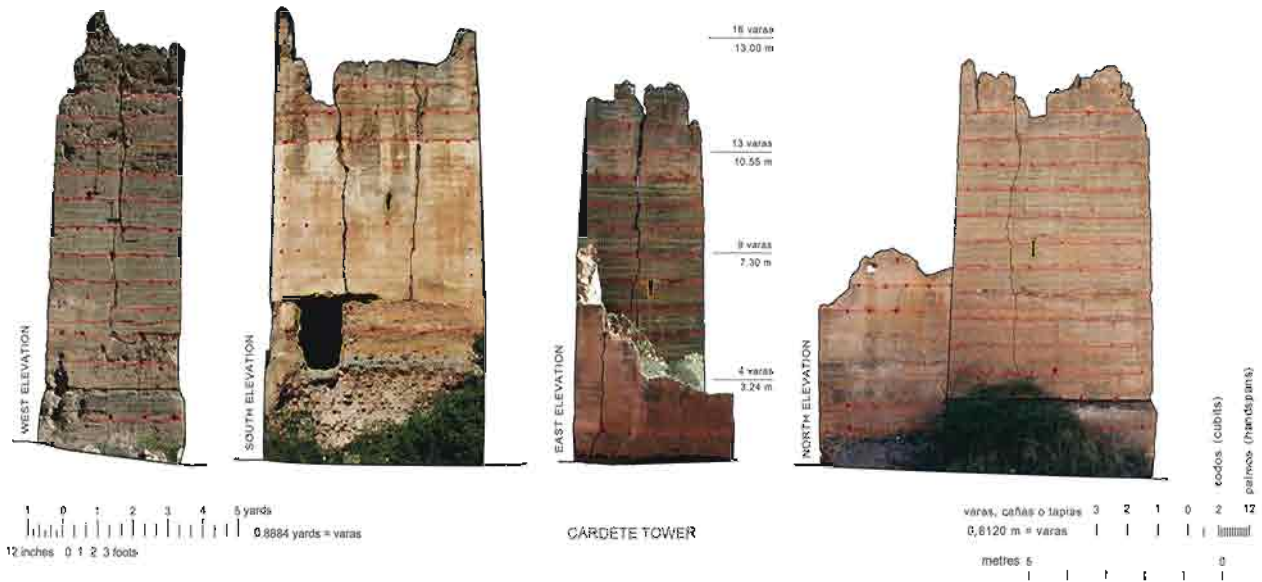


Figure 8. Architectonic survey and façade analysis of the tower of the fortified enclosure of Cardete.

the beginning of the twentieth century to the south of Great Atlas, in some of the valleys of Morocco close to the Sahara like Samoura, Agoummat, Bouaboud, Telouet<sup>xvii</sup> etc. and the *husûn* and *qasabat* (*alcazaba* in Spanish) built in al-Andalus, up to the enclosure of the Alhambra.

In addition, in the Segura valley there are material remains of other defensive structures as Puerta de Segura, the castle of Espinareda, La Torre, Fuente de la Torre, the castle and tower of Altamira or the castle of Gutamarta, which also might have belonged to this typology.

### Tower of the Water

There exists a particular structure that is named Tower of the Water, situated a few dozen metres to the south of the fortress of *Góntar*. The first floor of this tower has a U-shape and is supported on its open side by the cliffs, perpendicular to the hillside with its west side adjoining the rocky cliffs below the Castle of *Segura*. All the façades are completely blind and the typology corresponds to an advanced fortification connected to a main fortress, called *qawraya* in al-Andalus (*coracha* in Spanish). It was a defensive building to protect a spring or an existing well at

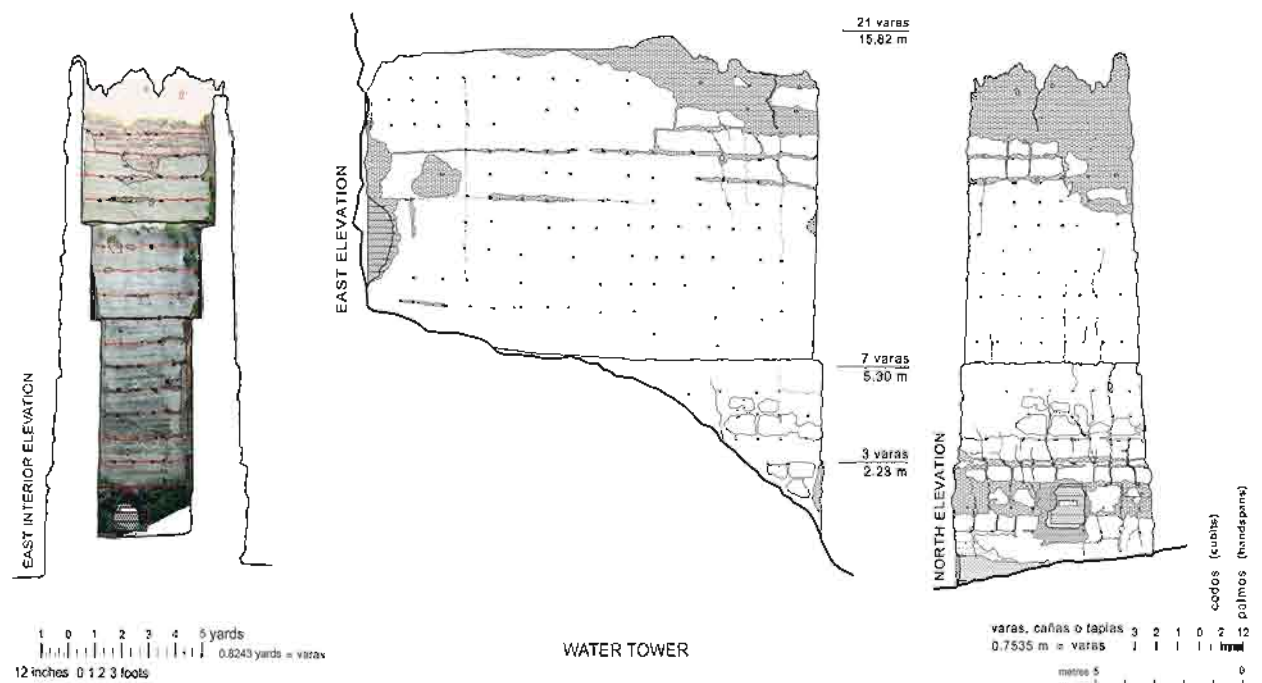


Figure 9. Architectonic survey and façade analysis of the Torre del Agua.

this site, according to a chronicle from the sixteenth century<sup>xviii</sup> (see figure 9).

Its exterior faces are slightly sloped and, as a result, the tower has a truncated pyramidal cross section. It has a height of 20 rammed-earth lifts (approximately 15.15m), with three interior stories and two stair-shape projections that could support two timber joists.

### Watchtowers

Inside the *Segura* valley there are three military structures in a triangular layout known as the towers of *Santa Catalina*, with visibility over almost the whole lower part of the valley.

The first tower, remnants of which could still be seen at the end of the twentieth century, is the nearest to the village of *Orcera*, and would have had its own walled enclosure. It is rectangular, the most sturdily built and the lowest of these three towers. It had inside three timber joists and was probably the only one that would have had a cistern.

On a hill in the middle of this set of three towers is situated the north *Santa Catalina* watchtower. It is the smallest one in shape and height (see figure 10). The

regularity and constructive rationality of this structure, with a height of nineteen rammed-earth lifts (approximately 14.50m), gives it a uniform modulation and layout of its constitutive elements.

The south *Santa Catalina* watchtower is the third one, and is practically a twin tower to the north watchtower, but slightly bigger (see figure 11), with a height of 20 rammed-earth lifts as in the Tower of the Water. Both watchtowers are equidistant to a medieval route that goes up to the Castle of *Segura*, and so its doors are facing this road. Their position could be linked to the communications control in the *Segura* valley in the Middle Ages, and perhaps for taxation purposes over goods or the passage of cattle.

The north and south *Santa Catalina* Watchtowers have three of their faces sloping, with the fourth one practically vertical, which gives them a truncated pyramid shape. These slopes were constructed by putting an upper strut smaller than the lower one. For a slope of 2° it should be 22.4mm smaller.

The height of the entrance of both watchtowers is at a considerable height from the ground. In the south watchtower the principal access is approximately 9

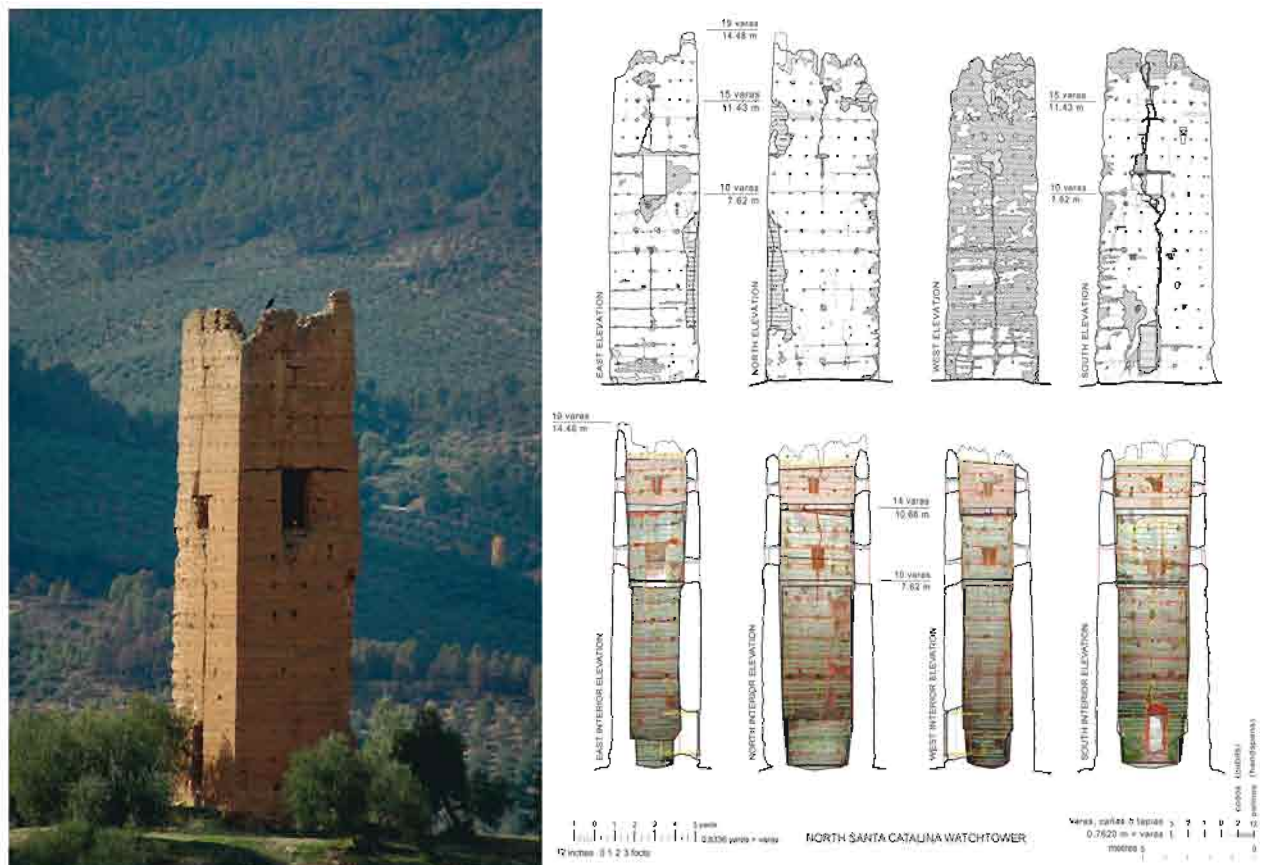
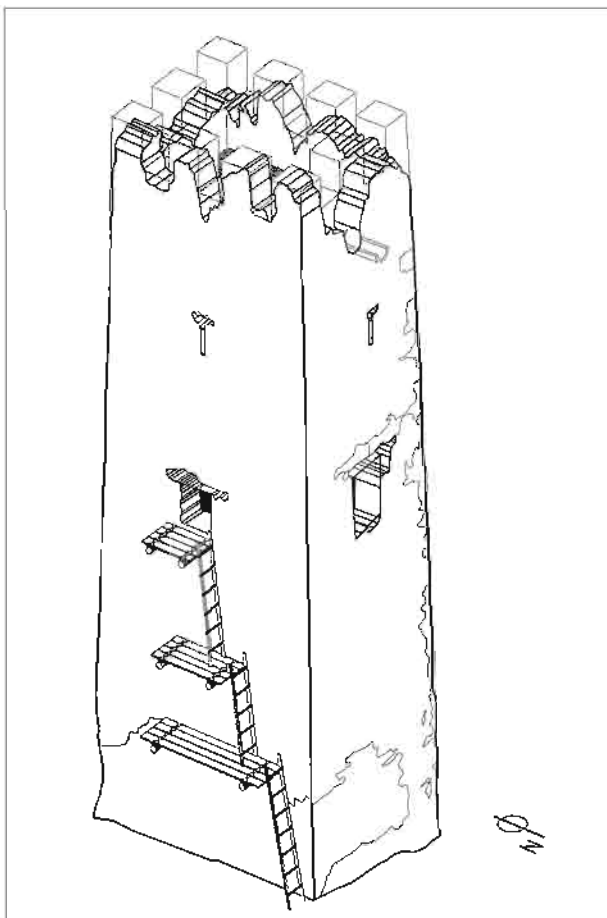


Figure 10. View, architectural survey and façade analysis of the north Santa Catalina watchtower.



Figure 11. View of the south Santa Catalina watchtower.



rammed-earth lifts from the ground (6.85m), and in the north one up to a height of 7.62m. This means that it was impossible to reach this point with a single ladder due to its weight and handling difficulties. Analysis of the façade and the existing hollows and holes reveal that the manner of climbing to the entrance door was by means of an exterior system of platforms or scaffoldings anchored to the wall, situated every two metres approximately. These platforms allowed a single person to manoeuvre one or two ladders easily from one platform to another and so climb inside the tower on his own. These holes for corbels were planned in the building of the tower, as is demonstrated by the stones that shape the formworks of these holes. To balance these platforms, they would be counter weighted on the interior with other boards that allowed for a descent inside the tower, since the first-story was not open to the outside (see figure 12).

Figure 12. Axonometric view with a volumetric reconstruction of the south Santa Catalina watchtower.

## Conclusion

With this study we wanted to uncover the underlying latent life in these fortresses, concentrated in a valley of the south-east of the Iberian Peninsula. They contribute very valuable information about the territorial organization in border areas between Christians and Muslims during the thirteenth century. The analysis of this set of sixteen towers built in rammed earth has answered some questions related to their settlement, use and constructive technologies. The study has allowed us to compare and to classify them with similar examples of rammed-earth architecture in the north of Africa and other Mediterranean places.

Among the main conclusions we can highlight that their truncated pyramid shape can be linked to the Islamic military architecture of the Spanish Levant, because this valley was the main communication way between the south and the east of the Iberian Peninsula. In the *Segura* valley, the shape of the towers depends on their three different typologies identified. The first one corresponds to a tower with rectangular plan inside a defensive perimeter. Their exterior size can be between the 6.70 x 4.20m of the tower of the castle of *Cardete* and the 8.80 x 6.45m of the tower of the Castle of *Altamira*.

The second typology is represented by the tower called of the Water (*Torre del Agua*), an exception in this area. It was a structure built to protect a key place for the hydraulic supply to the Castle of *Segura*.

Both the twin watchtowers preserved in the Plains of *Santa Catalina* would correspond to the last typology. They have the peculiarity of their access, situated at over 7m height from the ground. This fact shows that they probably were isolated towers and that they have not got a walled enclosure. The façade analysis of the rammed-earth walls and the existing hollows and holes reveal that the way of climbing to the entrance door was by means of an exterior system of platforms or scaffoldings anchored to the tower.

Other discoveries concern the quality of the constructive process of the towers compared to other contemporary examples. It shows an advanced use of the rammed-earth with lime crust technology. This is one of the causes for the exceptional preservation of several of these towers, placed in a mountainous landscape subjected to big changes of temperature and humidity, and one of the areas of major seismicity on the Iberian Peninsula.

The archaeological remains of these towers show the

proportions of the mixture, granulometry (the measurement of size distribution of the various elements from the bigger stones of the plinth to thinnest mortar of the battlements) and modulation of the walls, as well as an advanced use of structural reinforcements in the weakest points of the towers. In addition, as opposed to other examples located in the Maghrib, lime was used copiously as a linking agent, because of the abundance of raw material in these limestone mountains. As a result, some of these towers seem to have been built in lime concrete, with different granulometries of stones and earth, as some historical accounts from the 16th century report when describing them.

The settlement pattern of the castles of *Altamira*, *Gutamaria*, *Catena*, *La Torre*, *El Cardete* y *Fuente de la Torre*, fulfilled a double defensive and productive function, controlling roads and an agricultural area between 250 and 350 hectares, being a prime reference for territorial links and determining the economic and social development of their area of influence. This organization of the territory gives information to similar criterion shown in the defensive structures of the oases between the Sahara desert and the south of the Atlas mountings at least from the Middle Ages.

The stratigraphic and material analysis of the surface archaeological remains from the medieval fortifications of the *Segura* valley, when compared with other contemporary existing examples in the basin of the Mediterranean, has enabled the in-depth study of their details, particular characteristics and the constructive technology used. It has enabled such knowledge to be obtained and consolidated in the study process of these remains.

## Notes

<sup>1</sup> *Segura* is the main town of the north-west region of the *Sierra de Segura* mountain range.

<sup>2</sup> 'Abd al-Rahmān III (891-961), byname Al-Nāṣir li-Dīn Allāh ("Victor for the Religion of Allah"), was the first caliph and greatest ruler of the Umayyad Arab Muslim dynasty of al-Andalus. He started his reign as hereditary Emir ("prince") of Cordoba in 912 and took the title of first Caliph Umayyad of this city from 929 until his death. His son Al-Ḥakam II ibn 'Abd al-Rahmān III (915-976) was the second Caliph of Cordoba, and ruled from 961 to 976.

<sup>3</sup> Pérez-Malumbres, A. 2009, 5-19.

<sup>4</sup> Heras, E *et al.* 2008, Almagro, A 2008, 55-77.

<sup>5</sup> Martínez, A. 2005.

<sup>6</sup> Muñoz-Cobo, J F 2009, Canto, A and Rodríguez, I 2006.<sup>7</sup>

Almagro, A, Triki, H and Viguera, M J 1999

<sup>8</sup> Plural of *ḥiṣn*. Military enclosures that could be used to control an

important road and often to shelter the population distributed in an area organized around a route, a river, irrigation ditches, orchards, crops, etc. These *husûn* acted as defensive and organizational centers of a certain territorial area and some of them took on an essential role in the organization of al-Andalus in *kūrah*-s or territorial districts.

- <sup>9</sup> Rodríguez, P 2008.
- <sup>10</sup> Eslava, J 1999, 348.
- <sup>11</sup> Jaquin, P A and Augarde, C E 2012, 17-20.
- <sup>12</sup> Soriano, V 2006, 73.
- <sup>13</sup> López, F J 2003, 33-35.
- <sup>14</sup> Jaquin, P A, Augarde, C E and Gerrard, C M 2007.
- <sup>15</sup> Torres, L 1985: 560; Pavón, B 1993, 92; López, F J 1999, 88.
- <sup>16</sup> Azuar, R *et al.* 1996, 245-278.
- <sup>17</sup> Soriano, V 2006, 112-115.
- <sup>18</sup> Eslava, J 1989, 346; Ballesteros, M 2010, 115.

## References

### Published sources

- Almagro, A, Triki, H and Viguera, M J 1999 Itinerario cultural de Almorávides y Almohades: Magreb y Península Ibérica. Fundación El legado andalusí, 1999.
- Almagro, A 2008. 'La puerta califal del castillo de Gormaz', *Arqueología de la Arquitectura*, 5, 55-77.
- Azuar, R, Lozano, F J, Llopis, T M and Menéndez, J L 1996 'El falso despiece de sillería en las fortificaciones de tapial de época almohade en al-Andalus', *Estudios de Historia y Arqueología medievales*, 11, 245-278.
- Ballesteros, M 2010 'Establecimiento de la orden militar de Santiago en la Sierra de Segura. La Encomienda de Segura de la Sierra', *Boletín del Instituto de Estudios Giennenses*, 201, 87-130.
- Canto, A and Rodríguez, I 2006 'Nuevos datos acerca de la inscripción califal atribuida al Castillo de Baños de la Encina (Jaén)', *Arqueología y Territorio medieval*, 13, 2, 57-66.
- Caparrós, R 2011 'Arquitectura militar en la Sierra de Segura: Una interpretación paisajística y territorial', PH: *Boletín del Instituto Andaluz del Patrimonio Histórico*, 36, 225-232.
- Eslava, J 1989 *Los castillos de la Sierra de Segura*. Diputación provincial, Instituto de Estudios Giennenses, Jaén.
- Eslava, J 1999 *Los castillos de Jaén*. Universidad de Jaén, Papiro Ed. Osuna, Jaén.
- Heras, E, Escribano, C and Balado, A 2008 'La ocupación del Territorio', San Miguel de Gormaz, Plan integral para la recuperación de un edificio histórico, Valladolid, 11-28.
- Jaquin, P A, Augarde, C E and Gerrard, C M 2007

'Historic rammed earth structures in Spain: construction techniques and a preliminary classification', *Proceedings of the International Symposium on Earthen Structures*, Bangalore, India: Interline Publishing.

- Jaquin, P A and Augarde, C E 2012 *Earth Building: History, Science and Conservation*, HIS Bre Press, Garston, Watford.
- López, F J 1999 'Tapias y tapias', *Loggia – Arquitectura y Restauración*, 8, 74-89.
- López, F J 2003 *Tapias en fortificaciones medievales. Región de Murcia*. PhD Dissertation, Universidad Politécnica de Valencia, Valencia.
- Martínez, A 2005 *Inventario de fortificaciones del medio rural. Norte de Córdoba. Volumen I. Ficha 7, Castillo de El Vacar*. Archivo de la Delegación Provincial de la Consejería de Cultura de Córdoba.
- Muñoz-Cobo, J F 2009 'El Castillo de Burgalimar de Baños de la Encina (Jaén) y la lápida fundacional', *Boletín del Instituto de Estudios Giennenses*, 199, 57-106.
- Pavón, B 1993 *Ciudades y fortalezas lusomusulmanas: crónicas de viajes por el sur de Portugal*. Instituto de Cooperación con el Mundo Árabe, Madrid.
- Pérez-Malumbres, A 2009 'Las puertas califales del castillo de Tarifa'. *Aljaranda*, 75, 5-19.
- Rodríguez, P 2008 *La torre árabe observatorio en tierras valencianas, tipología arquitectónica*. PhD Dissertation, Universidad Politécnica de Valencia, Valencia.
- Soriano, V 2006 *Arquitectura de tierra en el sur de Marruecos: el oasis de Skoura*. Fundación Caja de Arquitectos, Madrid.
- Torres, L 1985 *Ciudades hispanomusulmanas*. Instituto Hispano Árabe de Cultura, Madrid.

### Biographical Notes:

**Santiago Quesada-García** (Jaen, Spain) has a Doctorate in Architecture from the University of Seville. His main lines of research are related to the Heritage, the Landscape and the Architectural Project in restoration and rehabilitation interventions.

He has an Extraordinary PhD Award from the University of Seville with his PhD dissertation titled "*Imitatio Naturae*. The landscape as a reference in contemporary architecture".

He is Associate Professor of the University in the Area of Architectural Projects. He has taught in the School of

Architecture of Seville from 1987 to 2012. He has been invited to teach in Brussels, Palermo, Milan) and El Salvador and has been a Lecturer in the course of *Architettura Ambientale* of the *Laboratorio di Progettazione Architettonica* in Milan.

Since 2013 he has been a member of the “*Collegio dei docenti*” of the Doctorate Program of Architecture in the *Politecnico di Milano*. He is the Principal of the School of Architecture of Malaga.

E-mail: [sqg@us.es](mailto:sqg@us.es)

<http://dialnet.unirioja.es/servlet/autor?codigo=3013446>

[http://investigacion.us.es/sisius/sis\\_showpub.php?idpers=2014](http://investigacion.us.es/sisius/sis_showpub.php?idpers=2014)

<http://www.santiagoquesada.com>

**Luis José García-Pulido** (Úbeda, Spain) has a Doctorate in Architecture and is Master in “*Archaeology and Territory*” from the University of Granada, and also

Master in “*Architecture and Cultural Heritage*” from the University of Seville. He is part of the research group “*Laboratory of Archaeology and Architecture of the City*” (LAAC, Hum-104, EEA, CSIC) and research associate to laboratory *Travaux et Recherches Archéologiques sur les Cultures*, CNRS-University of Toulouse 2-Le Mirail. He develops historical researches on Islamic Architecture, urban planning, territories and cultural landscapes; medieval and ancient hydraulic systems and devices; Architectural Heritage documentation and restoration.

From March 2012 he is developing Post-Doctoral research titled “*The Peri-Urban Territory of the Nasrid Cities and the Structures Preserved in them*” in the School of Arab Studies from Granada from the Juan de la Cierva programme of the Spanish *Ministerio de Economía y Competitividad*.

E-mail: [luis.garcia@eea.csic.es](mailto:luis.garcia@eea.csic.es)