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Fortified Construction Techniques in *al-Ṭagr al-Awsaṭ*, 8th–13th Centuries

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Received: 20 July 2018; Accepted: 31 August 2018; Published: 29 September 2018

Abstract: Spanish Islamic military architecture shows an attempt at the systematization of works, techniques, and defensive elements, commencing in the era of the Umayyad Emirate and Caliphate up to the North African Empires (Almoravids and Almohads). This article presents an analysis of the constructive techniques and systems employed in the fortified architecture in *al-Ṭagr al-Awsaṭ*; that is, the Medium Frontier Territory of al-Andalus, called *Marca Media,* between the 8th and 13th centuries. The fortification of the borders was an objective of the Umayyad Emirate and Caliphate, as well as of the new kingdoms of *Taifas* and the Almoravid and Almohad Empires. The buildings were designed not only to defend a territory but also as a way of demonstrating the political power, and thus they were used as "state propaganda". The triumph of the Islamic State over different groups, the advance of the Christian conquest, the decline of the Caliphate, and the invasion of the Almoravids and Almohads were situations that modified the definition of borders, the strategies of defense, and the organization of cities and territories. Therefore, the construction of fortifications acted as a mirror reflecting the social, political, and economic circumstances, whose changes depended on the real possibilities, knowledge, celerity, or technological evolution of the time. As such, these constructions permit an analysis of not only the building techniques, but also the people who carried them out, showing in their remains the social implications and organization of work from the master builders down to the quarry workers. This article presents the organization and technical knowledge of construction through a selection of cases studies, including watchtowers, castles, city walls, and fortresses.

Keywords: fortifications; medieval construction; work organization; construction history; archaeology; building techniques; ashlars; masonry; formwork masonry; rammed earth

1. Introduction, State of the Art, Objectives, and Methodology

Fortresses, castles, watchtowers, and city walls were built with different techniques and elements, including those borrowed from mosques, palaces, and other architectural types. In fact, this kind of architecture was sometimes built as a demonstration of power, with fine work and specialized workers. However, it sometimes had to be built quickly. So, defensive architecture was not always built by specialized workers, nor under favorable conditions (for example, they could be built during war times, periods between battles, sieges, etc.). Therefore, precision and subtlety are often lacking in the abovementioned architectures. However, their main characteristics are their simplified techniques and systematic methods, combined with a great versatility that allows building in any topography, condition, or time. Walls not only have to resist the loads of vaults or flats, but also the impact of

projectiles, the action of rams, and the openings of hollows. Defensive holes were not designed to compose a façade; they had to have complete visibility of the exterior with an opening as small as possible. Gates can be designed as propaganda, as is the case in Gormaz Castle (Figure 1), but most of the time they were designed to prevent entrance to the fortification, with complicated routes and specific layouts to defend the access. So, poliorcetics, or siege warfare, is an important factor influencing construction, more so than form or aesthetics.

When a fortification is built, it is necessary to finish it quickly, so the builders had to know the exact curing time of mortars and the dose of lime or gypsum, or their combinations, so as to avoid the occurrence of shifts or movements in the first layers while the uppers layers were being laid. They also had to know the organization of the works, the material supply and storage, the position of cranes and scaffolding, and the auxiliary elements of formwork.

Islamic architecture has been studied from the viewpoints of aesthetics, history, typology, functionality, forms, etc. However, it is less studied from the technical perspective, that is, the building techniques and technical knowledge. The artistic and historical studies on the first half of the last century by Gómez Moreno, Torres Balbás, and Félix Hernández (Gómez-Moreno Martínez 1951; Torres Balbás 1957; Hernández Giménez 1975) have served as the base for studies of Islamic architecture. From the 1980s until the first decade of the 21th century, several local studies were developed, such as those in Comunida of Valencia by the French School of Casa de Velazquez (Bazzana et al. 1988), and others reported in meetings (Congresos de Arqueología Medieval/Medieval Archaeology Congresses) or journals like *Arqueología y Territorio Medieval*. Also, some general studies have delved into the typology, territory, and other architectonic defensive elements of this type of architecture (Pavón Maldonado 1999; Zozaya Stabel-Hansen 1991, 2009; Azuar Ruiz 2005; Gurriarán Daza 2004; Valdés Fernández 1988; amongst others).

In the last years, several research studies have analyzed building techniques of Islamic architecture not only in Spain, but also, for example, in Jordania (Arce 2009, 2010). Archaeology and construction history can help to fill the knowledge gaps in the technical and scientific history of buildings and, in our case, fortifications, concerning mortars characterization, techniques descriptions, structural behavior analysis, etc. In fact, in this field of study, there is a lack of knowledge beyond the main examples. So, in this paper several new examples grouped by technique are presented with the aim of increasing the knowledge of the constructive methods of fortifications in a specific area of study, the ancient *al-Ṯagr al-Awsaṯ*, which covers an area of more than 80,000 km^2. Moreover, we discuss the Almoravid fortresses and techniques that have not usually been referenced nor studied in the history of fortification.

This research has the main objective of analyzing the construction techniques employed in fortifications in a determined geographical area and time interval: the Medium Mark (*al-Ṯagr al-Awsaṯ*) from the 8th to 13th centuries. This principal objective generates three specific aims:

1. To understand the specificity of Islamic fortified construction in central al-Andalus up until the invasion of the North African Empires of Almoravids and Almohads.
2. To study the building characteristics of the two main techniques employed—bonded masonry (with stone) and formworked masonry (with earth or concrete)—through several examples.
3. To show other study cases beyond the classical ones in order to increase the knowledge of Islamic fortifications in Spain, explained by means of the current research by the authors.
4. To organize and define a series of phases (according to technique) in order to understand their geographical and chronological distribution.

This article summarizes the recent work and thesis of three authors in an interdisciplinary study, investigating the methodology of architecture and archaeology of the buildings. We have characterized the area and the structure of the defensive Islamic settlements investigated in this article, and from this we observed techniques and coincidences from some of the main fortifications of our area of study through typology, technique studies, archaeometry, and some dating methods (stratigraphy and

TL, C14). Our overall aim is to elaborate a diachronic scheme of techniques related to the historical evolution of the *al-Ṭagr al-Awsaṯ*.

2. Islamic Fortified Construction: The Territory and the Actors

The early organization of the Islamic Empire was driven to, amongst other factors, the control of communications and frontiers by means of fortifications. The governors took care of the preservation and functionality of fortifications from early stages. For example, in Armenia there was, under an order by caliph Uthman in the 7th century, a person in charge of the fortifications (Grabar 2007, p. 66).

In the first centuries of Islamic domination there were several Berber tribes governed under the Ummayad and the Arabs. According to a number of sources, Arabs seemed to be more civilized than the Berber tribes, and they began to build better and stronger cities and fortifications. In fact, the al-Muqtabis V narrated the following in the years 931–932 (Ibn Ḥayyān 1981, p. 228):

> The Berbers have no skills in the siege of cities and the taking of fortresses with the use of military devices, so they cannot do it, and only the Arabs can do this as they are experts of the cities with all their armament, materials and tools, and they know how to build fortresses and all that is convenient to punish the enemies.

This strong organization not only seems to be about administrative aspects but also about the building works and techniques. It is commonly assumed that the Umayyad Caliphate of Cordoba preferentially built with ashlar masonry while Almohads built their fortresses by using formworked masonries. This belief is countered by the existence of evidences to the contrary; however, these evidences are few number. The remaining ruins and the main preserved examples of these architectures appear to confirm the aforementioned belief, but there are also several cases where rammed earth buildings of the Caliphate and stone masonries erected during the Almoravid and Almohad Empires have been found. Fortress construction tends to be systematized by the reigning power in order to maintain the control of communications and borders, but it also has to adapt to the vernacular materials, the skill of the workers, and the political, economic, and war circumstances of the time. Moreover, fortresses suffer the effects of sieges and attacks, and may be intentionally collapsed and destroyed, or reinforced and reformed or rebuilt many times over. A historic example of this occurred in 914 in Evora (Ibn Ḥayyān 1981, p. 84):

> The lord of Badajoz, ‘Abdalláh b. Muhammad, was afraid of some Berbers entered Evora when it had been deserted. So, along with his men, he destroyed the towers and demolished the rest of its walls, until they were brought down.

Therefore, we have to be cautious in our interpretations of ruins, as the preserved constructions may only represent a small part of the original corpus.

Following historical sources, such as the *Chronic of the Caliph ‘Abdarramān III an-Nāsir between 912 and 942* written by Ibn Ḥayyān, some circumstances that involved the building and use of the fortresses, from the design process to the construction, can be gleaned. This source, also known as al-Muqtabis V, describes, for example, the supply of an architect and specialized workers to build fortresses in 935–936 (Ibn Ḥayyān 1981, pp. 289–90):

> After, an-Nāsir received several letters from him [Mūsá b. Abī l-’Āfiya] asking for help to build the castle of Yara, where he had retired to, and asking for workers and material.
>
> ...
>
> an-Nāsir answered him with kind words ... and supported his request to build his fortress. And he sent his proto-architect Muḥammad b. Walīd b. Fuštayq, with 30 masons, 10 carpenters, 15 diggers, six competent lime mortar makers, and two matting makers, chosen amongst the most skillful of their profession, accompanied by certain number of tools and accessories for the works. All this was sent by the sultan for the period that the works required. He also sent to Musa many provisions for him and his people.

In fact, the figure of the architect (proto-architect, according to the *Chronic*) is important. He is in charge of the design of the building and organizes the process of the construction. However, as sources tell, it seems that the Caliph himself—or perhaps better, someone in his cabinet—controlled the design and construction of the fortifications. In 929, the Caliph 'Abdarramān III an-Nāsir rode quickly from his palace to Bobastro "to inspect the observance of his orders and to see the buildings and fortifications that he had ordered to build . . . He entered the city, he toured it, he observed the works of the *alcazaba* [fortified palace] done according to his layout and he urged the workers to finish the rest" (Ibn Ḥayyān 1981, p. 190). The governor had architects and supervisors in charge, in addition to Ahmad ibn Jamīl, "who was both superintendent (*al-wakīl*) and an architect-engineer (*al-muhandis*) of part of the city wall and two gates of Diyarbakir in 909–10" (Lewcock 1978, p. 130). This description represents another figure, that of the supervisor of the works following the design of other architects; this position was termed *al-bannā'*. This kind of architect would be destined to design official buildings, and they were required to have knowledge of mathematics and science (Lewcock 1978, p. 130). As the main constructive periods are characterized by their standard designs and techniques, the distinction between the architect-designer (*al-muhandis*) and the architect-supervisor (*al-bannā'*) is relevant and important.

Figure 1. South view of the fortress of Gormaz (Soria), which was remodeled in 965–966 by the general Gālib ibn 'Abd al-Raḥmān under the supervision of al-Hakam II (photo: authors).

Once the fortification was designed, it had to be built by builders and workers. According to the following quotations, the workers seemed to be specialized, and they were capable of building high-quality constructions during times of peace. They were grouped by profession (masons, carpenters, diggers). In other similar passages there are references about the professional builders, such as the excerpt below concerning the fortification of Calatalifa and Saktan in the year 940 (Ibn Ḥayyān 1981, p. 343):

> Also in this campaign, Aḥmad b. Muḥammad b. Ilyās started the building of the ruined city of Saktan in the central border, fortifying its flat areas with a great number of workers with building works which very soon made a strong city.

However, what happens during war campaigns, sieges, or battles? Moreover, what happens during short periods in which new and large border territories and many cities had to be fortified (as occurred under the North African Empires, the Almoravids and Almohads)? These kinds of fortifications had to be built more quickly and effectively. A construction work, though simple, requires some kind of specialization, above all when a big building as a fortress is built; the construction starts in several areas over a general layout and must then be connected. So, dimensions and modulations of

the constructive levels must fit together. Soldiers or part of the troops could help during the building process, but it had to be directed by groups of professionals.

The army could be accompanied by specialized workers with tools and auxiliary media (saws, axes, formworks, tools, etc.). Cutting down a tree to supply wood for construction is easy, but the creation of a flat board for formwork requires the use of fine tools and certain knowledge—even more so in the case of working with stones. So, it is plausible that the army was accompanied by "building troops" (Figure 2). In the al-Muqtabis V (Ibn Ḥayyān 1981, pp. 64, 214, 295), three passages describe the use of soldiers in building fortresses, in 913–914, in 930, and in 936–937:

> After this, Muḥammad b. Ibrāhīm b. Ḥāŷŷāŷ, lord of Carmona, returned to Cordoba to subdue himself . . . he was associated with the police chief Qāsim b. Walīd al-Kalbī, who he was friends with. Both of them went towards Carmona and, close to Seville near the Tocina Gate, mercenaries entered the Lora fortresses and then went to Aljarafe, where they built the fortress of Cabra.
>
> . . .
>
> He ordered the city called Madinat al-fath (City of the Conquest) be built on the mount of Chalencas, his first stop, to which he brought tools and workers to finish it rapidly.
>
> . . .
>
> He [the Caliph] assigned an army to Durrí as caíd [a kind of judge who represents the supreme authority of the Caliph] of the Medium Mark. He had to go around the Muslim fields and ways from Atienza to Talavera, distributing men in these areas to build and repair with excellent quality the damaged fortresses, towers, and watchtowers, supplying them with food and many tools.

Figure 2. Detail of the inner part of the north wall in the castle of Gormaz. The construction shows that it was built quickly but systematically with a clearly organized design, assembled by skilled people. One row of poorly cut stones was not laid horizontally but appears slanted (this allows an arrangement of stone with different heights), Subsequently, a layer of lime mortar was poured on top of this layer order to achieve horizontal levels (photo: authors).

When the Almohads refortified the new borders and reorganized the territories, many new defensive buildings were built or repaired. They built from *al-Ṭagr al-garbī* (south Portugal) to *al-Ṭagr al-šarqī* (the east coast of Spain) a new web of fortresses and city walls. Many of them were built with

the rammed earth method, and there are several constructive and dimensional similarities that induce us to believe that there were general rules or a State-led attempt to build quickly, safely, and effectively.

So, according to this and another sources, there seem to be differences between the "official" construction (Figure 3) of defensive buildings (built with similar dimensions, elements, and techniques) and the "campaign" fortifications, in which speed and effectiveness was prioritized over the promulgation of an image of power. However, in both cases, the use of professional builders was essential (Ibn Ḥayyān 1981, p. 90):

> 'Abdallād b.Marwān was the first to capture the city of Evora, rebuilding it with men and tools and accessories, bringing builders with materials and beginning to rebuild the demolished wall, closing breaches and reinforcing corners and closing then its strong gates.

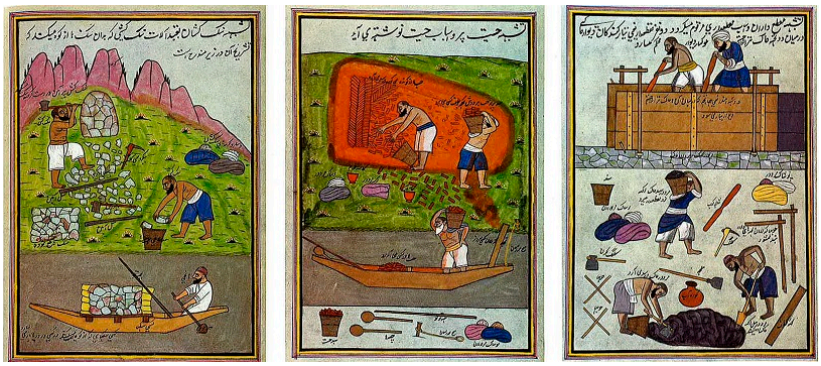


Figure 3. Three Islamic drawings showing the traditional craftsmanship of building works: stone masons (in the quarry and transporting the stone by boats); the brick supply and the rammed earth building; with their tools and auxiliary elements. These images were sourced from a book printed in Kashmir in the 1850s (Lewcock 1978, p. 113).

3. Fortified Systems in the Territories of al-Andalus and the Medium Mark (*al-Ṭagr al-Awsaṭ*)

The military and civil administration of the territory in al-Andalus was described by Al-Idrîsî. The Muslim territorial organization was a hierarchic and defensive organization (Bazzana 2009, pp. 11–14). The walled city (*madīna*), serving as a political and social center, represented the nucleus of this organization. The castle (*ḥisn*) completed it, surrounded by a web of watchtowers (*buruŷ*) and small farms of rural communities linked to a tower (*al-qarya*).

The Umayyad Caliphate organized the border territories under the generic name of *Ṭagr*. Under this denomination, the northern frontier was sectored in several parts. In the *Chronic*, it is named the Medium Mark or *al-Ṭagr al-Awsaṭ*, which seems include the region between Atienza and Talavera (Ibn Ḥayyān 1981; Manzano Moreno 2006, pp. 44–60). After the reconstruction of Medinaceli in 946, the border of the Medium Mark seems to increase to include part of the current province of Soria. At the opposite border, several sources collected by Manzano illustrate a map of the Mark that includes the territories between the Tajo and Guadiana rivers (Manzano Moreno 2006, pp. 56–57). The *Taifa* kingdom of Toledo acted as the heir of this geopolitical structure until the Almoravid invasion in 1086. A year before, Toledo was reconquered by Alfonso VI and the "border line" was set, more or less, at the Tajo river. The Almohad Empire concentrated their border fortifications along the line of the Guadiana river, with Calatrava la Vieja serving as the capital. This frontier not only separated foreign territories, but also marked the location of several areas with local uprisings, for example Toledo. For this reason, the *Chronic* tells us that a general was directed to restore order (Lévi-Provençal 1957, p. 32).

So, it is possible that the global concept of the Medium Mark, almost until the defeat of the battle of Navas de Tolosa (1212) and the fall of the Almohad Empire (1223), included the territories from south of the headwaters of the Duero to the Guadiana; that is, the current provinces of Soria, Guadalajara, Madrid, Cuenca, Toledo, and Ciudad Real (Figure 4).

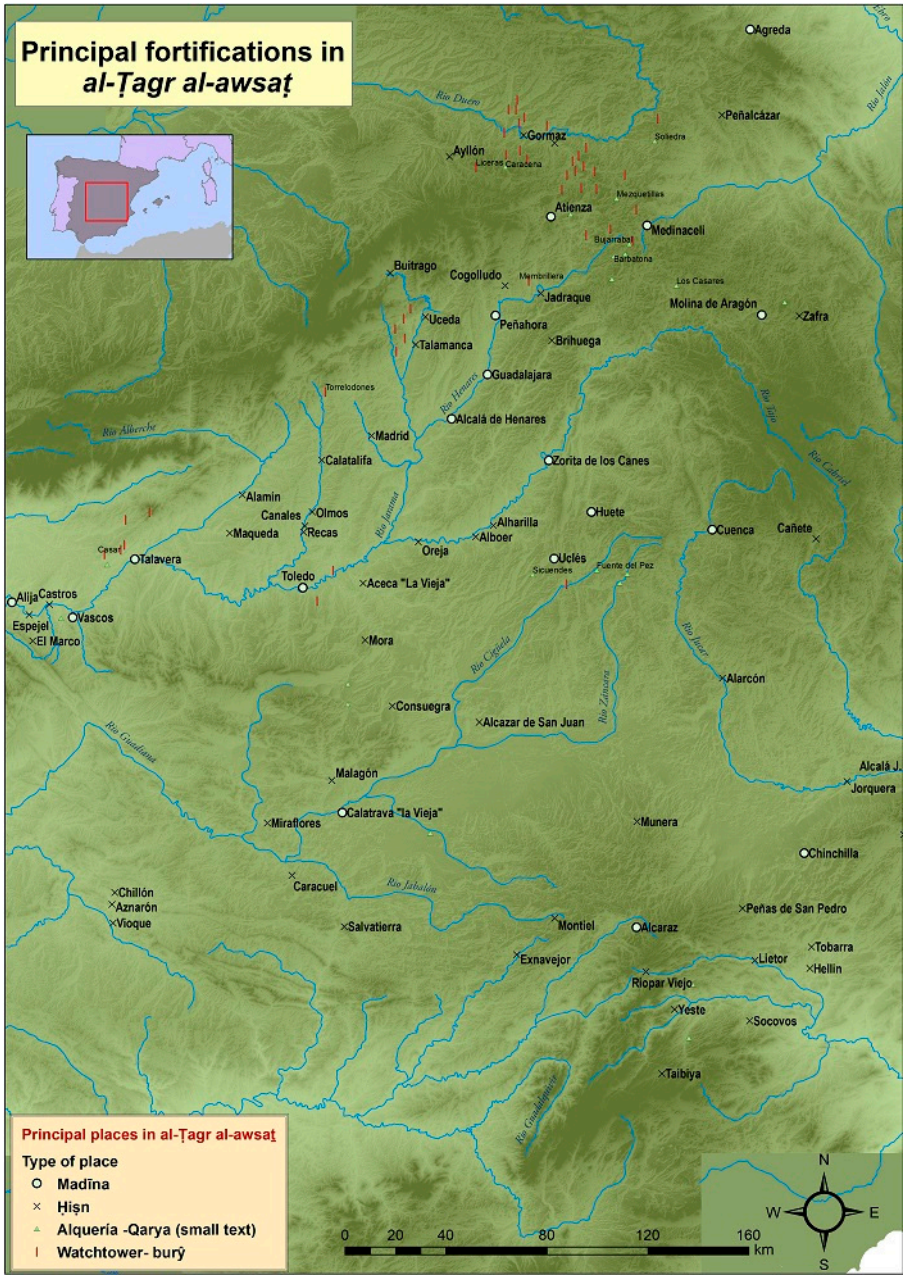


Figure 4. Map of the territories that could be included under the generic name of the Medium Mark between the 8th and 13th centuries, with toponyms of the referenced places (authors).

4. Stone Techniques in the Fortified Buildings of *al-Ṭagr al-Awsaṭ*

In al-Andalus, the development of stone techniques in fortifications is associated with an architectural program dictated by the current power, in addition to being connected to a gradual assimilation of technical traditions of the classical world. These can be associated with the processes of the establishment of the Umayyad Empire, first in Middle East, where they assimilated an official constructive policy based on the assumption of technical knowledge, as well as a qualified workforce from the former Byzantine province of Syria. These standards were reflected in the monumental buildings of the 9th century such as the Al-Aqsa Mosque, the Dome of the Rock, and the so-called desert castles: Qusayr al-Amra, Jirbat al-Mafyar, Qsar al-Hair, Msatta, the Palace of Amman, and Rusafa-Sergiopolis, among others (Creswell 1979; Grabar 1986; Enderlein 2001; Almagro Basch et al. 2002; Barrucand and Bednorz 1992; Arce 2006).

This tradition, converted into an iconographic and political program, was transferred to the other side of the Mediterranean, after the Abbasid *coup d'état*, by the only one of its members who survived the massacre in Damascus, 'Abd al-Raḥmān al-Dākhil, as supported by the *ŷund* Sirius that settled in the 40s of the 8th century (Chalmeta Gendrón 2003, p. 382).

The history of al-Andalus has since been associated with the successes and failures of the power of this family in the Iberian Peninsula, linking the construction of certain buildings with a constructive political propaganda. This led to a relationship between the transmission of classical know-how, as well as the social organizational and hierarchical capacity that entails the realization of these works in certain buildings, and their aesthetic taste; for example, see the mosque of Córdoba (Ewert 1968; Hernández Giménez 1975; Fernández-Puertas 2008), the *almunia* of the emigrated Emir of *al-Rusafa* (León Muñoz and Murillo Redondo 2009), or the *alcazar* of Córdoba (León Muñoz and Murillo Redondo 2009).

The assimilation of craft knowledge and the geographic extension of stone techniques progressed gradually from this moment onwards, reaching the zenith of the building program under 'Abd al-Raḥmān III, with the construction of Madīnat al-Zahrā (Vallejo Triano 2010). This palatial and fortified administrative city displayed all of these constructive traditions; as a result, chroniclers such as Ibn Ḥayyān praised this magnificent enterprise (Vallejo Triano and Fernández Barba 2010), in clear opposition to the Palatine cities of the Fatimid and Abbasid Caliphates.

In *al-Ṭagr al-Awsaṭ*, the fortifications were the constructions that conveyed the implications of "officialism" (Gurriarán Daza 2008) (Figure 5). Families and groups related to the Umayyad power were the holders-governors, qadies, amiles, etc. They showed their connection to the reigning power through the use of techniques and construction models that had certain common elements, such as horseshoe arch gates, which reflected that power relation. It is important to see that from the beginning of the Emirate until the end of the Caliphate, there was an improvement in construction techniques and constructive propaganda, linked to the development in techniques but also to the social articulation and the progress of a human specialization in this type of construction. We can see these differences between the irregular ashlar of the Casares Tower (Riba de Saelices, Guadalajara) and the quality of the Bujarrabal or Barbatona (Figure 6); or the differences between the stonemason work from Huete to Cuenca, or the Alcazaba and the West Gate of Vascos; or between the gate of the *madīna* of Calatrava and the construction of the west side of Gormaz.

Figure 5. View of one of the most relevant fortifications in the Umayyad Caliphate of al-Andalus that employed stone techniques, the *madīna* of Vascos (Navalmoralejo, Toledo) (photo: Junta de Comunidades de Castilla La Mancha-Ciudad de Vascos).

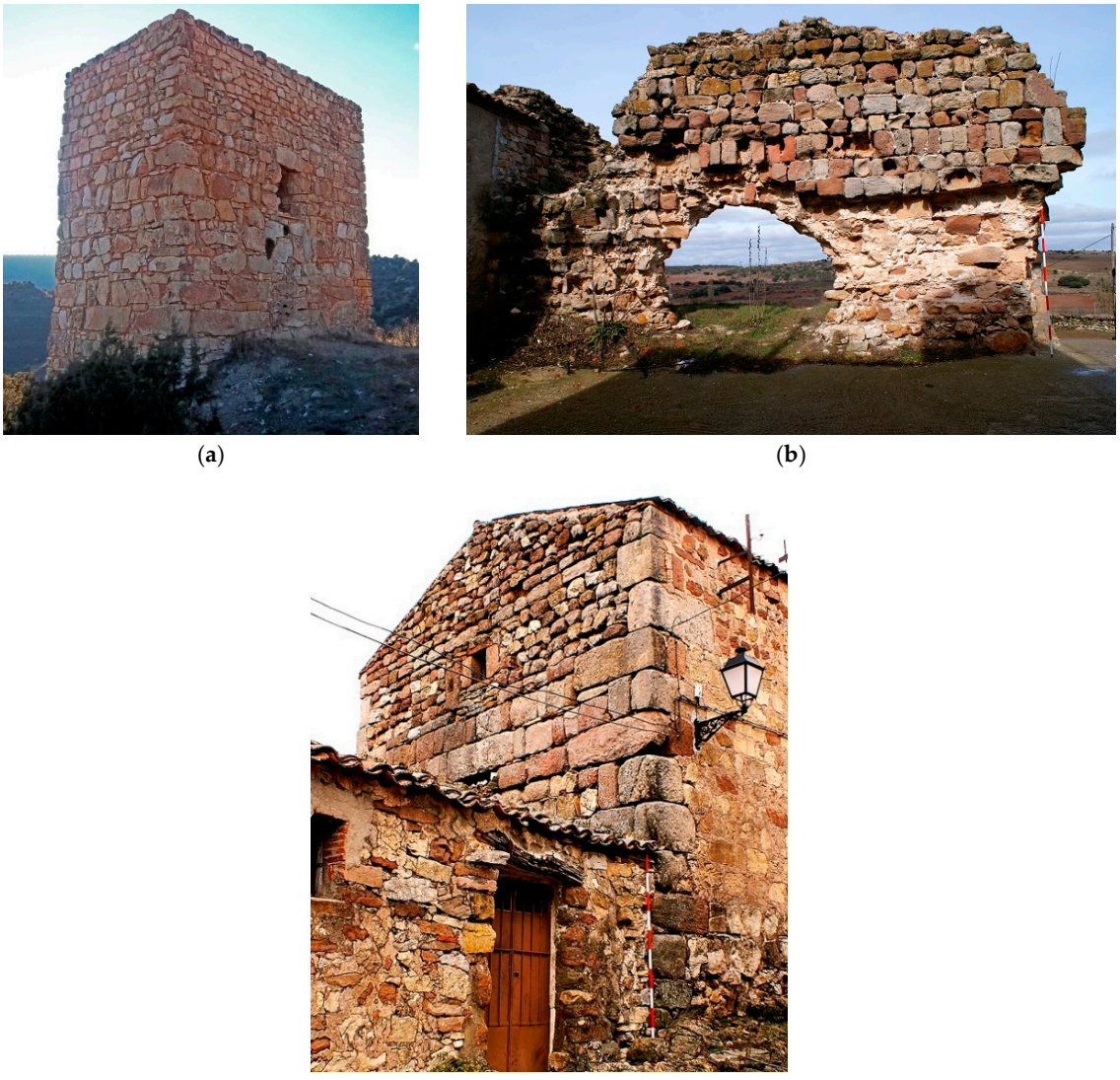


Figure 6. Progress and the evolution of quality in stone building techniques, in the same region and in similar structures (Guadalajara): (**a**) Los Casares (Riba de Saelices), (**b**) Bujarrabal, and (**c**) Barbatona (photos: authors).

The reuse of Roman and late Roman building materials gave way to a specialized construction group, which continued to reuse these materials but mostly employed *spolia* with propagandistic interest. This reutilization of construction material has been found in Talabīra, Toledo, and Zorita de los Canes (Figures 7 and 8); however, it is not the same as the intentional location of the Gormaz *spolia* (Figure 9). Still, it must be borne in mind that work on high-quality stone coexisted with techniques chosen mainly for their speed, which can lead to complications in the interpretation of the construction. For example, buildings with "faceted" stone masonry coexist with irregular ashlar in the *alcazaba* of Vascos, with the aim of showcasing the exterior of the structure while prioritizing material saving in the interior, emphasizing formwork that was slowly imposed on the construction. Sometimes, the stones from a demolished fortification were reused in the construction of a new one, as reported in the *Muqtabis V* (Ibn Ḥayyān 1981, p. 197):

> The fortress of Ma'zūna . . . was excellently built and, when he [the jew 'Abdarraḥmān] learnt this, he sent many teams of workers to demolish it and, with the wood and the stones, he built a tall fortress in the place called H.nd.r.ŷ, garrisoned with men and supplies.

In addition to the fortifications that had an "official" character made of stone, other were found to be made with less refined techniques, corresponding less to propagandistic aims and more to functional needs. We found, for example, more masonry whose purpose was functional and not propagandistic in the majority of the watchtowers. In this way, we could observe different work processes of placement and the elaboration of stone techniques, eventually leading to the discovery of some less developed techniques employed in the construction of government buildings.

(**a**) (**b**)

Figure 7. Reuse of Roman material in the walls of Talavera. The *spolia*, such as columns, or *stela* were reused in the foundation of a tower in the *alcazaba* (**a**) general view outside of the *alcazaba* with the *spoliae* marked with arrows. (**b**) Roman *stela* reused in the foundation of tower 2 in *alcazaba* of Talavera (photos: authors).

(**a**) (**b**)

Figure 8. (**a**) *Coracha* Tower and (**b**) the gate of *Doce Cantos* in Toledo. The reuse of stone materials in the construction of the *al-Hizam* of Muhammad I forced the builders to adopt irregular building techniques (photo: authors).

The investigation of stone building techniques allowed us to evaluate both the form in which materials were obtained in the quarry and the way they were set in the building. We observed the size and composition of the material, the geological type (whether easy or difficult to cut/work), and distance from the quarry to the construction site (the stone's origin), as well as the way in which the material was placed on the wall and the type of mortar used. So, we can organize our investigation according to the elements affecting the construction:

1. Materials (origin and type)
2. Disposition in the wall
3. Binding element (type of mortar)
4. Finishings (interstice—curb, plaster)

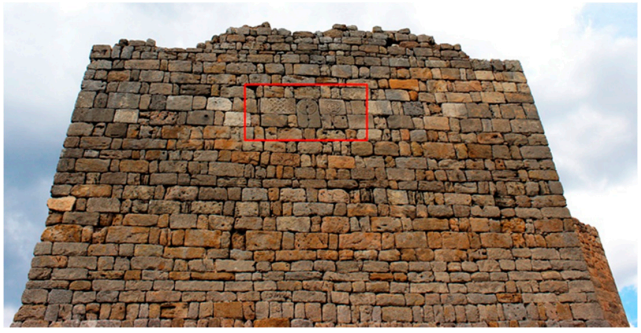
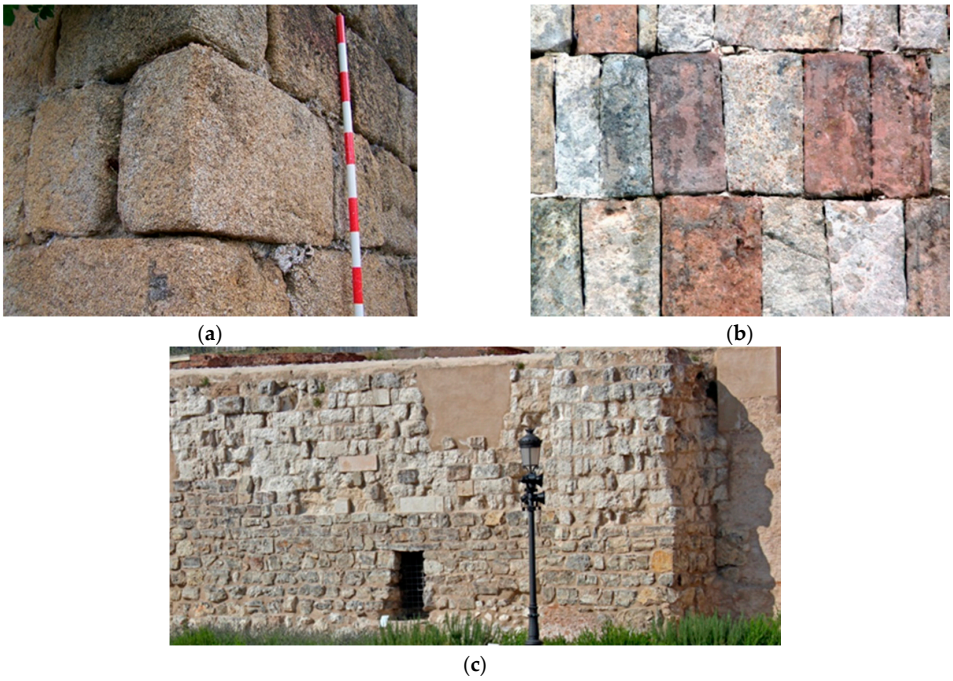


Figure 9. In Gormaz (Soria), stone makers, builders, and the proto-architect of the Caliphate worked together in the establishment of a homogeneous construction program. The *spolia* were integrated into the constructions (photo: autors).

4.1. Materials: Origin and Type

Usually the stone was cut from a source close to the construction site and was therefore from the immediate geological area—even if it was hard to cut or work, such as the granite in the zone of the Central System, in settlements like Vascos, Castros, and Alija, or the silex in valleys of Madrid, which was used in the walls of the capital. However, the use of sedimentary rock such as sandstone or limestone was more common and "easy" to work with; these types of rock were found in Calatrava La Vieja, Zorita de los Canes, and Huete. The fact is that, during the Caliphate, construction techniques were greatly improved and refined, such that a high-quality, fine result could be obtained in carving both metamorphic and sedimentary rocks (Figure 10).



(**a**) (**b**) (**c**)

Figure 10. Carving work shown using different materials: (**a**) granite in Vascos; (**b**) limestone and sandstone in Mezquetillas; and (**c**) flintstone in Madrid (photos: authors).

In some cases, quarries were located in ancient Roman towns or previous settlements and the material was transported from these locations. Examples of this include the transport of stone from Segóbriga to Uclés, or from the Visigoth settlement of Recópolis to Zorita de los Canes. More commonly, as mentioned above, the quarry, whether of natural extraction or through reuse of material, was close to the fortification; or the new building was built directly from previous fortifications, as was the case for the walls of Calatrava La Vieja on the *oretano* oppidum (Blanco García et al. 2012); or old materials were reused, as occurred for the construction of the walls of Toledo and Talavera de la Reina.

Depending on the interest, disposition, technical quality, and constructive need, different ways of shaping the material before its placement in the fortifications were employed:

1. Ashlar
    - 1.1. Square on all sides
    - 1.2. Squared only on visible faces
    - 1.3. Reused materials
2. Irregular ashlar
    - 2.1. Beveled
    - 2.2. Only faceted
    - 2.3. Very irregular ashlar—characterized by poor construction
3. Masonry
    - 3.1. Squared masonry
    - 3.2. Masonry extracted from a quarry and faceted
    - 3.3. Raw large masonry
    - 3.4. Raw medium/small sized masonry

Ashlar masonry: We define ashlar masonry as a type of finished stone that has been squared and worked on at least five of its facets. These would be marked with a square, inside which it is possible to see marks of stonework tools such as carvers, smooth chisels, pointers, and claw chisel, topped with bush hammer marks (Figure 11).

Depending on the hardness and the difficulty of finishing the stone blocks, we can discern the techniques and tools used, from the quarry to the necessary touch-ups on site and the use of levers or post-installation sculptures, such as the horseshoe arch carved in Vascos (Figure 12).

Figure 11. Use of a lever in Wicket Gate 1, Vascos (photo: authors).

(**a**) (**b**)

Figure 12. Horseshoe arch carved in Vascos: (**a**) general view and (**b**) detail (photo: authors).

Irregular ashlars: This type of stone used in the construction is worked in a shallow way (not having been squared); although the use of stonework tools is apparent, irregular ashlars do not have a squared, homogeneous profile. Some element of elevation or mechanical aid must be used for the placement of irregular ashlar in a wall. They have also been found in different sizes (not only small), but is usually greater than 0.30, up to 1 m. They have more quality in their preparation than raw masonry, although less than square ashlar (Figure 13).

(**a**) (**b**)

Figure 13. Irregular ashlars in (**a**) the *alcazaba* of Alija (granite) and in (**b**) the *alcazaba* of Huete (limestone) (photo: authors).

Masonry: Masonry here refers to the type of stone used in construction and placed by hand on the wall. It can have different sizes; the usual is the size of a hand, but can be larger, up to 50 cm, as required. In order to understand the different types of masonry, three ranges of sizes can be defined (height, width, thickness):

- Small masonry: between 10 cm × 15 cm × 10 cm and 20 cm × 15 cm × 10 cm;
- Average masonry: between 25 cm × 25 cm × 15 cm and 35 cm × 25 cm × 15 cm;
- Large masonry: between 40 cm × 35 cm × 25 cm and 60 cm × 35 cm × 25 cm.

However, masonry can also be worked in two ways. The first is type is extracted from a quarry and faceted, in which the stone receives a minimum amount of carving, and only on the face that is visible from the exterior of the wall. The other type is squared masonry. These pieces are worked using stonework techniques to achieve a polyhedral shape (Figures 14 and 15).

Figure 14. Wall with faceted masonry in Uclés (photo: authors).

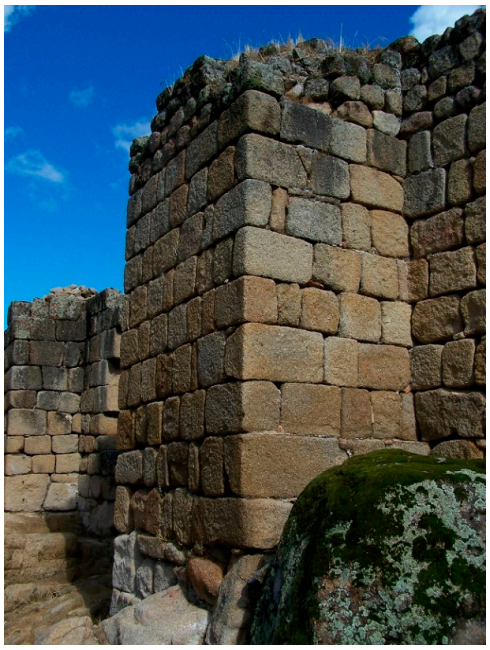


Figure 15. Tower 4 in Vascos. The square masonry on the top of the tower exhibits a model of ashlars (photo: authors).

4.2. Disposition in the Wall

According to the disposition of the material in the work, we can discern different techniques of bonding used in the fortifications built with stone (ashlar, irregular ashlar, or regular masonry):

1. In regular courses
    - 1.1. Laid in headers (Figure 10b)
    - 1.2. In rope
    - 1.3. In headers and rope (Figure 16)

1.4. Without a clear alternation

2. Alternating courses

2.1. With *engatillados* (any angle to adapt to the course the ashlar)
3.2. With different materials (masonry)

3. Irregular courses

3.1. *Spicatum* masonry (Figure 17)
3.2. Masonry
3.3. Brickwork masonry with brick courses or in brick "boxes" (Figure 18)

The use of these techniques throughout the whole territory reveals that the builders travelled and their knowledge was expanded with them. So, there are remains of *spicatum* masonry both in the northern border in Gormaz and in the southern part in Montiel. Moreover, the use of bricks to frame stones is observable in the external wall of Jadraque (Daza Pardo 2003, Figure 2), Cogollugo, Peñahora, and Buitrago de Lozoya (however, some authors believe this to be from the Christian period (Jiménez Esteban 1992; Sáez Lara 1993, pp. 138, 142–43).

Figure 16. Ashlar masonry in the foundations of the castle of Soliedra (Soria) (photo: authors).

(**a**) (**b**) (**c**)

Figure 17. *Cont.*

(**d**)

Figure 17. Differences between constructive techniques in some watchtowers: (**a**) El Casar (Velada, Toledo): the lower part exhibits irregular ashlar and "faceted" stone masonry; the higher part shows formworked masonry (photo: authors). (**b**) Liceras (Soria): the lower part exhibits ashlar, placed irregularly; masonry was employed in the upper part (photo: authors). (**c**) Torrelodones (Madrid): this is an image taken prior to the restoration (image retouched from AEAC Archive; author J. Pastor; restoration Kurtz). (**d**) Interior of the Toba or Membrillera in Guadalajara: masonry and spicatum rows can be observed (photo: authors).

(**a**) (**b**)

Figure 18. Two cases of the use of brick. (**a**) Albarrana Tower in Talavera de la Reina (12th century) and (**b**) stones in brick boxes in Peñahora (Guadalajara) (photos: authors).

4.3. Binding Element

The binding element is the element by which the rigging is joined, as well as the different materials that make up the wall; in some cases it is called mortar. The binder was in lime, gypsum and depends on quantity and debugging. The mortar is a material that bonds other materials. The study of mortars elucidates its importance in the processes of construction as well as facilitates the establishment of a chronology.

We observed the employment of different bonding elements. The first consists in the arrangement of a mass of clay-earth clamped onto the stone. The second, which is the most common, is made in lime, with different proportions in its composition. The third consists of gypsum, and the use of this element appeared in times of technique development in due to the proximity of the material (Figure 19).

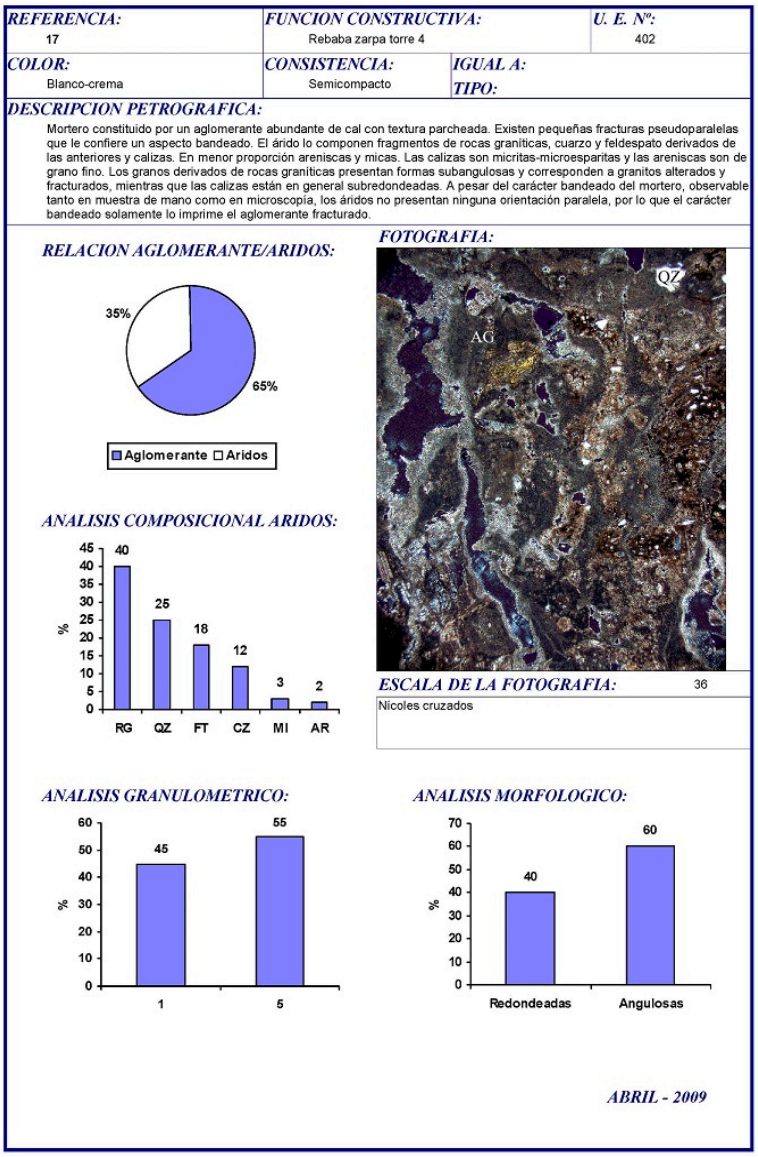


Figure 19. Depending on the quality of the composition of the mortar, we can also determine the technology and the resources used in the construction. In this analysis, we can discern the high quality of the construction based on the quantity of lime material employed in Vascos (analysis: Blanca Guarás).

Related to mortar, we noted the insertion of chocks and levelling in the formation of the structure, which were composed of reused elements or debris, normally from the same material. However, if these elements were composed of pieces of different, relevant structures, they further served to elucidate the chronology of the construction. Some of these elements can also be used in archaeometry for dating, keeping in mind that the data would reveal the moment that a certain element was created, which is not necessarily the same moment as the creation of the entire wall (Figure 20).

(**a**) (**b**)

Figure 20. Chocks and level elements: (**a**) doorjamb or fine decorative late-antique plaque reused in the wall of Talamanca to level the row; (**b**) chocks in Vascos to level the row (photos: authors).

4.4. Stone Finishing

Finally, the finishing elements on the exterior of defensive construction systems were considered. These elements have the objective of generating a homogeneous plane, particularly to isolate the interior (Figure 21). These are very difficult to find, due to the amount of time elapsed. However, in those we did find, we observed different finishing works, showing that in fortifications the walls only have lime marks in the interstices and the stones are left in view. This finishing technique was observed at least up until the *Taifa* period. After that (in periods of Almoravid and Almohad Empires), they started to cover all surfaces with simulation ashlars (Azuar Ruiz et al. 1996) (Figure 22).

The analysis of the complexity of the building processes—including extraction, elaboration, and commissioning—and due to the durability of the constructions, the identified stonework techniques reveal the complexity of the society that engaged in the construction and its social articulation (stonemasons, porters, carpenters, *alarifes*, masons, architects, etc.), as well as the speed and necessity of building or if the purpose of the work was for the exhibition of power and political propaganda.

(**a**) (**b**)

Figure 21. Final rendering of the walls in Vascos (**a**) with evidence of finishing tool (**b**) Covering space between stones in circular and irregular form (photos: authors).

Figure 22. Miraflores Castle, final simulation of ashlars (photo: authors).

5. Formworked Masonries in the Fortifications of *al-Ṭagr al-Awsaṭ*

One of the most widespread techniques used in building fortifications is formworked masonry. Under this generic name, there are a multitude of techniques and examples—from the use of concrete to the use of masonry as formwork. Formworked masonries enabled fast construction without the specialization of masons, as opposed to other techniques. It only required the supply of the formworks, into which the building material was poured. The use of formworked masonries dates back to the beginning of the Islamic period. We know that the walls of Huwaysilat (Iraq) were built during the Abbasid period with a kind of concrete (it seems to be an imitation of Roman concrete) made with gypsum and pebbles, subsequently finished with a veneer of stone, stucco, and plaster (Lewcock 1978, p. 135).

Rammed earth was also employed in the construction of fortresses, since the early days of the Ummayad Emirate and throughout all of the Islamic domination of al-Andalus. It was widely and mainly used during the North African Empires, when a multitude of city walls and fortresses were built by employing this technique. These walls were usually finished with a plaster simulating an ashlar decoration.

There are very well-known cases of rammed earth walls, as mentioned in previous publications. Here, we show the current research in order to analyze the lesser-known buildings in the history of the construction of Islamic fortifications in al-Andalus.

Evidence of rammed earth fortifications in the Emirate and Caliphate are less numerous, but they have been reported. In the *Muqtabis V*, it is described that the walls of Badajoz in the 10th century were built with "rammed earth and adobe" (Ibn Ḥayyān 1981, p. 83). This source also states that there were foremen and workers for the construction of the wall and the fortification of its crenellations.

Gormaz seems to be an ancient building made with rammed earth that was later reformed with a stone wall. That is one explanation for the difference between the external face with ashlars and the internal face of the walls, as well as for the shape of the towers (Almagro Gorbea 2008). Very close to Gormaz, the castle of Caracena encloses several ancient remains of the Caliphal fortification built with rammed earth (Gil Crespo 2016a, pp. 6–8).

In order to distinguish the different types of formworked masonry, we followed the distinction made by Gurriarán Daza and Rodríguez (2002, p. 582). They distinguished between two main types: those built mainly with earth and those built with others masonries in which the conglomerate is concrete. Within the study area, we found numerous examples that belong each of these types. They were chronologically assigned to different periods and located nearly throughout the whole territory.

5.1. Rammed Earth Masonries

Rammed earth masonries are those which use earth as the main filling material in the formwork; earth is defined as clays, gravels, and sand in variable proportions (Gurriarán Daza and Rodríguez 2002, p. 582). This basic mixture is usually added to other materials for reinforcement, especially lime in different proportions, stones of different sizes, coals, logs, ceramic materials, etc. Usually, earth walls are set over a foundation built by stone masonry or a lime layer over a rocky substrate, in order to avoid the rise of moisture by capillarity. Alternatively, although poorly preserved, clay, lime, or plaster coatings are provided on both sides of the wall, and can be used directly in the formwork when the mixture is poured (this technique is known as *calicostrado* or lime-crusted rammed earth) or applied afterwards.

As we have seen previously, the Arabic chronicles of the Umayyad Caliphate cite a very important profusion of earth masonries. However, the nature of the types of masonries employed is difficult to ascertain, since many of them have disappeared or have been embedded in later walls. In the territory of the Medium Mark there are several examples of this type of building in fortified works from the Umayyad period (mainly dated in the Emirate, possibly before the refortification made by Muhammad I). These fortifications that may have been built with earth are nowadays lost, and we do not know if they had any kind of rendering of plaster or lime.

An example of this is the primitive castle of Gormaz (Soria) that should have been built in rammed earth, as was the nearby castle of Ayllón (Segovia). Later, this primitive enclosure was lined with stone masonry (Almagro Gorbea 2008, p. 57). A similar case, although better known, is found in the interior of the fortress of Calatrava La Vieja (Retuerce Velasco and Herrera 2009; Hervás Herrera 2016, p. 88). Here, there were a series of towers built with rammed earth that were later embedded in the stone walls. The same situation occurred in some points of the city wall of Vascos (Bru Castro 2016b, p. 163) and in Caracena and Ágreda (Gil Crespo 2016b). Perhaps, one of the lesser-known but more interesting buildings is the city wall of Huete, where both towers and several curtains were built with rammed earth, and at least at some points, the presence of *calicostrada* is a possibility (Figure 23). Archaeological intervention has dated these walls to be in the epoch of the Emirate (Retuerce Velasco and García 2013, p. 383). In the latter case, the good preservation of some walls has elucidated how it was built by small constructive levels. The average height is 0.55 m, which can be understood as a module of one *rassasí* elbow (Hernández Giménez 1961; Vallbé Bermejo 1976; Graciani García 2009). However, we are aware of the complexity of systematically assimilating box metrics with chronological phases, except for very specific moments, especially during the Almohad Empire.

Figure 23. Huete city wall, in the area close to Las Tiendas; the wall and tower were built with rammed earth (photo: authors).

Although there are examples of lime-crusted rammed earth throughout the territory, there is a greater density of fortifications built in this manner south of the Tajo river where, which are dated

between the 12th and 13th centuries. In the province of Albacete, the defenses of the area of Júcar river (Alarcón, Alcalá de Júcar, and Jorquera) were found to belong to the Almoravid phase or to the Second Taifas. In Jorquera, we studied part of the *alcazaba* (citadel), mainly in the north and west sides, and also in a possible *coracha* (crossing wall that descends towards de Júcar) on the northwestern side (Peña Ruiz et al. 2017). This wall was built with lime-crusted rammed earth with an external lime crust layer of 20 cm. The interior of the wall was filled with earth from the clogging of the hill with previous structures, as well as with aggregates from the crushing of the limestone where the fortress is placed. The height of the rammed earth levels, in these cases, is between 0.7 and 0.75 m, with needles that are usually set in the lower level. In addition, at some points we found remains of tying ropes that were employed in the construction of the external layer of the wall. Carpentry elements were also identified inside as internal fastening nails for the pouring and sealing process.

From the Almohad period, we also present some examples. Among them is the castle of Salvatierra, which we have studied for some time (Molero García 2007; Gallego Valle et al. 2016). Rammed earth masonry is documented mainly in the western barbican, where several towers were built as well as a whole set of curtains that rest on an important masonry base with a historic covering. The wall presents constructive levels that already up to 0.85 m. It is formed by rammed earth with a mixture of lime concrete. The thickness of the lime crust is between 0.15 and 0.2 m (Figure 24).

Figure 24. Lime-crusted rammed earth in the wall of the *albacar* in the castle of Salvatierra (photo: authors).

5.2. Concrete Masonries

When the main material which is poured inside the formwork is formed by a mixture of lime concrete with other materials (in various proportions), such as earth and stone, this is termed concrete masonry (Gurriarán Daza and Rodríguez 2002, p. 582). This masonry is different from stone-formworked masonry, where the main element is stone of a particular size, with a smaller proportion of mortar. Moreover, it is different also from *tapiales*, or lime concrete formworked masonry, where there is a high proportion of lime mortar, to which other elements such as clays, sands, pebbles, stones, or limestone nodules are added, in moderate proportions (Gurriarán Daza and Rodríguez 2002, p. 582). Between both types, there is a whole set of local variants depending on the presence of certain materials in the area. These materials can present external terminations, mainly in the meeting joints of the formworks.

The use of these masonries is very widespread, so we cannot analyze in detail its variants or its use in the different chronological moments of the history of al-Andalus, which has motivated numerous studies to try to frame the elements following different methods that concern their metrics,

materials, or execution systems (Azuar Ruiz 2005; Márquez Bueno and Daza 2008; Canivell et al. 2015; Gil Crespo 2013). Within the scope of our study, due to the limits of this research, we here present a set of examples that we are able to categorize typologically and chronologically, which allows us to advance in the study of the characterization of this type of masonry.

The first of these examples is associated with a process of fortification, through the use of rammed earth masonry, carried out by the Emir Muhammad I (Acién Almansa 2002, p. 60) both in cities and rural military enclosures. The aim of this fortified system was to combat the climate of instability that was produced by rebellions, especially those of Toledo against the Cordovan power. The systematic use of concrete masonries was documented for the first time in Calatrava La Vieja (Hervás Herrera 2016, p. 166). Here, the building was stratigraphically well framed, which allows comparative studies with other nearby fortresses such as Salvatierra and Caracuel (Molero García 2016). In these examples there are similar masonries. As they have archaeological contexts, it is known that this phase is primitive within the constructive sequence. In the case of Salvatierra, where we have previously carried out studies of walls (Gallego Valle et al. 2016, pp. 226–27), the masonry in question was built with levels of 0.9 m, with some slight variations. The walls joined with lime and filled with concrete of this same material (Figure 25).

The Almoravid Empire represents a second chronological moment in which the use of formworked masonry walls is documented. In 1108, the North Africans took Uclés after a battle and they reorganized the surrounding territory (Gallego Valle et al. 2016). During this time there was a need to refortify a series of cities in a strategic area next to the Tajo river. The control of this area enabled an attack on Toledo as well as the control of communications to Zaragoza. At this moment, as we have been able to verify archeologically (both by subsoil stratigraphy and by the study of walls), a series of works were carried out using stone-formworked masonry. This series of works exhibited parallels with that documented in Calatrava at this time (Hervás Herrera 2016, p. 180), presenting including important similarities in metrics (0.8 m constant height of level), execution, and use of materials (Figure 26). This led us to hypothesize that they were made by specialized groups of workers, perhaps belonging to the Almoravid army. It was observed that in most cases 0.2-m boards were used for the formwork. This coincides with the masonry course (in this area using gypsum stone) until the height of the box was completed. After this, gypsum concrete was poured against the board. In this manner, a very powerful coating that remains incorporated after removing the formwork is created.

Figure 25. Formworked masonry in the castle of Salvatierra (photo: authors).

This type of masonries is located mainly in Huete, in the urban wall, as documented during an archaeological intervention (Retuerce Velasco and García 2013, p. 384). However, there are more remains in the citadel, where the Umayyad walls (ashlar and small sized ashlar) were systematically covered. In the case of the Fuente del Pez Tower (Palomares del Campo), we found similar masonries, which we were able to document more completely when digging into the foundation (Figure 27).

This allowed us to identify a correlation with the chronological moment that we have been describing (Gallego Valle et al. 2016, p. 229). We located these types of works in nearby fortifications, such as Uclés and Sicuendes (Torrubia del Campo). However, in these cases the masonry was less noticeable, as it was covered by Christian works after the conquest of the mid-13th century. In this latter case, the walls were built with concrete lime with levels about 1 m in height.

Figure 26. Lime and rubble masonry in the south wall of the *madina* of Calatrava la Vieja (photo: authors).

Contrastingly, there are some fortresses in which concrete is the predominant material: Montiel, Eznavexor (Villamanrique), and Alcaraz (Gallego Valle 2016). According to archaeological investigations, we stratigraphically documented their masonries. These masonries clearly precede the Almohad works, because these are attached to them, and they follow the Umayyad structures. The Umayyad walls are built with levels of 0.7–0.8 m. The putlogs are inserted in the lower level of those that are being built. We found a whole system of reinforcements based on nails and logs. The mixture of the material alternated the use of stones, found mainly in the lower part of the formwork, with the use of a lime concrete. The presence of the aggregate still contained a significant amount of earth taken from the nearby area. The builders added, perhaps intentionally, the remains of slag from iron. Similar masonries of this period were found in the castle of Consuegra (de Juan Ares and del Cerro 2005, pp. 123–32). The researchers documented this type of work in the fortification of the fortress, later enlarged by the Order of San Juan.

Finally, the main lime concrete masonries are those that we can place in the Almohad period. This type of work presents a set of solutions that are practically similar in all the cases studied. For this reason, several researchers (Azuar Ruiz and Fernandes 2014; Márquez Bueno and Daza 2008; Canivell et al. 2015) proposed the employment of specialized workers, possibly within the army corps, who repeated the same constructive systems both in large works and in small military enclosures. The height of the constructive levels of the walls was increased, clearly using the 0.45-m *mamuní* elbow. The horizontal levels oscillated between 0.8 and 0.9 m in height. The needles used to secure the boards were already arranged in the formwork itself as it was being built. This is an innovation that some authors attribute to this moment (Graciani 2009). Because of it, we sometimes find stone schist caches used to protect them.

Figure 27. Tower of Fuente del Pez in Palomares del Campo; formworked stone masonry and gypsum-crusted external layer. (photo: authors).

The main works of this moment, within the scope of this study, are in the area of the Guadiana border and behind it, where the presence of a process of refortification after the battle of Alarcos (1195) and the campaign of Navas de Tolosa (1212) is clear. The towers belonging to this period that are located in Calatrava La Vieja (Hervás Herrera 2016) are very interesting. The formworked masonry was built over an ashlar foundation, and it was rendered with the classic lining based on ashlar cutting (Azuar Ruiz et al. 1996). The castle of Miraflores was built almost entirely at this time using lime concrete masonries. As the works have been well preserved, practically without alterations, its general morphology helped us to study its construction process in detail (Gallego Valle et al. 2015). This type of wall, although without presenting the famous coating previously mentioned, is found in Montiel, Eznavexor, and Alcaraz, attached to the earlier Almoravid works. Then again, these bonds appear once more in the citadel of Jorquera, where the earlier military enclosure (that we have previously analyzed) was enlarged (Figures 28–31).

Figure 28. Eznavexor Castle. Concrete masonry preceding the Almohad phase (photo: authors).

Figure 29. Alcaraz Castle. Towers in the middle of the fortress built with concrete masonry (photo: authors).

Figure 30. Tower of Gallo, in the castle of Montiel, as example of Almohad concrete masonry wall (photo: authors).

Figure 31. The castle of Jorquera (photo: authors).

6. Conclusions

In this article, we have examined several examples of Islamic fortifications in the central area of al-Andalus, in the borders of *al-Ṯagr al-Awsaṯ* or the Medium Mark. We have organized them by techniques in order to understand their geographical and chronological distribution. Therefore, we are be able to explain a possible scheme of the main phases of building techniques employed in the fortification works in this area from the 8th to 13th centuries, in reference to stone and formworked masonries. Highlighting examples of which we have material evidence, we can differentiate four phases in this region.

6.1. Phase 1: From the 8th Century to the Middle of the 9th Century

This is the first phase of occupation. There are constructions in masonry or, in some cases, irregular ashlars with techniques lacking constructive development. We observed low-quality mortars with the presence of clay and little lime. Adaptation depended on the terrain and there was a reoccupation of earlier settlements or fortifications were built close to them. It is difficult to detect this phase because of the development of subsequent constructive phases, as indicated by TL dating in Vascos's *alcazaba* (Bru Castro 2016a).

6.2. Phase 2: The 9th to 10th Centuries

This period (from Muḥammad I to Caliphal stages with cAbd al-Raḥmān III and Al-Ḥakam II, the latter of which constitutes the main proponent of the period) exhibited the maximum development and implementation of constructive techniques in stone, linked to the process of social Islamization (Gutiérrez Lloret 1998, p. 151). New power centers were developed, and the cities of Roman tradition were structurally transformed. These new centers articulated the politics of the territory. In relation to these power centers, a series of settlements arose and gained importance, including Calatrava la Vieja, Vascos, Madrid, Guadalajara, and Zorita de los Canes.

There were some "official" techniques employed: ashlar or irregular ashlar and with the reuse of quality material (*spolia* and ashlar masonry). Works reached a high constructive quality in the main political and military centers, such as Talavera, Toledo, Gormaz, and Ágreda. Although the use of stone ashlar and masonry is the best-known technique in this period, there were other techniques that were widely used in fortified construction.

In addition, there was another series of defensive elements, such as *buruŷ* (watchtowers) and *almunia* (towers of farming operations), that helped to extend the domain of the territory. They were erected in stone with ashlar and irregular ashlar techniques. The masonry techniques such as *spicatum* (that appeared to be widespread in places as far as Atienza and Montiel) and others were commonly used. In rare cases they included bricks in the formation of boxes or rows, but this technique was more commonly employed in the next phase.

However, in this period we also observed the development and coexistence of formwork building techniques. Sometimes both techniques were employed in the same building, i.e., watchtowers with ashlar in the base and formworked masonry in the walls. The use of rammed earth, or even adobe, was occasionally documented in this period (Vascos, Huete (Figure 32), Consuegra, Ayllón, Calatrava).

Therefore, although the official construction of the Umayyad state seems to have been stone ashlar or masonry, there are enough examples to show that formworked masonries and rammed earth techniques were well-known and employed. However, problems of preservation and/or reoccupation have led to losses of this evidence, as occurs in *ḥisn* Gormaz (Almagro Gorbea 2008).

Figure 32. Vertical succession of masonries in the main tower of the *alcazaba* of Huete. The stone formworked masonry is laid over the Ummayad small sized ashlars and is anterior to the Christian phase (photo: authors).

6.3. Phase 3: The 11th Century

After the crisis and civil wars of the beginning of the century, we observed a contradictory period, with no clear evidence of new fortification or relevant methods and techniques. In this area the *D-l-Nun* Berber dynasty was in power and attempted to reenact the glorious times of the Caliphate (Viguera Molins 2000).

Regarding the principal evidence of fortification, the construction methods tended to be quick and economic. In Vascos, for example, some towers and the barbicans of the gates of the *madīna* were built with masonry and a large amount of lime (Bru Castro 2016b). There was also the use of brick laid in rows and the inclusion of large chocks or levelling elements in *al-Hizam* of Toledo (Zozaya Stabel-Hansen et al. 2005, pp. 217–25).

The confluent techniques between Christians and Muslims was also remarkable. In that moment, Granada was at war with the kingdom of Seville. The Vizier of Seville, Ibn Ammar, built and enforced the fortification of Belillos (in front of Granada) through the labor of the army of Alfonso VI (‘Abd Allah b. Buluggin 2010, p. 178).

6.4. Phase 4: The 12th and 13th Centuries

With the fall of the Caliphate of Cordoba and the end of “official” architecture and construction, there seemed to be a loss of technical knowledge. Yet, these were also times for internal organization, civil wars, fights, and treatises to maintain or obtain power amongst the *Taifas* kingdoms in relationships (of war or peace) with the Christian kingdoms. Later, the North African Empires (Almoravids and Almohads) needed to re-organize the territories and their fortifications. So, a strong state who controlled the building process returned. There was still the need to build fortifications, and because of the geopolitical situation speed was a determining factor.

The use of stone, in a general way, was partly relegated in these years to the baseboards and foundations and in some cases to the openings of walls. However, the inclusion of stone in the formwork was extended.

This loss of interest in the placement of stone and its massive utility, as verified in the previous periods, is associated not with a loss of technical knowledge, but rather with the necessity of fortifications having high functionality and the development of faster techniques. Hence, there was not a loss of knowledge in this apparent lack of constructive quality. In fact, there are works with high-quality ashlar masonry in some examples, such as those found in the pentagonal tower of Calatrava la Vieja or the foundations of Jorquera.

Author Contributions: The article was written by the three authors, with each contributing his specialty. The authors are specialists in fortified architecture. I.J.G.C. is a specialist in Construction History and he has

analyzed several construction processes, especially in the field of fortification. M.Á.B.C. has worked on the city of Vascos and the Umayyad architecture of al-Ṭagr *al-Awsaṭ*. D.G.V. is an archaeologist, co-director of Montiel Castle archaeological field, and he has worked in several excavations in Castilla-La Mancha.

Funding: This research was funded by Cárdenas Foundation grant number PI-18-02. The study of the castle of Jorquera was founding by Instituto de Estudios Albacetenses "Don Juan Manuel".

Conflicts of Interest: The authors declare no conflict of interest.

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