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Constructional Chronotypologies of the Military Structure in the Qasabat Al-ḥamrā

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Abstract The monumental complexes of the *Alhambra* and the *Generalife* in the city of Granada (Spain), built by the Nasrid sultans more than six centuries ago, constitute the final phase of Hispano-Muslim art in which Islam reached its greatest splendour and marked personality in the Iberian Peninsula. The attraction and interest that these ensembles have aroused in the sensibility of contemporary man, especially from the 18th century to the present day, hardly find a parallel in the world's historical heritage, and the consequences of this fascination have been considerable both on the architecture itself and on the ornamentation that distinguishes the Alhambresque revival. For this reason, any serious approach to the knowledge of the Alhambra site cannot do without a scientific analysis of its constructive characteristics and its evolution over the centuries, thus dismantling any possible distortion of the historical truth in favour of a false historical romanticism. From the analysis of the constructive chronotypologies that can be recognized in The Spanish Muslim architecture from the beginning of the Islamic domain until the end of the 14th century, constructive characterization patterns are identified regarding the geographical, social, technical and material variables in the field of military architecture present in the Qasabat Al-Ḥamrā (hallmark of the period) and the analyzed contexts. Based on the seriation of functional and material values, and identification of local patterns, an interpretative model of the documented construction systems and materials is proposed, providing an unprecedented typological-constructive analysis of this paradigmatic heritage. Based on these premises and following the itinerary proposed by Vargas in 2013 to manage the different functional, material and technical variables used to identify types and systems, the aim of this work is to elaborate a model which meets formal, stylistic and constructive aspects. Thus, by identifying the constructive systems, techniques and typologies, we present a chronological description and review of the different types existing in the territory, extrapolated to the analyzed local context and supported by updated planimetries of the places of study.

Keywords Al-Ḥamrā, Medieval Military Structures, Spanish Muslim Defensive Architecture, Constructive Chronotypology

1. Introduction

The Alhambra is a monumental palace complex made up of a group of ancient palaces, gardens and fortresses, initially designed to house the emir and the court of the Nasrid Kingdom. It was built on the hill of the Sabika, one of the highest points in the city of Granada. This location was intended both as a strategic defensive position and as a clear symbol of power for the rest of the city; in other words, a location chosen to be contemplated by the people of Granada.

The Alcazaba is the enclosure located in the

westernmost part of the complex and was built on the remains and vestiges of earlier constructions and pre-exists as the oldest building in the complex. It is trapezoidal in plan, somewhat irregular in shape and with a forceful volumetric form. It constitutes the military zone and the centre of the defence and surveillance of the complex.

To the methodological principles of constructive characterization used by Pavón [1] and the metrical principles regulated by Jiménez [2], new protocols of the archaeological discipline have been added such as stratigraphy, typology, documentation and analytics. As Vargas claims: it allows to get strict dated seriations, functional evaluations, and specific local and regional patterns [3].

The trend nowadays leads to improve the chronotypological reading system using standards as reference to define, contextualize and determine the different constructive techniques in their temporary context. Some experts in the subject such as Bendala [4], Tabales [5] or Quirós [6], have condensed an extraordinary collection which can be used to get reliable typologies which (as it will be demonstrated) support the extrapolation of the representative information proper of this local subject of study.

The geographical range, and the variety and diversity of constructive solutions detected serve as a guide to compare the typologies established by these experts in Islamic culture, architecture and society and as the key to identify those used within the military architecture of the Qasabat al-Hamra.

2. Materials and Methods

This investigation focuses on an evolutionary study of the constructive systems of military architecture used for the defensive constructions of Rome and Byzantium and enclosed on the medieval poliorcetic [1]. It is intended to demonstrate that emblematic military constructions such as the Qasaba of Granada respond to an evolved model of ancient cultures whose purpose and shapes are present in both walls and towers. It is evidenced by the clear continuity observed on the image formed by these fortresses along the north of the Arabic Africa and the Islamic Spain.

2.1. Geographical, Historical and Constructive Context

The rapid expansion of Islam forged the identity of its architecture without eliminating the rooted constructive traditions of the conquered civilizations. The absorption of cultures such as the ancient Rome -rooted afterwards on the Byzantine Empire- Mesopotamia, Egypt or Persia, added to the constructive method of the Islamic architecture, leaded to new techniques which will become universal references of vast richness because of its range and cultural diversity on the conquered territory. Furthermore, on Iberia, they were mixed with the influences of the Berbers from Magreb (previously conquered), the Almoravid, and the Almohad dynasty. The use of the cultural and constructive traditions of these conquered civilizations, along with a noticeable carelessness of having their own language will finally determine the identity of a culture with unique manifestations on the Al-Andalus (Figure 1).

2.1.1. The First Centuries of the Islamic Dominion

The archaeological excavations in the Peninsula have verified that, between the eighth and the eleventh century, urban areas from where houses and fortresses remain, were reduced and reconstructed using materials and techniques from the original constructions. In this first period of the Islamic dominion, Roman and Visigoth buildings are reconstructed and enlarged maintaining the pre-existing walls and supporting structures which preserve the classical brickwork system [5]. In Granada, according to the findings of different excavations, it seems that the first urban agglomeration of the Islamic era was built over the primitive Roman-Visigoth settlement, using part of their materials and giving birth to the Arabic fountains *Ḥiṣn Garnāta*. As Roca said:

> *It is a squared tower built of slaked lime mudwall with pebbles and rests of probably the original plaster. Inside, once the whole perimeter is clear, a new tower appears with mudwalls and bricks on their Northwest and Northeast sides. The East section, which is maximal 3.80mts height offers two constructive techniques clearly differentiated: the west side, in contact with the tower and the lower part, has a bond made of medium size stone and rows of brick [...]... the rest is made of brick which, in its original state was probably covered with plaster [...].* [7]

Some authors such as Torres Balbás [8], and Bermúdez [9] after him, claim that the alcazaba of the Alhambra was built reconstructing a late Roman castle, as the foundations of most of its walls and also some towers date from before the eleventh century. Other authors such us Malpica think that the date in which the Sabīka hill was occupied is ambiguous:

> *[...] the remains which stand today do not allow to know the vestiges of these first constructions -that in any case should not be considered more than a castral structure- although opposite to the city because of the excellence of this space Ilbira [...] Thus, nowadays it has been admitted that, from that moment on, the Red Hill was first occupied on the medieval era [...].* [10]

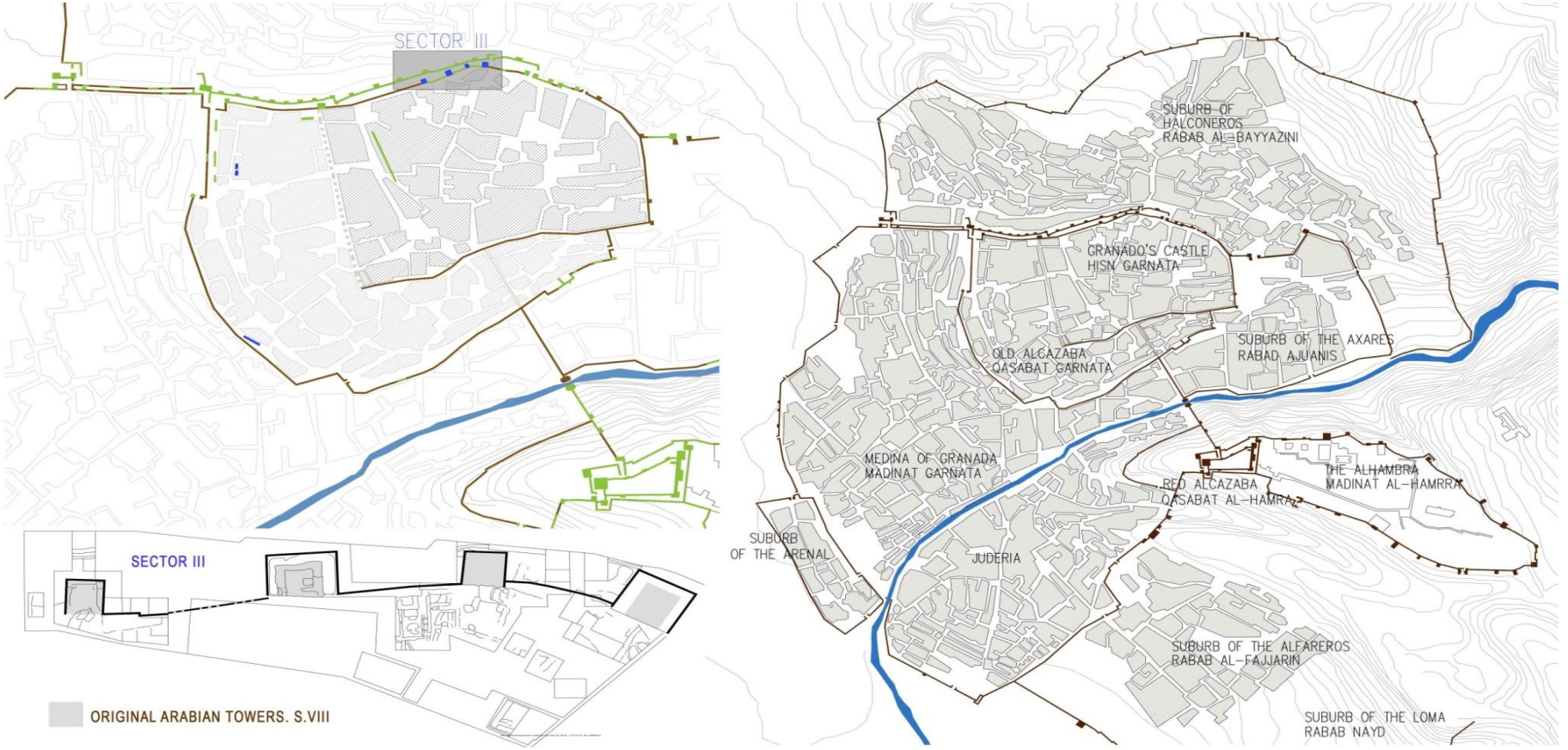

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Figure 1. Analysis of the urban perimeter of Granada. The hypothetical layout of the Iberian-Roman city is represented in the upper left plan. The possible delimitation of the Iberian-Roman city is shown in gray scale: the dark gray identifies the walled perimeter of Granada upon the arrival of the Arabs; in brown the theoretical evolution of the walled enclosures; in green the remains of fabrics currently preserved are marked; in blue the location of the Iberian remains. In the lower left margin, the general plan of the excavated area of the primitive wall is represented, extracted from the work of Moreno, Burgos and Casado in 1993. In the plan on the right, Granada is represented in the Nasrid period

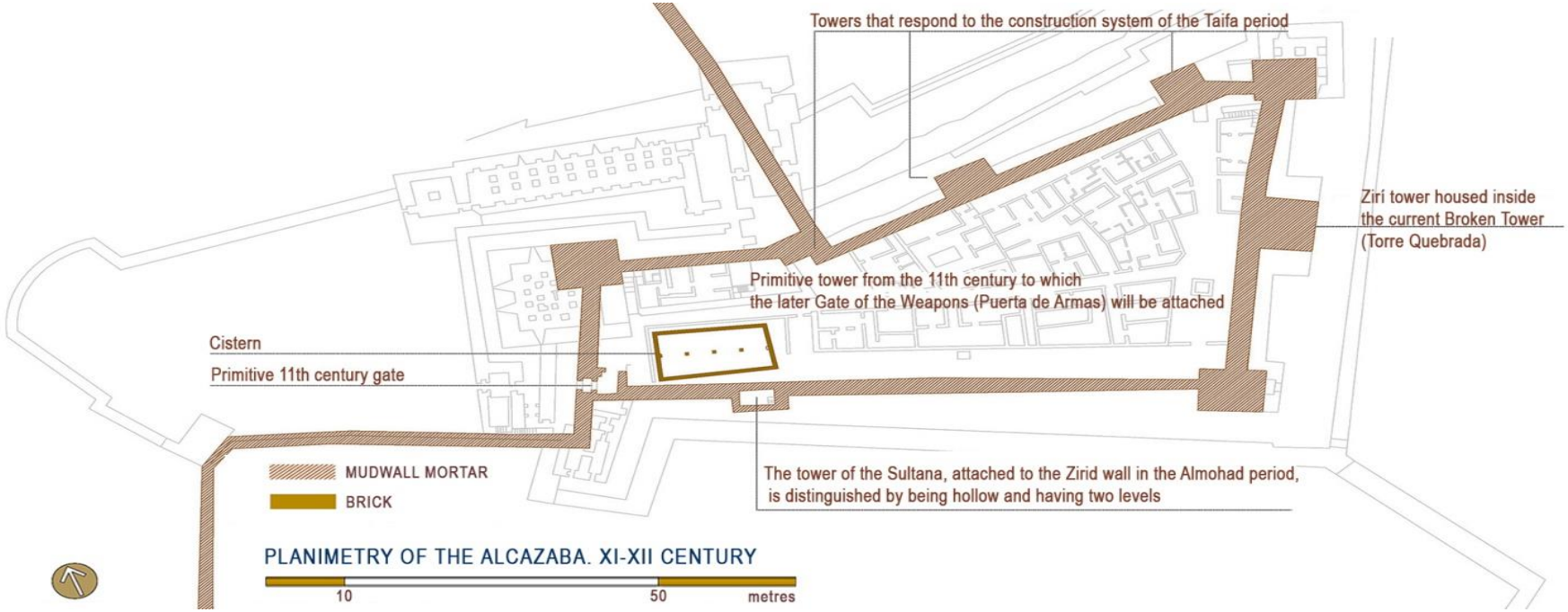

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Figure 2. Evolution of the Qasabat al-Ḥamrā between the 11th and 12th centuries

It seems logical that Arabs used materials from the Roman city of Iliberis when they arrived. They will take advantage of the proximity of materials as they were rare, so they will use stones from ruined buildings whose formats correspond to the opus quadratum, typical of the Roman and Byzantium techniques, where ashlars of the same high were disposed in parallel rows with dry joints. On the walls of this first period, wall coverings were made of ashlars with emplecton layers. These first walls, although with a similar brickwork, are less thick and usually less than 2.75 meters high, according to the studies of Tabales Rodríguez. The general pattern on the first constructions were to arrange stones in headers and stretchers repeated on groups of two to four with only headers on the first row. It is not usual to leave the blocks unbounded, so they used plaster or lime mortar, underpinned through wedge bricks and pebbles (Figure 2). There is also an irregular mix of ashlars with a well-squared dimension stone, little ashlars and bricks. The standard brickwork prior to the eleventh century keeps the Byzantine alternation of horizontal brick rows with ashlars or little ashlars.

The stylistic undefinition of this architecture at that time and the military character of the Syrian, Yemeni and Maghrebi troops inside the Peninsula are defined by: the presence of heterogeneous materials from different places in the same construction; the usage of materials from Roman buildings; the continuity in using the Hispano-Roman metrics and the mudwalls from the first years. Torres Balbás [11] claims that, during that period, stonework is the consequence of the existing materials and the economic resources of the governors who raise it: dimension stones, mudwall mortar, masonry stones with lime or brick mortar. These are the materials used in fortresses, at least from the tenth century (Figure 3).

2.1.2. After the Fitna

After the political disaggregation at the beginning of the eleventh century (on 1009) which contributed to the growth of the Taifas, an evolution of the styles, techniques and use of materials is perceived. From then on (along with the arrival of Almoravids and Almohads) an interesting transfer of constructive techniques used on both sides of the Strait begins. Between the thirteenth century and the beginning of the fourteenth century, the Nasrid Kingdom of Granada will preserve the Almohad heritage as a part of a cycle which will last from 1492 until the seventeenth century through the Mudejar architecture. The main characteristics defining the period of time between the eleventh and the fifteenth century are: (i) the usage of the mudwall in its different types; (ii) the sections of roman bricks were replaced by Arabic red bricks of one foot on its three metrics: major foot brick, fine brick and Almohad brick; (iii) the progressive disappearance of the ashlars, used in few occasions; (iv) the usage of masonry or mixed stonework on defensive constructions solved with a wide variety of brickworks: tenoned joints, mixed material rows, combinations of ashlars, Arabic bricks, Roman bricks, mudwalls, etc; (v) the replacement of stone walls by sand and lime walls of the defensive constructions from the twelfth century, and (vi) the usage of water infrastructure, grouting walls on mudwalls or stoneworks.

In addition, there are two essential aspects which determine the evolution of the architectural and constructive characterization of the analyzed models: extensive constructions with little resources and local materials, and the ephemeral condition disassociated from the artistic condition proper of this nomadic civilization (Figure 4).

Figure 3. Minaret of San José. Drawings by López Reche and M. Gómez-Moreno-. Torres Balbás comments that he does not know any documentary data about the date of construction of the minaret and tries to fix it using buildings with similar rigs, since the layout and carving of its ashlars are the only particularities that can serve as a guide to determine the time in which he got up

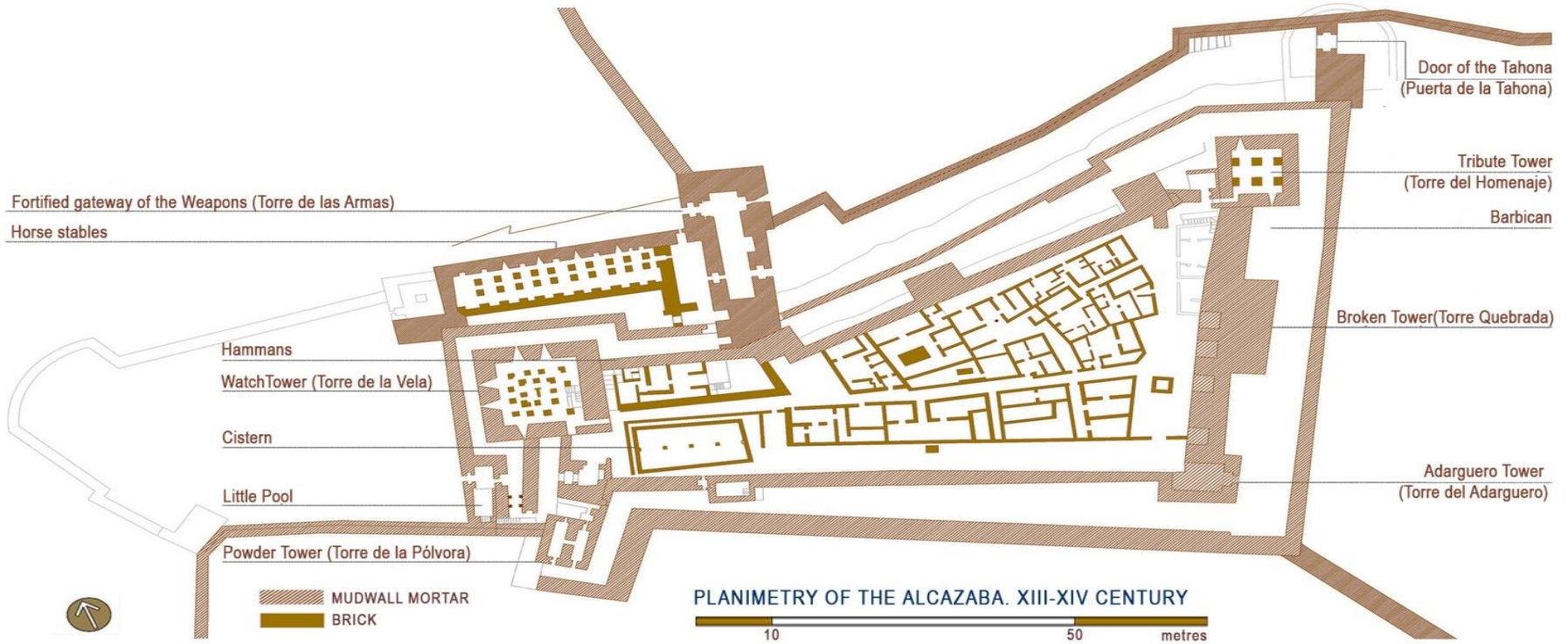

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Figure 4. Evolution of the Qasabat al-Ḥamrā between the 11th and 12th centuries

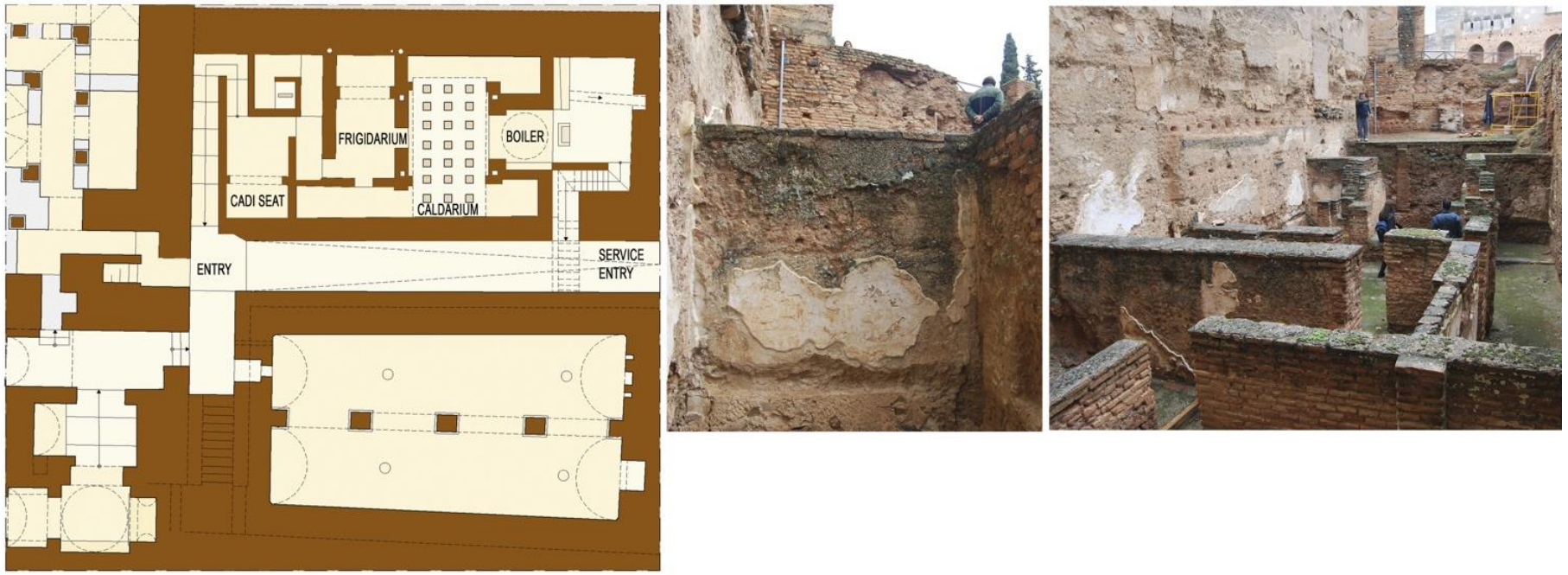

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Figure 5. Current plan, hamman and cistern of the Qasabat al-Ḥamrā. Detail of rammed earth walls in hamman

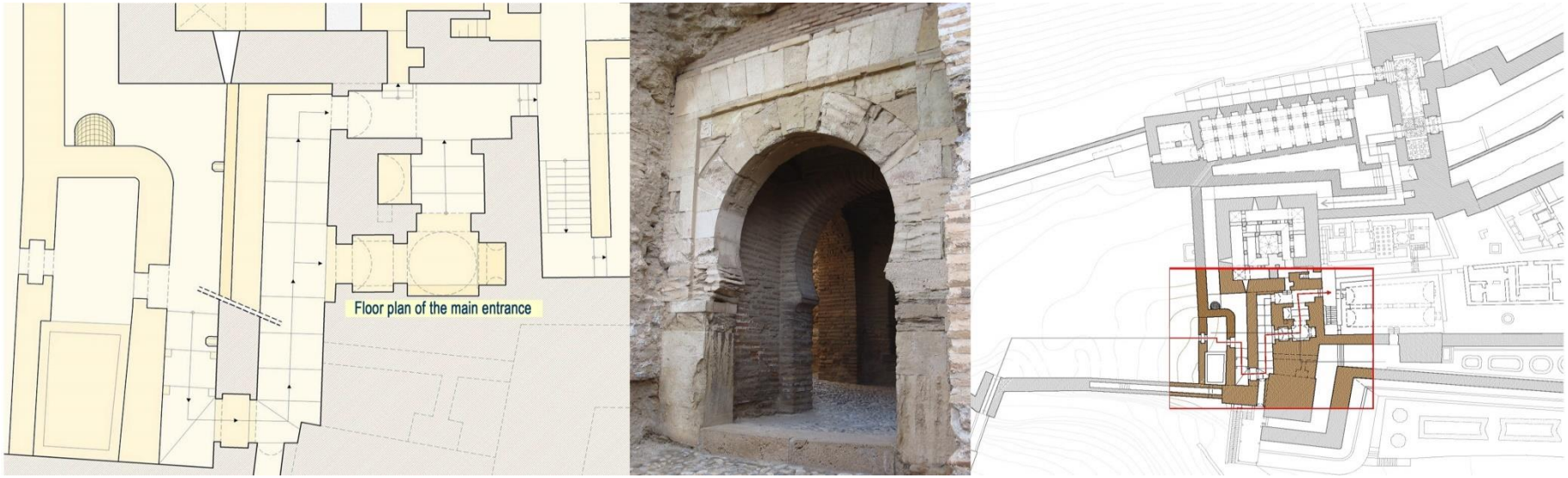

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Figure 6. Door of Weapons

2.2. Material Register

The choice of materials is based on vernacular matters, mainly using materials from the area, with some exceptions. The main materials used are described below:

2.2.1. After the Fitna

This material requires formwork, as it is a shaping material which requires a mould to create little blocks or adobes and mudwalls. Its composition and grading coincide with these from the area near to the fortress and it is also used in minimal humidity conditions to avoid retraction.

Within the defensive architecture of this study-where resistance is key to resist against projectiles- binding materials such as lime, slag material, ceramic fragments or pebbles are used.

Both in the mudwalls and the foundations of the Qasabat al-Ḥamrā, the combination of the main materials is known as *conglomerado Alhambra* (pebbles binded with sand and mud). This material mixed with water is easy to work and is reinforced with lime on the mudwalls or using stabilized rammed earth (Figure 5).

2.2.2. Stone

Limestone and sandstone are the most used, as they can be easily found in this area. They are mainly rough; dimension stones are only for sumptuous constructions. This material is also used for doorposts, arches, and foundations.

It is usual to employ stonework until the eleventh century, mainly on military constructions from emirates and caliphates and less on sacral and palatial architecture. On this Almohad period, it is occasionally used on the main doors of walled areas (Figure 6).

2.2.3. Masonry

The use of masonry along the Islamic period is accomplished by disposing different forms of brickwork. This type of work is frequent on fortresses and defensive elements and usually combined with dimension stones to define the edges of the walls. Its appearance depends on the dimensional variables which are also determined by the material and its extraction technique. It is useful to remember that the idea of coursed stonework fits the wise and logical placing of bricks or stones (or both) so that the wall is perfectly joined, and its covering is flat.

Until the Taifa period (eleventh century) the use of masonry mixed with ashlars and rough stones is predominant.

The constructions with the most uniform morphology are from the earliest period, focusing on Byzantine brickwork -alternating ashlars and rough stones of different heights- and African brickwork (alternating ashlars, rubble masonry and rough stones). This last technique will disappear after the caliphate. Periods in-between will be distinguished by the use of mixed brickwork with horizonal rows of bricks.

This technique is typical from the Grenadian fortresses, which evidences the great specialization of the builders, as it is arranged with exactitude. Some examples can be found on constructions raised during the reign of Muhammad IV. According to Gurriana [12], during the study of the Ihāṭa of Ibn al-Jaṭīb (22 constructions inside the villages of Mocl ń, Loja, Archidona and Antequera) Manuel Almansa identified a series of defensive constructions of bush-faced masonry arranged in rows with stone rubbles and slabs. Nevertheless, many Grenadian fortresses -same as the walls and towers of the Qasaba from the fourteenth century- are made of mudwall. When artillery started to be used for the battle, the defensive capacity of its weak walls decreased, so from that moment on, they were reinforced with ramparts.

The Almoravids from the twelfth century used to supply from the material extracted onsite and placed the masonry in rows, filling the spaces with smaller stones. It is usual to see mortar between both coverings.

This type of material is also arranged in boxes between rows of bricks. This is also used on some of the slabs in the Alhambra and the Qassaba of Malaga [13], among others (Figure 7).

Figure 7. Mudwalls. Watch Tower (Torre de la Vela) and its surroundings

Figure 8. Brick pilasters of the defensive towers

2.2.4. Ashlar Masonry

One of the best preserved are the ones inside the Alcazaba of Mérida, built by Abd al-Rahmān II in 835. They were raised using granite ashlars from ruined Roman constructions, poorly joined and with a quite rough constructive technique. The inside of the walls is filled with the same ashlars, randomly arranged. The irregular execution on this defensive compound diverges from the delicate and defined masonry of the Mosque of Córdoba, built by Abd al-Rahmān I at the end of the eighth century. It is only after the proclamation of Abd al-Rahmān III in the tenth century, when a socioeconomical inflection contributed to the renovation of the constructive techniques.

There are several stone works made of ashlars with stretcher and header bond inside the military constructions of the Caliphs [8]. As an example, the double walls and towers of the Madīnat al-Zahrā'. The stone becomes the main actor, as it is finely worked and finished as never before. The emiral squared ashlar led to a more lengthened stone. Stretcher and header bonds evolve to three or four headers to achieve the same bond.

These perfectly aligned stretcher and header bonds in alternated rows are unusual on the Al-Andalus of the eleventh century. In this case, stretcher and header bonds are mainly disposed on the same row. On the first stages, less headers were used, and later, the stone walls are disposed on the first foundation rows. Dimension stones with irregular heights are typical from the last stages, using tight bonds to level and correct the rows in pseudosquared shape.

The fall of the Caliphat led to the decline of great works of ashlar masonry, although the knowledge of the Cordoban workers was shared with the Grenadian Taifa kingdom. This situation coincides with the evolution of mudwall on the 11th century on both domestic and monumental architecture.

The constructive archetype typical of this monument led to the disuse of the ashlar, which was replaced by masonry stonework, mudwalls and bricks, mainly used on arches, hollows and domes, depending on the region (in the case of Granada, the use of mixed mudwall and bricks). Anyway, on our subject of study, this resource is only part of the foundations of the roman walls which are used to rise new Muslim defensive fortresses.

2.2.5. Bricks

The use of bricks on military fortresses is isolated, as they appear only in foundations or pilasters in rows -to regulate the previously poured materials-, occasionally in boxes of imperfect concrete and mainly in coverings.

On a first stage, bricks are used as complementary pieces of bond, filled with stone wall coverings, between dimension stones and in Byzantine bonds. Only from 11th century on, its use becomes regular.

Bricks are found in socles, mudwalls, fronts, doorjambs, and lintels. On minarets, it is used in bearing walls and decoration, becoming a common resource for Almohads and Mudejars. Almoravids will influence on the incorporation of bricks, using brick pilasters instead of stone columns in their mosques and other constructions (Figure 8).

As Torres Balbás describes, the use of bricks is different depending on the regions. In such regions, such as Granada, brick is used combined with rough stones:

> *Following a well know process for the Romans and usually employed during the empire, the masonry of the walls can be associated to brick -either arranged in properly spaced rows or in angles. This type of construction is typical from Toledo. It can be found on the Alcazaba of Malaga, in some parts of the wall of Granada and on the lower parts of the Alhambra fortress.* [9]

Pavón Maldonado analyzes the Torre de la Vela or the water reserves of the Alcazaba:

> *[...] This tower, like others in the Alhambra is made of a very consistent concrete, whose ingredients are crushed stone, sand, ferruginous clay and a lot of lime.*

Inside, the vaults, pillars and arches were made of bricks of 29x14x5 or 6 centimeters, same as in the primitive door of the Alcazaba. [14]

The metric of the classic bricks used before the 11th century follows the roman proportion of 2/3 in their dimension stonewalls or masonry, disposed in thick kerfs, in a Byzantine way. Later, the Arab brick (or one foot brick, proportion ½) is used. Its format 18 x 14 x 4/5 or 24 x 12 x 2/3 is known as the small form. Islam foot bricks provide a wide range of formats. According to Pavón Maldonado [15], on the North of Spain, the *módulo besal romano* of 2/3 is mainly used, whereas on the South and East of Spain, the Arab module of 1/2 is more present. Within the most originals, the *spicatum* (bricks disposed in 45 ºat different positions on each layer) and *sardinel* (bricks in edges, where headers can be seen). The thickness of the walls is the result of the combination of sizes of the foot. For domestic architecture, sections of one foot (30 cm), foot and a half (45 cm) and two feet (60 cm). Bonding is usually minded even in modest buildings, by using the combination of stretchers and headers on different rows, only being disposed on the same row on certain occasions.

The most splendid moment of this constructive element is reached on the Almohad architecture where it is a versatile element to resolve vaulted elements, arches and lintels in simple or monumental doors.

2.2.6. Wood

It is used for auxiliary constructive means: in gallows, balconies, closures, lattices and stonework; sometimes being part of the inner structure of the mixed ceramic walls.

By identifying and cataloging the poor remainings that exist nowadays, it can be observed that no special attention was given to the arboreal surroundings, using the nearest or easiest supplies. In Granada, the use of softwood such as Populus or hardwood such as pine is documented.

2.3. Characterization of Constructive Systems

In the Alhambra, the character of the foundations is reflected on the below text of Orihuela Uzal and gathered by Gámiz:

[...]nasrids were careful both on the choice of the location of the fortresses and villages and on the foundations. This is because of the great seismological activity of the territory and mainly on the capital area. The subsoil of the city -dominated by the actual geology formation of the Alhambra- is very appropriate for decreasing the seismic risk. This is one of the factors that contributed among others to the fact that the only completely preserved medieval palaces in the world are inside the Alhambra... when the walls were made of lime mudwalls, the foundations were differentiated from the gradient through the use of bigger crushed stone [...]. [16]

In this context, the importance and perfection of the Islamic architecture is highlighted in relation to the adaptation to the environment. In some studies performed on different towers of the Alhambra (specially the tower of Comares) it was difficult to distinguish the foundations from the walls, as the same material was used (a mix of river stones and a clayey thin material). On both elements, the materials used are found on site and without external transformations [17].

2.3.1. Vertical Systems: Stonework of Walls and Towers

There are two types according to the set up: coursed and mudwall stonework. The coursed stonework forms a spatial web on the covering which ensures its balance, thickness, endurance and shape through the disposure of different bonds and materials. On defensive architecture, walls are made with two faces of masonry, leaving a space filled with lime and pebble mortar, rubbles and sometimes soil.

Mixed walls (masonry and brickwalls) are one of the most characteristic bonds where different types can be seen; the most common is the masonry with ashlars on its corners and dimension stones about 25-30 cm height disposed on horizontal rows. The outside coverings are faced but not the beds, usually filled with rubbles and even ceramic. Same as corner ashlars are shaped for better settlement.

It is usual to cover the stonework in order to improve its protection against meteorological agents, its appearance and defensive properties against the picks and levers used in war times.

Mudwalls have been used since time immemorial. The *Islamic tabiya* [18] is undoubtedly the most characteristic technique from the Moorish constructions. The shape of this constructive system is achieved using boards of approximately 2,50 x 0,80 meters, made of three or four planks on their longest side and fixed by slabs. They will be moved through wood or rope handles, inherited from the Roman *opus caementicium*, (mortar and stone bond that looks like concrete) and it is present in the Spanish historiography as a very common technique. Most of the walls and towers of the remaining castles of the Calipha have mudwalls but they are covered by paintings imitating the *opus quadratum*.

On fortresses, this technique is settled by Almoravids and will be used in the Almohad and Nazari periods on the construction of their monumental *puerta acodada* (doors inside an angled hallway), chemises and albarran towers.

Mudwalls are made of Roman concrete -very fine, compact and finish lime- whose final color depends on the type of soil from the land. Boxes are cemented directly over the land or over stones to isolate them from the ground and/or align the base.

On mudwalls, the layer resulting from the demolding act as a finishing layer. Nevertheless, in some cases, the mudwall was plastered with thin mortar. On walls exposed to water, the joints between the boxes were filled with lime to seal them imitating stonewalls.

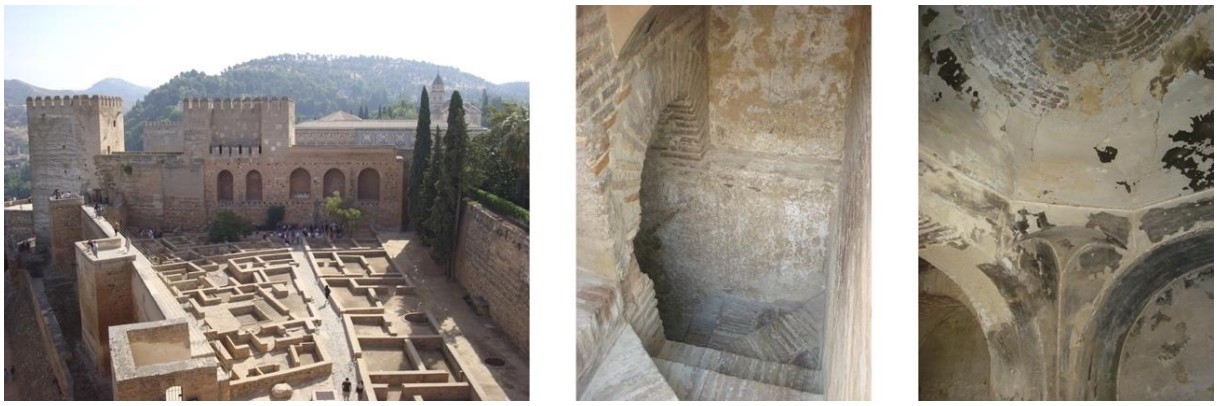


Figure 9. East front elevation of the enclosure. Interior of the Tribute Tower

This construction is considered the traditional way of building of the Alhambra, being used on most of the outside walls of the compound (Figure 9).

As Gómez Moreno describes:

[...] The shallow vault of the tower is made of crushed stone, sand, ferruginous clay and lime -this last on the exterior to strengthen the surface and the rest comes from the ground of the hill, which is the modern mudslide with clay. Inside, pillars, arches and vaults were made of irregular well-burned bricks [...] the rows over the bricks [...] are made of grout of soil, clay and lime, except on the vaults which are set with hard white gypsum. This is applicable to the rest of the buildings of the Alcazaba [...]. [19]

Most recently and based on scientific research, De la Torre claims:

In the Alhambra we find that all concretes [...] are in the form of mudwalls. The most noteworthy are made of rammed earth whose external side is made of lime rich concrete and the inside is red because of the clay. From the outside appearance and the relationship with both concretes looked through the microscope, it can be deduced that they were both settled and flatted simultaneously. [20]

Walls are considerably thick, although a relationship between the thickness and the lights covered by those walls has not been stablished. Also, the higher the towers are, the tighter they get. This condition can be confirmed on most of the defensive towers of the Alcazaba.

The Islamic architecture is modulated using the cubit as measure. The dimensional variants of this measure have been studied, among others, by Hernández Giménez[21], on his contribution to the study of the mosque of Cordoba, and Vallvé[22].

The Islamic cubit is divided into two basic types: the *Rasasi*, typical of the Emirate and Caliphat, and the *Maamuni*. The submultiples of both cubits are the foot, the palm and the finger. The multiples are the cana and the gala.

The measures of the boxes differ along the periods and regions. The regular measures were 0,60/70 x 2,20 whereas on the Almohad period, they evolved to two cubits (0,85/95 x 2,50).

The oldest dimensions (around 60 cm) seem to follow the *Rasasi cubit* of 58,93 cm while the most advanced -between 80 and 90 cm- are linked to the *Maamuni cubit* of 47,14 cm. The measurement of the box can be considered short below 85 cm and high over 85/90 cm.[23].

The length of the boxes is not continuous as it varies between 180 and 360 cm, with multiples of 45-47 cm, equivalent to a cubit. The Nasrid mudwall is usually 80 x 250 cm and is made by three of four slabs.

2.3.2. Arches

On walled compounds, depending on the case, bonds are either stone cut in wedges and prismatic joints, or bricks of different shapes on depressed, horseshoe, stilted or lobed arches.

Arches are also used to solve stairs, arranged one after another and maintaining the same high, so the stepped shape can be seen on the ceiling. The structural arch appears also as bearing wall for vaults, made of bricks (Figure 10).

Figure 10. Different arrangements of arches in the Qasabat al-Ḥamrā

Figure 11. Vaults and domes in the Qasabat al-Ḥamrā

2.3.3. Vaults and Domes

Stone allows very poor illumination, whereas brick without a vault or a dome is useless when building roofs or floors. Thus, different ways of brick arches, vaults or domes are designed which solve this problem through compression.

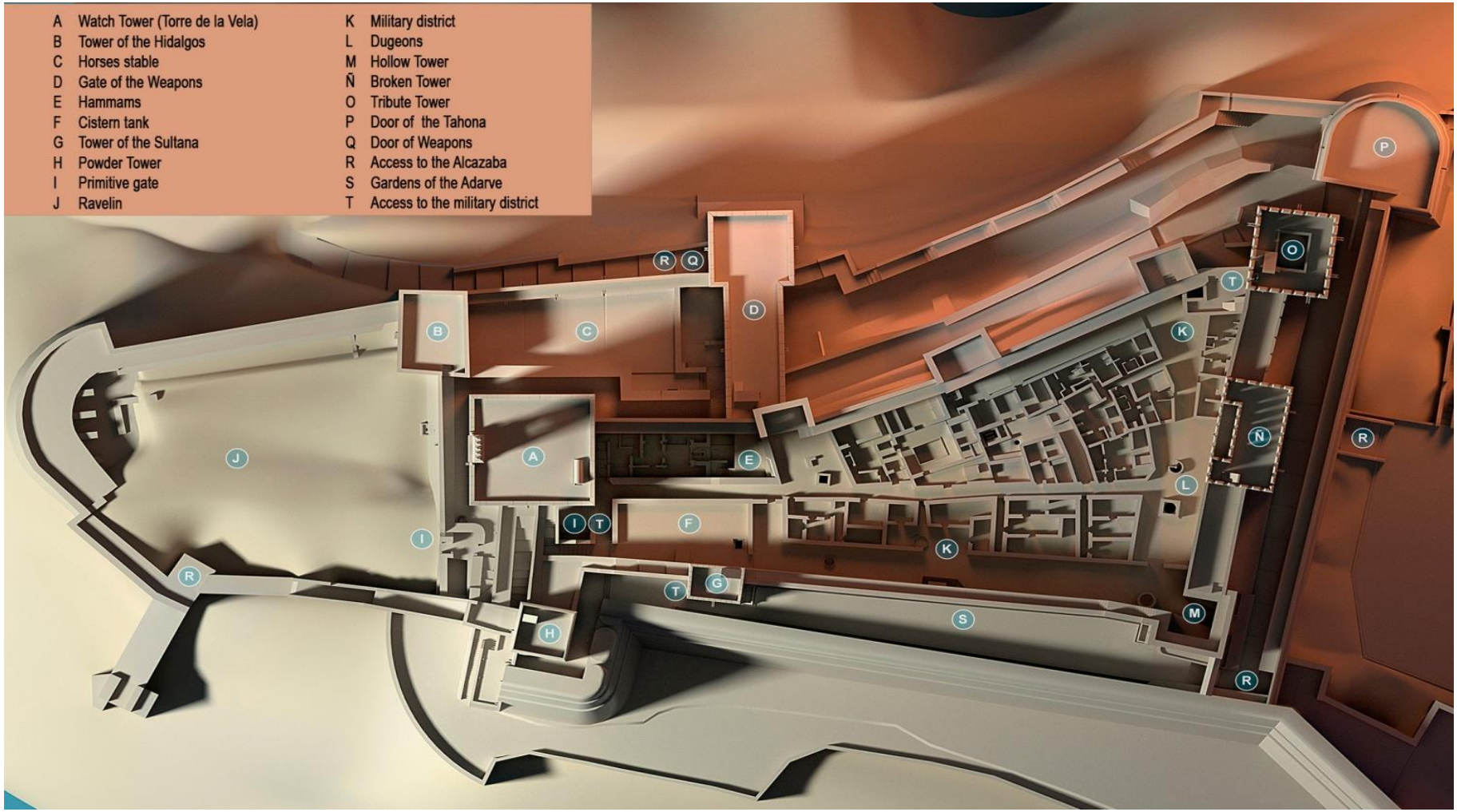
As an improvement to the technique of the barrel vault, the edges appear; and as an evolution to the dome or semispherical vault -raised from a circular wall or tambour- the semispherical pendentive vault. These techniques begun to be mastered within the Caliphat of Abd al-Raḥmān III and al-Hakām II.

In Al-Andalus, the covering of spaces through vaults is mainly found in military buildings and hammams. However, domes are found almost exclusively on palaces and religious constructions.

The most usual types of vaults are based on barrel vaults -on all its variants: rib vaults, domical vaults, cloister vaults, lunette vaults, arched vaults, surbased vaults. Domes usually are also variations of the hemispherical vaults: surbased, squinch domes, onion domes, gadrooned domes or elliptical domes (Figure 11). Under the dome, the Islamic architects transform the squared plan into a polygon by using squinches in the corners. By subdivision, superposition and squinch-shaping, an approximation to the circular shape is achieved. On a later stage, the hemispherical pendentive will be the solution, although it is limited to small spaces.

Afterwards, the real hemispherical pendentive was discovered but, as it did not reach a guaranteed technical development, the systematic reinforcement of the base of the dome with wooden rings along with iron clamps or wooden struts through the semidomes. Two parallel domes separated by radial walls would suppose a second option.

It is also known that concrete domes were built by using brick formwork, domes that were more decorative than structural.



Source: own elaboration

Figure 12. Scale model of the Alcazaba

3. Discussion

Based on the experiences of general studies along with the local casuistic of the constructive process of the patrimonial model analyzed, this interpretative model of the military architecture of the al-Qasaba of the Alhambra is proposed from the classification of the constructive techniques contextualized on his chronological phase, places and functionality. The results of the register of the different materials and constructive systems support the hypothesis that it is a defensive military structure which maintains and develops loyally the constructive models inherited from the different examples of the Almohad period. This circumstance provides a great conceptual unity to the compound. (Figure 12).

4. Conclusions

One characteristic of the whole Nasrid compound of the *Alcazaba* is its outside image, which does not attempt to hide its nature. On the contrary, it displays it by emphasizing its condition. Its materials combine with its shape from its own conception as a reflection of its structural and constructive function. Its shapes define a deep knowledge of the constructive system which explain the use of those materials.

In the *Alcazaba*, the amount of natural stones is poor compared to the manufactured materials: mudwalls, bricks or mortar. The mortar in the mudwalls (made of gravel, sand, clay and lime) make the walls robust and consistent. This architecture is complete with the use of bricks specially in pilasters, arches and domes. The dimension of the bricks is considerable, characteristic of the Almohad period.

There are no accurate data currently which confirms the moment in which the Alhambra hill was occupied for the first time. Recent investigations claim that it was after the Roman and Visigoth so it will be difficult to demonstrate an origin prior to the 11th century.

Regarding the remains found on the hill, it is logical to think that the Arabs used materials from the Roman city of Iliberis on their first constructions. In this first period, the Arabs, surrounded by their rivals, will collect those materials due to the lack of means and the urgency to build.

From the 11th century, unlike the previous centuries, documentary reviews about the analyzed compound have been obtained. The oldest quote date from 860, from which it can be deducted that a castle existed already on the same site of the Alcazaba, where Muslim troops sought refuge while persecuted by the native Andalusian. Muslim historians while describing similar facts on 889 also mention it. They called it Qal'a al-Ḥamrā', which means *red castle*.

Two hypothesis can be deducted from the texts about the existence of a fortress: (i) the existence of a castle in Garnāta and its renovation by Sawwār Ibn Ḥamdūn on the 9th century and (ii) the creation of a new fortress by Sawwār on the 9th century.

So far, it has been impossible to recognize original traces of the first constructions, so it is not possible to determine which of the hypothesis about renovation/creation is correct. Furthermore, the texts analyzed are not original, but a copy from later centuries, which raises even more uncertainty. Independently of these two theories, it is clear that the name of the Alcazaba, al-Ḥamrā' dates from before the settlement of the Nasrid dynasty and so it is mentioned on the texts analyzed.

For the analysis of the evolution of the compound during the 11th century, the Memories of 'Abd Allāh [24] offer more facts for the knowledge of the historical evolution of the future Alcazaba of the Alhambra. Those texts mention the constructions made on the hill of Sabīka, strategical place for the Muslim leaders, being the Alcazaba the emplacement for their first constructions.

These texts will demonstrate that the citadel of Alhambra is configured (same as the city of Granada) through the spatial and functional transformations made on the fortress through time: from Ḥiṣn (11th century) to a Qaṣabat (13th century) to be integrated inside a city (citadel of Alhambra) [25].

Ḥiṣn al-Ḥamrā' raises from the most western side of the Sabīka hill, adapting to the topography of this site. The fortress, with irregular form, is higher on the North and the South and lower on the East and West; being the West the longest, and the entrance is located on the Southwest.

During this period, the North side is reinforced with three towers, what can be demonstrated through the constructive system utilized (concrete and lime mudwall) and the size and proportion of its reinforcement.

On the South, there were no towers until the 12th century, being the Almohad period when the tower of the Sultana was raised. It is dated from this period because of its constructive and spatial characteristic, which totally differ from the Ziri period. This tower, unlike the others, is empty and has two floors.

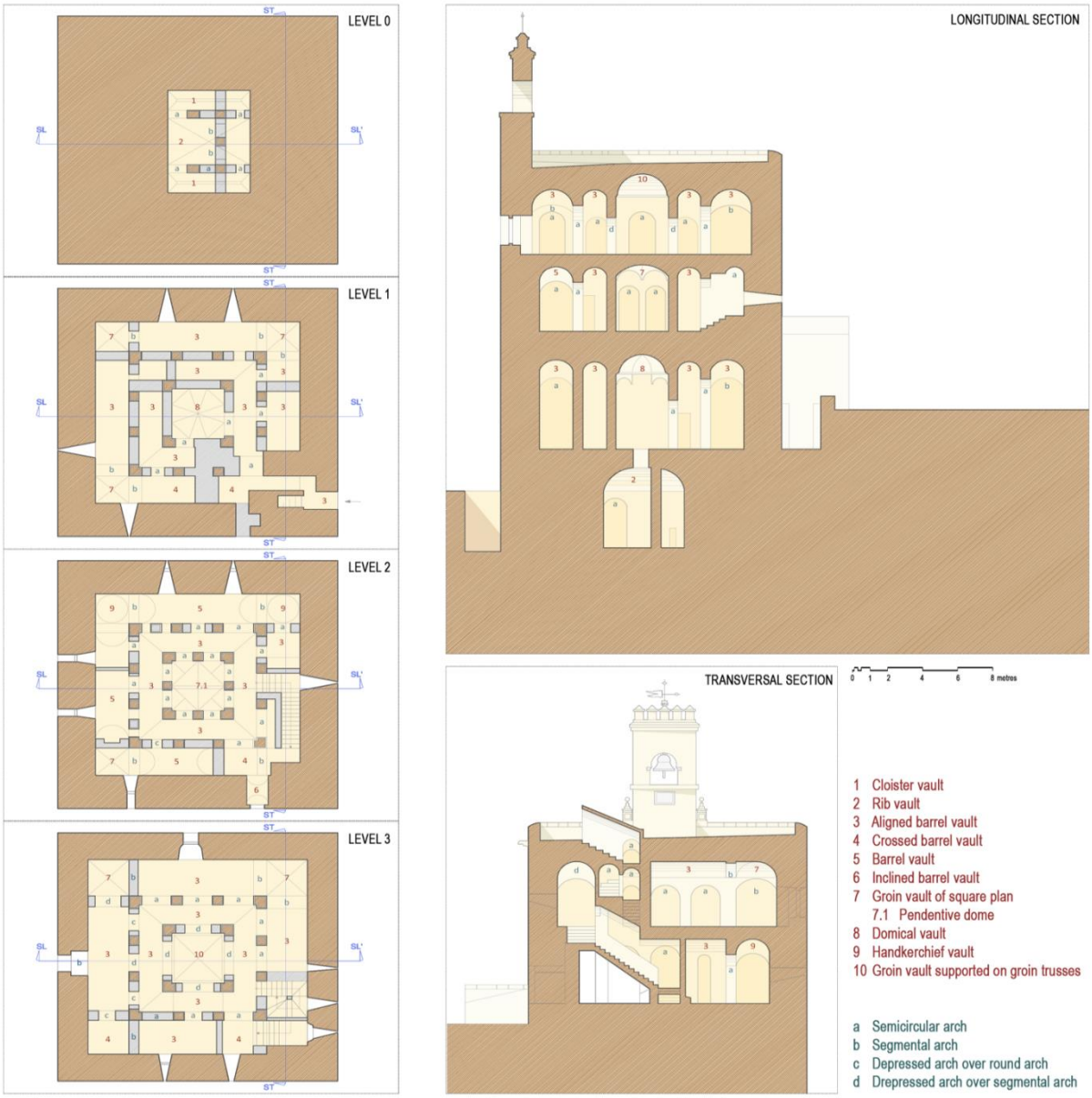
The East side is reinforced with other towers which will contain bigger towers on later stages, as the central tower (embedded inside the Quebrada tower) or will be substituted by new ones (the towers on the edges were substituted by others like the Homenaje or the Adarguero). Obviously, the North and South angles, following the constructive and defensive logic, have towers to reinforce the corners: the existence of a ziri tower on the Southwest corner, where the Adarguero tower was built on the Nasrid period can be demonstrate if a deep excavation on the inside was carried out.

The entrance to the compound will be located on the Southwest corner. Inside, we will probably find the cistern tank and the Plaza de Armas with tents called *jaimas*, the common home of the Berber of the North of Africa (tribu Ṣanḥā ŷ), the al-Magrib or Ifrīqiya. Inside the Casita de las

Pinturas del Partal of the Alhambra, from the Nasrid domain of Muḥammad III (1302-1309), some representations of these tents can be seen, where they celebrated the victory of the *razzia veraniega* [26].

On the Northeast side, a reinforcement tower will probably exist at that time, which will be substituted by the *Torre de la Vela* on the 13th century. In this time, the founder of the Nasrid dynasty, Muḥammad Ibn al-Alhamar stablished Granada as the capital, being responsible of the constructive system of the Sabīka hill, finished by configuration of the citadel. The actions developed between 1238 and 1239 will be accomplished by Muḥammad II between 1239-1302.According to Gómez Moreno [19] some Castilian chronicles assign to Muḥammad II the first improvement tasks of the existing fortress.

Muḥammad I rebuilt over some ruined towers (Ḥiṣn al-Ḥamrā) and almost all of the most old walls. For this purpose, they used the preexisting walls and completed them with some new sections and towers. The weak points are reinforced through the big towers of the East area: *torre del Homenaje*, *Quebrada* [17] and *Adarguero*; and to the West, between both doors of the compound, the huge Torre de la Vela was raised. Thickening the coverings of the eastern wall, reinforcing ramparts, and surrounding the compound with a barbican renovated the walls.



Source: own elaboration

Figure 13. Constructive analysis of the Torre de la Vela

After several reconstructions, it is transformed in a new solid and impressive fortress. Some of these towers are huge and constitute genuine independent fortresses, indifferent to the military practices of the Moorish architecture so far. The most outstanding tower may be the Homenaje. In addition to the reinforcement works, new towers, doors and coverings, the construction of baths and houses (dominated by patios) on the *Plaza de Armas* are added. Later, during the Nasrid period, some key elements of the renovation of the fortress will be incorporated: (i) the door-tower of Armas on the North side of the compound -probably made by Muḥammad III-, (ii) the Puerta de la Tahona, the conjunction point between Alcazaba and the palaces, (iii) the stables on the West side of the door-tower of Armas and (iv) the Torre Quebrada on the side of this compound during the domain of Yūsuf I, replacing the previous and smaller ziri tower.

As a final summary, a self-made, genuine figurative restitution is provided based on the results of the study of the identified chronotypologies of the structural and constructive systems of the compound along with what it is deducted as an evolution of the Qasabat al-Ḥamrā. It is graphically represented the results from the analysis of the materials and constructive system of the study of the planimetry and historical texts, the justified referenced of experts on the subject, as well as the numerous guided visits to the Alcazaba of the Alhambra (Figure 13).

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