

Notes on ‘Tapia Walls’ in Seville (Spain) during the 16th Century in the Modern Age

Amparo Graciani

Tapia (or *tapial* as it is called in Southern Spain) is an earth construction technique based on wooden formwork, within which a mixture consisting of earth, aggregates, lime, water and even organic components (oil, straw, chaff, etc.) is repeatedly rammed down. This rammed-earth technique has been in very common use in Seville from the Middle Ages to the present. However, due to the use of lime in the mixture, it was *improved rammed earth*, called *tapia real* or *tapia mejorada* in Spanish; the first tapia walls in the city appeared as early as the beginning of the 10th century (and more commonly during the Taifa period) and grew more widespread in use with the invasions from North Africa, especially between the second half of the 12th century and the first half of the 13th century with the Almohads. Its popularity can be ascribed to its speed of manufacture and to the solidity of the resulting material, which made it especially common in military constructions such as the city walls.

The recent boom in studies on both earth construction techniques and on the Islamic period in the city, as well as the recovery and rehabilitation of military urban infrastructures, have allowed us to considerably advance our knowledge of tapial constructions in the Islamic period in Seville, particularly those of the Almohad period. The recent increase in archaeological excavations in Seville’s historical centre and in its building heritage have influenced this process, adding new Islamic tapia elements to the known ones. We have recently presented our research on the walls of *Isbiliya* (as the city was called) (which were reconstructed and expanded in this period) in a number of forums and contributed to interdisciplinary studies which seek to synthesize the historical, archaeological, constructive, urban development and material viewpoints. These published works present the initial conclusions for a synthesis study of this technique in the Province of Seville on which we are working as part of an interdisciplinary group (Research and Development Project I+D (2004-2007) BIA 2004-01092, *Maintenance, Evaluation and Restoration Proposals for Rehabilitation of Buildings and Urban Infrastructures with historical tapia walls in the Province of Seville, Spain*, financed by the Spanish Science and Technology Ministry; Graciani et al. 2005; Graciani and Tabales 2005).

Despite this resurgence of interest, the Mudéjar tapia walls of the city have barely been studied (Tabales 2002, 180-187) and nor have those of the Renaissance when Seville became the most important city in the Western world because of the demographic and economic boom generated by the concession of the commercial harbour monopoly with the Indies (when the so-called *Casa de Contratación de Indias* was established in Seville in 1503).

This oversight is especially curious bearing in mind that this construction technique was common throughout Spain during the Modern Age, as shown by references in diverse construction treaties and the use of the *tapia* as a unit of measurement. Consequently, it would be odd if it had not proliferated in a city such as Seville which has a long tradition of using this technique and which had an evident need to build with the speed appropriate to its expansion. In response to the discussion of whether it is appropriate to term the technique *tapia* or *tapial*, it seems timely to recall that in the 16th and 17th centuries walls made with rammed-down earth were known as *tapias*, whereas *tapial* was reserved for the wooden formwork used to make the parts of a *tapia*. Covarrubias (1611) said:

“*Tapia*. Pared que se haze de tierra apisonada, que en algunas partes por la calidad Della y el modo de hazer las tapias, viene a ser no menos fuerte y durable que si fuesse de piedra y cal; *Tapial*. Molde o tablero con que se hacen los adobones de una *tapia*.”

(*Tapia*. Wall built with rammed earth, which in some parts and due to the quality and the way of building the walls, is no less strong and durable than if it were made of stone and lime; *Tapial*. Formwork crate or wooden board with which the *adobones* of a wall are made”.

The most recent studies on construction techniques or on building types in Seville during this period (Pleguezuelo 2000) barely make reference to the use of the technique, concentrating more on analysing the use of brick – also a material long used in the city - and of stone, employed mainly in the facades of monuments and occasionally as the sole material in the most important civic buildings. Pleguezuelo refers to the name of the tool used to ram down the mixture (*pison*, currently *pisón*) and the relation between the dimensions of the formwork and the unit of measurement at that time, the *tapia*, equivalent to 40 or 50 square feet (Pleguezuelo 2002, pp. 104 and 91); in fact, this unit was used to calculate not only *tapia* load-bearing walls, but also walls built by other techniques and the surfaces of ceilings and pavements, especially stone pavements; the success of this unit of measure is itself due to the prominence of *tapia* work during the Middle Ages, which continued well into the 16th and 17th centuries.

The cleaning work involving the stripping of wall surfaces (e.g. paint and/or plaster) undertaken during the restoration and rehabilitation processes carried out in some of the more important religious and civil 16th century buildings of the city have shown the use of the *tapial* technique in different types of construction: house-palaces, such as *Miguel de Mañara’s House – Casa de Miguel de Mañara* - or the *Almansa House – Casa de los Almansa* - (Falcón 2003, pp. 33-34), hospitals, such as the *Hospital of the Five Wounds – Hospital de las Cinco LLagas* (VVAA 2003), convents (such as the *Carmen Headquarters, Cuartel del Carmen*, so called because of its change to a military use (Tabales, Pozo and Oliva 2002), and olive-grove estates (*haciendas de olivar*)(Aguilar 1992, pp. 104-106).

The bibliographical references published after these interventions only indicated that they are chained *tapia*, with brick males, and no analyses of material characterization nor measurement of formwork have been carried out; in relation to the olive-grove estates (*haciendas de olivar*), Aguilar has referred to the function of the wall housings as a ventilation system once the formwork has been removed.

The Research and Development Project was organised into diverse interdisciplinary teams aimed at reaching a deeper understanding of Sevillian *tapia* walls. This paper presents the initial findings on these walls from the Modern Age, based principally on the data obtained up to now in one of the most symbolic and representative convents of the city, the Convent of Santa Clara.

This convent was established in the city in the second half of the 13th century when, after King Fernando reconquered *Isbiliya* in November 1248, the lands occupied by the Muslim kings' houses, gardens and palaces were distributed among the royal family, the great nobility and the military and religious orders that had participated in the Reconquest (Lázaro 2002). In fact, the Convent was founded in 1298, adapted a palace previously belonging to Don Fadrique (one of King Fernando's sons) and was further transformed around the start of the 14th century. Over the next few centuries, especially in the 15th and 16th centuries, its initial patrimony and properties were expanded, incorporating Mudéjar (14th century), Gothic (15th century) and Renaissance (16th century) elements.

The Municipal Office of City Planning ordered extensive and expensive restoration and renovation in the convent in order to locate a new project called "The Poets' House"; this has allowed us to analyse some *tapia* walls. Two archaeological interventions have been directed by Dr. Tabales Rodríguez, with whose research team we have collaborated. The first intervention was in 2002-2003 and the second one is currently underway. In the 2002-2003 campaign, we studied walls in three areas of the convent: the Cloister, Prior's Cell and Novitiate area. Once the walls had been cleaned and their pictorial covering removed, we could see that they had been built not only of brick (as had been assumed) but also of *tapia*.

The information is especially interesting for three reasons. First, our discovery of the different building processes found in the convent shows the evolution of the *tapi*al technique in Seville from the Mudéjar period to the Early Renaissance. The convent was located in a former suburb of Almoravid and was built in the 13th century, annexed to Don Fadrique's Palace, which was adapted to be a convent and not razed, as was previously thought. Later, the convent underwent another important transformation when, in the 16th century, it was first enlarged. Secondly, as the walls are well dated, our research group has been able to use the established *tapi*al types in the tables we are putting together to systematise the types corresponding to different historical periods, showing its evolution after the advance and expansion of the technique with the Almoravids, once Seville was reconquered in 1248.

Finally, the extended use of the tapial technique in the convent shows that, during the Middle and the Modern Ages, the main buildings in Seville were not built of brick but tapial, confirming that this technique was not exclusive to military buildings, as has been widely believed until now. It is our intention to demonstrate how this technique was ubiquitous at all levels of construction (even domestic, religious and public buildings) after the Reconquest, and that Christians went on using tapia walls because of their advantages in construction.

However, the tapial technique in the Convent of Santa Clara is important not only due to its widespread use, but also to the qualitative properties of one of the fabric types we have identified in the building. In fact, the second type (an earthy tapia wall, with gravel aggregate, chained in brick in Flemish bond and with a high-module formwork crate, hereafter termed SC2) is one of the best fabrics of the convent. Our affirmation is based not only on visual observation but also on the results of the chemical analyses of material characterisation made by one of the members of the research team, Dr. Alejandro Sánchez, included in the corresponding report, an extract of which has recently been published (Alejandre, Tabales, Graciani and Martín 2004).

In this paper, I will follow the work line we established in a previous publication in the *Proceedings of the First International Congress on Construction History* in which Tabales and Graciani (2002) proposed a typology for tapia walls in the area of Seville during the 11th to 19th centuries. In the *Proceedings*, we based our chronological conclusions on three premises: the compositive one, the dominant aggregate and the module of the mould or crate used. For the first one, we distinguished among *common* or *simple tapia* (when the formwork crates are directly superposed without any vertical elements), *chained tapia* (with brick or stone males), and *mixed fabric tapia* (when formwork crates are separated by a brick course or by a series of courses. For the second one, the dominant aggregate, we established two types of tapia: *gravel tapia* and *ceramic fragment tapia* (made of crushed aggregate). For the third one, the module of the mould or crate, always determined according to height, we distinguished between the short-module tapia (lower than 0.85 m) and the high-module tapia (between 0.85 and 0.95 m). In our work, we also indicated other secondary features, related to boards, formwork needles or pictorial coating and *calicastro* (lime coating).

TAPIA TYPES CHARACTERIZED IN THE CONVENT OF SANTA CLARA

An initial study on the Renaissance tapia fabric of the Convent of Santa Clara is presented, which makes a comparison between it and the previous Mudéjar fabric. This study will likely be enlarged upon as a result of the ongoing archaeological excavation campaign. In fact, in this campaign we have detected two tapia types, both corresponding to well differentiated historical periods. The types dated show basic differences in their components and quality of execution, but not in compositive structure.

The older type (hereafter Santa Clara 1, or SC1), is poorer in quality and dates from the first adaptation of the civic building (Don Fadrique's Palace) to the new religious use, between 1289 and the 15th century. SC1 appears in the Lower Bedrooms (used in summer), the Chapel, the western area of the Cloister, and also in the southern one, specifically in the Novice Cloister (in the *Novitiate Area*), which was outside the noble area of the Palace, corresponding to a new floor (*L-shaped*). Although the main remains are in the western area of the Cloister, where five tapia formwork can be seen, they are very altered; first of all, because in the 16th century (in about 1532) the walls were reinforced with brick in order to build a new upper floor and to open new windows. The tapia walls in the Lower Bedrooms are especially interesting; the total length is more than 90 m and the inner width is 7.40 m, with a height of 6.00 m. The fabric is almost a metre thick, with flat arches; the use of wide walls was common at the time, taking advantage of the thermal insulation that the material offers. Recent restoration processes, as undertaken in the Almansa House (Casa de los Almansa or Casa de Miguel de Mañara) have allowed us to verify the generalized use of thick tapia walls.

Santa Clara 1 is an earthy tapia fabric, with rubble aggregates, chained in brick in Flemish bond and with a short module. The chemical analyses carried out in the Cloister to determine the material components have corroborated the visual estimates, evidencing a very low-quality fabric that is consequently fragile, lacking strength and very poorly executed, and without any lime layering (*calicestrado*).

This is the worst tapia fabric in the Convent and, although its percentage of calcium carbonate is high (22%), it has the most clay of those analysed. This high percentage of clay minerals therefore categorizes it as an earthy tapial. Granulometric analyses show a low level of durability. They also reveal abundant coal, the result of impurities generated during the calcination process in firewood kilns; consequently, black spots are clearly visible in the fabric.

Although it is a chained tapia fabric, the Western Cloister wall has no chain, which in other walls of equal fabric is built of bricks in Flemish bond, alternating stretcher and header bricks of 31 x 15 x 5 cm with lime head joints of 3 cm. The chain is present because the builders made use of the pre-existing brick walls of Don Fadrique's Palace. Later, in the brick chains of the Novitiate Area, two pointed arches with a 3.65 m span were opened, one of which was blinded in the 17th or 18th century.

The formwork crates are separated with lime, converting it into a reinforced rammed-earth wall (*tapia reforzada*), in which lime improves the wall, reducing shrinkage effects, improving joints, and reinforcing weak points. This kind of rammed earth is not new in Seville, as it has already been reported in the Islamic palace of San Clemente (Tabales 1997, pp. 54 and ss.), in diverse parts of the Alcázar, and in the Almohad city wall.

This first type (SC1) is 83 cm high, so that they are short-module tapia. This measurement is not common in the Middle Ages in Seville, when, due to the Almohad influence, it generally ranged from 90 to 94 cm (never exceeding 95 cm, Valor 1991); there are some other samples dated from the 15th century, which have recently been uncovered in Abades Street.

The Cloister walls are quite wide, suggesting that the builders allowed for future galleries in the upper floor. At some points in the cloister walls, the traces of the beam heads can be seen, corresponding to the floor built at the beginning of the 16th century; moreover, it can also be seen that various windows were opened in the fabric at that time.

Santa Clara 1 is very similar to one of the two types we reported from the Mudéjar period in Seville (Graciani and Tabales 2002). On that occasion, we described a type of tapia wall exceptional for its time: a common tapia fabric of minute pea gravel with high superposed formwork crates. This fabric (Mudéjar 1, or M1) can be seen in the *Muro de la Judería*, partially conserved in The San Marcos and Jewish quarters and dating from the beginning of the 14th century. We also described a second Mudéjar wall (Mudéjar 2, or M2) with a chained tapia fabric in brick rubble with high formwork crates on brick courses, corresponding to a type already noted in the Almohad period (*Muralla del Agua*). This Mudéjar 2 type also appears in the Alcázar (in King Don Pedro's Palace and in the Justice Hall (*Sala de la Justicia*), in the Mudéjar churches (San Marcos, Santa Lucía, El Carmen, etc.) and in private homes. Santa Clara 1 is quite similar to Mudéjar 2, although there are some significant differences, which allow us to add a third Mudéjar type (Mudéjar 3, or M3) to the classification we established in 2002: a chained tapia fabric in brick rubble tapia with low formwork crates and without brick courses separating them.

In Santa Clara, a second type (SC2), corresponding to a third building adaptation during the first third of the 16th century, appears in the eastern part of the Cloister, the Refectory and the Upper Bedrooms, used in winter. At the same time, significant renovations took place in the convent as a whole, so that it acquired, basically, the present aspect with all the own elements of a convent community around a cloister of 25 metres per side. For example, the church was built, with a rectangular layout and a single aisle, corresponding to the prototype of an Andalusian convent church, called *de cajón* (*drawer church*).

In the eastern wall of the Cloister, there is a tapia fabric of 10.5 metres length that dates to the beginning of the 16th century. This fabric (SC2) is joined to a coetaneous but secondary brick fabric, both corresponding to the period when the eastern part of the Mudéjar palace was 'razed' (in fact, altered). The wall comprises two tapia formwork crates and wide brick chains, where some windows were later opened.

In the lower part, the original wall was altered in 1532 by adding a Mudéjar ceramic base and, in the 17th or 18th century, by opening the Chapel door, breaking the tapia fabric, opening a window in one of the brick chains and covering the tapia in lime.

The same fabric appears in the Upper Bedrooms and in the Novitiate Area. It is a soil fabric, with gravel aggregate and brick chains, in Flemish bond, and with a high module. The quality of this tapia wall is visibly better than SC1, which is corroborated by the material characterization analysis. It is quite different to the other not only in its composition (quantity of lime, covering, dominant aggregate etc.) but also in the measurements of the brick of the chains and in the formwork crate module.

Chemical analysis indicates this wall contains more lime than SC1, as it has a higher percentage of calcium carbonate (22.0% and 38.8 % respectively), and less sand. In addition, lime nodules are visible to the naked eye, and are confirmed by microscopy. As in the case of Santa Clara 1, gypsum was not even used, as the low quantity of sulphates evidences. The aggregate is smaller and vegetable fibres were also deliberately added (straw, chaff, etc.) to the mixture to reduce shrinkage and plastic cracking when the water from the ramming evaporated, and with the secondary aim of reinforcing the tapia. Its percentage of open porosity, reckoned at 40%, indicates a very porous and low-quality mortar, although definitely of better quality than SC1. Furthermore, in this case, the wall is whitewashed (*calicastro*), considerably improving the quality and durability.

The module of the formwork crates is high in SC2 and they are separated from each other by lime whitewashes with needle housings protected in their upper part by bricks. Although, as with SC1, it is a tapia chained in brick, the pieces comprising the brick males are larger (30 x 14 x 5.5 cm), they are of good consistency and, normally, in Flemish bond, with abundant lime and 3.5 cm joints.

This Santa Clara 2 type is very similar to one of the two types we detected in the Modern Age in Seville (Graciani and Tabales 2002). On that occasion, we also established two types. The first one, a chained tapia fabric in gravel tapia brick and of high formwork crates on brick courses, appeared in the *Hospital de las Cinco Llagas* (1555-1560), with, in this case, two brick courses separating the formwork crates. The second type, a chained tapia fabric in rubble tapia brick and of high formwork crates on brick courses is the most common; in fact, it can be seen in convents and palaces of the 16th and 17th centuries: *Santa María de los Reyes* at the end of the 16th century, in the *Cuartel del Carmen* in the first third of the 17th century, and in Santa María de Jesús. However, there is an evident difference between it and the type we found in the Convent of Santa Clara, in which there are no brick courses separating the formwork crates.

CONCLUSIONS

Santa Clara's Renaissance tapia walls (rammed earth walls) allow us to describe the main characteristics of Sevillian tapia walls at the beginning of the Modern Age, by comparing them with the older tapia walls (from the Mudéjar period) from the same convent. In fact, there are some general characteristics that remain from the Mudéjar period, as both types have the four following generic features in common. The first is the low quantity of lime used and the abundance of clay minerals; in both cases, therefore, the tapia is earthy. Although such a composition was common in

the rest of Spain, it had not been usual, to that date, in Seville, since Islamic tapias had been characterised by the opposite quality - a high quantity of lime in its composition which gave it its resistance and characteristic compactness.

The second characteristic of both tapia walls is a high percentage of open porosity, indicating very porous and low-quality mortars; so much so that in one of the samples taken, because of the fragility of the mixture, the open porosity factor was impossible to measure, while in the other it reaches as high as 48%.

A third feature they have in common is that they are chained tapia walls, a type that appears in Seville's buildings from the Almohad period. Commonly in the Mudéjar period, the males of the chain are of brick, though some size differences can be seen in the chain pieces. Some chains were built with bricks in running bond and others in Flemish bond. In tapia chained walls, brick males are also used to reinforce the corners and to define the openings. Brick males contribute to fabric strength, although, as noted above, they are also employed in corners to protect the walls and surrounding openings. These reinforcements allow each wall to comprise, usually, six tapia formwork crates (*adobones*, as they are currently called); note the height of the tapia walls of the Bedrooms in the Convent of Santa Clara and the façade of the Almansa House. In the Hospital de las Cinco Llagas, concretely in the Patios de la Fuente y del Cardenal, there are eight formwork crates (Tabales et al. 2003, 38).

Finally, none of these walls were built on a basement. In fact, bases are not very common in Seville, where a brick basement has been found only twice, in the wall of the Jewish quarter, dated to the 14th century, in a well-executed Flemish bond (Tabales 2002, 185); and, more recently, in the *Hospital de las Cinco Llagas*, in the *Patios del Cardenal y de la Fuente* (1559-1569), where the basement was 1.5 m high (Tabales, Oliva, Jiménez and Huarte 2003, 38).

Despite the evident similarities between Santa Clara 1 and 2, there are also qualitative differences that are visually discernible which are also corroborated with chemical analysis of the materials. Five different aspects are observed, although the quality index is, in great measure, inter-dependent for the first four.

1. The proportion of lime. Although in both cases the quantity of lime is low, it is evidently greater in the 16th century tapia, in which lime nodules can be seen with the naked eye.
2. The dimension of the aggregate. In SC1, the aggregate is ceramic rubble and in SC2 it is a pea gravel aggregate. The use of the rubble, in addition to other reasons, is the reason for the greater fragility of SC1.

3. The presence of the *calicastro*. Although SC1, the earliest sample, was not covered in lime, SC2 was, so its fabric is reinforced.
4. The care taken in making the mixture. Little care was taken in the first tapia wall, SC1, as evidenced by the abundance of coal impurities generated during calcination. In contrast, the presence of plant materials in the 16th century SC2 wall, the protective brick in the upper part of the needle housings and the separation of the formwork crates by lime whitewashes imply a greater care on the part of the builders.
5. The module of the formwork crate. Santa Clara 1 was built with a low or short module (83 cm), an uncommon measurement in Seville. Nevertheless, SC2, corresponding to the 16th century, is a high-module type (94 cm), following the common tendency in the city due to the Almohad and Mudéjar influences.

The Convent's Renaissance tapia walls show that they correspond to an early Modern Age. This can be affirmed not only because we know the date of construction but also from the compositive characteristics. Thus, in this case we have not detected brick courses separating the formwork crates, while we know that in the middle of the 16th century two brick courses for separation are quite common; they increase from two to three from the 16th century to the 18th century. However, brick courses have already been found in Sevillian buildings dated in the 14th century, such as the Palacio de los Marqueses de Marchelina and the Mudéjar churches (Tabales 2002, p.183).

Furthermore, the abundance of lime apparent in Santa Clara's Renaissance tapia walls can also be noted in tapia walls built by Hernán Ruiz in the *Hospital of the Five Wounds (Hospital de las Cinco Llagas)* in the middle of the 16th century.

BIBLIOGRAPHY

Aguilar, M C, 1992. *Las Haciendas. Arquitectura Culta en el Olivar de Sevilla* Universidad de Sevilla, pp. 104-106.

Alejandro, F J, Tabales, M A, Graciani, A and Martín, J J, 2004. "El Real Monasterio de Santa Clara de Sevilla (España): estudio analítico de los Tapias, morteros y ladrillos utilizados en diversas etapas constructivas". *Actas del VII Congreso Internacional de Rehabilitación del Patrimonio Arquitectónico y Edificación*. Congreso Internacional de Rehabilitación del Patrimonio Arquitectónico y Edificación. Num. 7. Lanzarote, Canaria Islands, Spain. Centro Internacional para la Conservación del Patrimonio. Cicop-Spain.

Covarrubias, S, 1611. *Tesoro de la lengua Castellana o Española. Según la impresión de 1611, con las adiciones de Benito Remigio Noydens, publicada en 1674*. Martín de Riquer, ed.. Barcelona, Edit. Alta Fulla, 1987.

Falcón, T, 2003. *El Palacio de las Dueñas y las casas-palacio sevillanas del siglo XVI*. Colegio Oficial de Aparejadores y Arquitectos Técnicos de Sevilla, pp. 33-34.

Graciani, A, 2001. *Fábricas islámicas en el Alcázar de Sevilla. Memoria Arqueológica de la Segunda Campaña (2001) de investigaciones en el Alcázar de Sevilla* (inédita).

Graciani, A, Tabales, M A, Alejandro, F J, Barrios, A, García, R and Ponce, 2005. "Review of the analyses of the tapia construction in the Islamic City Wall of Seville" *Proceedings of the I Meeting of Construction Research (Actas de las Primeras Jornadas de Investigación en Construcción)*. Instituto Eduardo Torroja de la Construcción, CSIC. Madrid, pp. 213-222.

Graciani, A y Tabales, M A, 2005. "On the Construction Techniques of the Almohad City Wall of Seville (Spain)". *Proceedings of the International Seminar Theory and practice of construction: Knowledge, means, models. Didactic and research experiences*. Ravenna (Italy), Ed. Moderna, vol. 4, pp. 1559-1567.

Lázaro, F, 2002. "El Monasterio de Santa Clara (1). Su origen y evolución arquitectónica". *Revista Aparejadores*, Colegio Oficial de Aparejadores y Arquitectos Técnicos de Sevilla, núm. 64, December 2002, pp. 16-31.

López, F, 1997. "Tapias y Tapiales". *Logia* núm. 8, pp. 74-89.

Tabales, M A, (dir. y coord.), 1997. *El Real Monasterio de San Clemente. Una propuesta arqueológica*. University of Seville, Fundación El Monte. Seville (Spain).

Tabales, M A, 2000. "Algunas reflexiones sobre fábricas y cimentaciones sevillanas en el periodo islámico". *Actas del II Congreso Nacional de Historia de la Construcción*. Sevilla, 2000. Sociedad Nacional de Historia de la Construcción, Instituto Juan de Herrera, E.T.S.A., Universidad Politécnica de Madrid, CEHOPU, II, pp. 1077-1089.

Tabales, M A, 2001. "Las murallas del Alcázar de Sevilla. Investigaciones arqueológicas en los recintos islámicos". *Journal Apuntes del Alcázar*, Patronato del Real Alcázar, Seville (Spain), núm. 2, pp. 7-35.

Tabales, M A, 2002. *Sistemas de análisis arqueológico de edificios históricos*. Universidad de Sevilla, Secretariado de Publicaciones. Instituto Universitario de Ciencias de la Construcción. Seville (Spain).

Tabales, M A, Pozo, F and Oliva, D, 2002. *Análisis Arqueológico. El Cuartel del Carmen de Sevilla*. Monografías Arqueología, núm. 4. Junta de Andalucía, Consejería de Cultura. Seville (Spain).

Tabales, M A, Oliva, P, Jiménez, P and Huarte, R, 2003. “La intervención arqueológica. Análisis murario”, *Arqueología y Rehabilitación en el Parlamento de Andalucía. Investigaciones Arqueológicas en el Antiguo Hospital de las Cinco Llagas de Sevilla*. Secretaría General del Parlamento de Andalucía, Seville (Spain).

Pleguezuelo, A, 2002. *Arquitectura y Construcción en Sevilla (1590-1630)*. Excmo. Ayuntamiento de Sevilla. Seville (Spain).

Ramírez de Arellano, A, Enríquez, E, 2001. *Tapiales de los Reales Alcázares de Sevilla*. Memoria Arqueológica de la Segunda Campaña (2001) de Investigaciones en el Alcázar de Sevilla. Seville (Spain).

Valor, M, 1991. *La arquitectura militar y palatina en la Sevilla almohade*. Sevilla. Diputación Provincial. Seville (Spain).

VVAA, 2003. *Arqueología y Rehabilitación en el Parlamento de Andalucía. Investigaciones Arqueológicas en el Antiguo Hospital de las Cinco Llagas de Sevilla*. Secretaría General del Parlamento de Andalucía, Seville (Spain).

