

## **KNOWLEDGE OF TRADITIONAL BUILDING METHODS TO SAFEGUARD AND PRESERVE THEM. EVOLUTION OF MASONRY TECHNIQUES IN VALENCIA CITY**

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### **Foreword**

This study of brick fabrics and the finishing techniques used on them especially in the 16<sup>th</sup> and 18<sup>th</sup> centuries in the city of Valencia is based on the direct examination of some twenty buildings in the historic centre and the perusal of the available historical documentation about regulations for the production, control and sale of ceramic material and its use in building as an indirect source of information. A detailed comparative analysis of both revealed interesting aspects previously unknown, particularly regarding the building methods used to finish and decorate the surfaces. The conclusions of this general study about local techniques were then put into practice in the detailed study and ensuing project for the restoration of three residential buildings of different types, namely the Palacio del Marqués de Caro, the palace in Calle Exarchs and Casa Raga, described in detail below.

### **Cultural context**

The use of brick in Valencia has been documented since the city was founded around the 1<sup>st</sup> century B.C. However, thanks to specialised labour and the system of fluvial transport, the principal building material that characterised the settlement in olden times is calcarenite stone (Martí 1999).

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In the High Middle Ages, the city underwent a period of economic decadence and a progressive decline in techniques and building as a result of the fall of the Roman Empire. This circumstance also affected the choice of building materials and techniques, and inexpensive, simple, autochthonous solutions were sought. In fact, after the Islamic conquest of the Iberian peninsula in 711 A.D., Muslim architecture in the city was characterised by two types of building solutions (Martí & Pascual 1995): on the one hand, the plunder and retrieval of materials taken from Roman buildings, and, on the other, the progressive use of pisé-de-terre, that is, walls made of unfired rammed earth. Nevertheless, brick began to be used to the same extent from the Almohad period in the 12<sup>th</sup> century, especially for pavements and interior partition walls.

In the years that followed the Christian Reconquista (1238), the city was divided between Christian and Islamic cultures. This mixed presence of cultures implied miscellany both in constructive techniques and the choice of finish. In this period the method of brick fabric was consolidated. In this case it is interesting to note how pisé-de-terre walls began to be reinforced with rows of bricks, whose sides appear slightly sunken in the earth surface. This hybrid between rammed earth and brick became more popular in the city especially from the 16<sup>th</sup> and 17<sup>th</sup> centuries onwards, for several reasons (Barceló 2000): the fact that the Counterreformation required churches to be built fast with plain materials, the dwindling of expert stonemasons and the impoverishment of the city because of the shift of trade from the Mediterranean to the Atlantic. This climate of financial dearth and decadence led to a radical simplification in building techniques and favoured the predominant use of brick, which went from being a secondary or auxiliary element in traditional walls to occupy a leading role in building because it was practical and economical, gave a satisfactory result and boasted good mechanical properties.

### **The brick fabric building method**

The brick fabric building method used in the centre of Valencia is especially interesting because of the variety of building solutions and the many years it was employed in the building history of the city. For this reason, a detailed study of brick fabrics was performed on religious and civil monumental buildings in the historic centre of the city (See Figure 1) in order to find out more about the technique and, at the same time, to date any evolution or change. The data obtained in the study of twenty-one cases provided some ideas about brick production in Valencia and the bonding methods used. Observations were made particularly about the relationship between the colour and the thickness of the bricks, between the colour and the finish, between the characteristics of the joints and the thickness of the bricks and between the characteristics of the joints and the finish.

As regards the first point, the connection between the colour and thickness of the bricks, it is clear that thinner bricks are also paler in shade, yellowish rather than the traditional red colour. This is important because it indicates that they were fired at lower temperatures and, at the same time, it reveals a low clay and a high lime content. These light-coloured bricks have more discreet resistant and mechanical properties than darker bricks, are less porous that are better fired and made of higher-quality raw material. In the second place, the

relationship between the colour and the finish implies that these characteristics, typical of paler, thinner bricks, denote in building terms a choice of finishing treatments intended to protect the wall. Thus the walls are covered with a layer of rendering applied in three successive coats, the bricks are not top quality and the joints are especially thick.



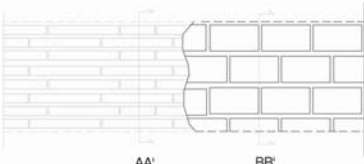


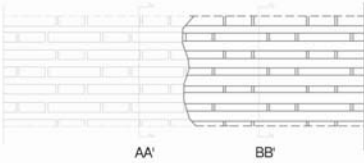


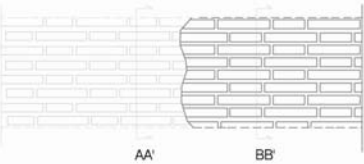


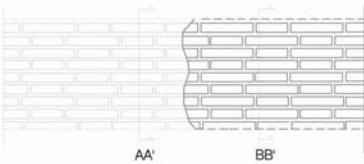
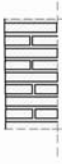

**Figure 1.** Situation of the examined buildings during the research. The three buildings detailed in this paper appear in blue

In the third place, in the different cases studied, the relationship between the joints and the thickness of the bricks reveal an inverse proportionality between the thickness of the brick and the thickness of the mortar joint. Another rather curious fact is the proportion between the horizontal and vertical joints. In all the samples studied, the vertical joints are always finer than the horizontal. Besides, after the 18<sup>th</sup> century, the thickness of the bricks increased progressively and the section of the vertical joints decreased proportionately at the same time.

Finally, concerning the relationship between the characteristics of the joints and the finish, it has been observed that the presence of a fairly thick horizontal joint (40-52 mm) implies two different finishes: either the sealing of the joints or the lime rendering of the whole wall. On

the other hand, a thinner horizontal joint (20-37 mm) is usually linked to other types of techniques: either the application a light wash of ochre glaze or a bare brick finish. The sealing of the joints (or *agramilado*, S.A. 1999) is used for bricks of average thickness (32-41 mm), thick horizontal joints (40-52 mm) of aerial lime mortar and inert materials with rather large granulometry and medium vertical joints (20-29 mm) (See Figure 2). This process is not only due to the aesthetic objective of regularising the fabric, but is used for functional purposes also. In fact, the final result, thanks to its finish on the same level as the outer edge of the brick, contributes to protect and conserve the wall.

## MASONRIES PATTERNS IN VALENCIA CITY CENTRE

Pattern's definition	Century	front view of the masonry	section AA'	section BB'
<p>"ENLUCIDO"</p> <p>XV- first part of XVI Century</p> <p>The plastered masonries are the ones that have bricks lines with big horizontal joints (25-48mm) but with very thin vertical joints (5-17mm). In this case the render it's quite with a honey-ochre tone, on purpose to seem a limestone's worked surface. The bricks' thickness is 32-42 mm.</p>				
<p>"AGRAMILADO"</p> <p>Second part of XVI- XVII Century</p> <p>This technique is used in presence of squat and dark bricks, (thickness of 32-41mm). with wide horizontal joints (40-52 mm), thick vertical unions (20-29mm). This method needs a filling of the huge space between the bricks, not merely for aesthetic reasons but especially for the protection of the bricks' outlines and edge.</p>				
<p>"FINGIDO"</p> <p>XVIII Century</p> <p>This technique uses a special treatment for masonries with medium-size joints (30-7mm), and quite thick bricks (40-45 mm). This coating is by a painted pattern of sham bricks, more regular and shaped than the real bricks. Besides regulations treatment concerns also the frame of the joints that is more geometrical, and clearer.</p>				
<p>"CARA A VISTA"</p> <p>XIX Century</p> <p>This technique is based on well fired bricks, that are able not to be plastered. They're well cooked, brown and the masonry only needs a veil/coat of light lime's diluted mortar. The vertical joints are between 15-22 mm, in spite of the horizontal that is from 22 to 34mm. The thickness is around 40mm.</p>				





Sealing is performed after the bonding of the wall but during the building work, and consists of a lime mortar filling called specifically *zaboyado* (S.A. 1999) in the joints to level them with the exterior surface, leaving them perfectly flat and smooth.

The importance of this building method called *agramilado* that seals the joints resides precisely in that it reduces the number of bricks used in the masonry. In fact, the joint is practically the same thickness as a complete row of bricks. Analyses with an optic microscope revealed a first layer of lime mortar with quartz sand in a 1:1 proportion (quartz 47%, lime 46%). A small amount of gypsum and feldspar was also detected.



**Figure 2.** Communion Chapel of the Church de Santos Juanes (1644). Detail of *agramilado* method that shows the first layer of the joint and rests of the sealing second layer called *zaboyado*.

It is a semi-opaque treatment with lime and red ochre, a pigment with an iron oxide base that can be painted over in order to regularise the joints with geometrical precision. This method is used in the case of fabrics with medium horizontal joints (30-37 mm), slightly thinner vertical joints (20-25 mm) and rather thick bricks (40-45 mm). It is interesting to note that this technical solution, linked to academicist cultural trends in the second half of the 18<sup>th</sup> century, arrived on the scene after the *agramilado* method. This method enriches the range of possible opaque treatments of walls, thus improving and completing the stereometry and uniformity of the surfaces.

The presence of gypsum helped accelerate the carbonation process and the feldspar appeared as a result of the precipitation of alum, a type of potassium sulphate used as a consolidant of the mixture. On the other hand, the second layer called *zaboyado* has a simpler composition, without complex minerals, made up only of lime and aggregates in 1:1 proportion (lime 57%, quartz 43%).

Another extremely interesting technique in the characterisation of Valencian building methods is the fake brick wash or *tingido de ladrillo* (See Figure 3). It is a finish that covers less than a simple layer of rendering.



**Figure 3.** Aduana Palace- 1758-70. Detail of the original fake brick wash and the recent restoration (1996-1997)

## Three instances of the building techniques used in Valencia

### ***A building that has expended over the years: the Palacio del Marqués de Caro***

The Palacio del Marqués de Caro is situated in one of the most emblematic sites in the historic centre of Valencia: the Seu-Xerea district, the residence of rich Valencian families in olden times, inside the old walled Roman city. The beautiful late 19<sup>th</sup> century facade with the family crest on the corner of the palace gives on to the main street. In spite of the fact that it looks like a late 19<sup>th</sup> century palace, the entrails of this noble dwelling conceal a long history that reflects all the stages of Valencia's history from the time of the Roman city until the present day, not forgetting the Islamic Conquest, the occupation by the troops of the Christian king Jaime I and its expansion in the Baroque and Neo-Classical periods. In fact, during the preliminary study performed by the authors of this text for the restoration of the palace (Mileto & Vegas 2005, 2), underneath the 19<sup>th</sup> century rendering of the exterior and interior of the building, a great many different fabrics were identified corresponding to the numerous refurbishment works carried out on the house. After carrying out a meticulous descriptive survey, the spots where the discontinuity of the fabrics lay were identified (See Figure 4): the presence of geometric irregularities (variation in the thickness of the wall and variation of direction), corners between walls, the presence of vertical or semi-vertical cracks not related to structural pathologies, etc.

Tests were performed in all these places to discover the different building methods used, and this information was filed in over 170 cards describing types of fabric.

Furthermore, the probes were carried out at the points of contact between the different building methods in order to perform a series of stratigraphic observations to establish the chronological order of the fabrics.

The study of the palace, a veritable catalogue of historic Valencian fabrics, provided first-hand knowledge of all these techniques. The methods found can be summed up in five major types, some of which have an amazing number of subtypes: lime-coated pisé-de-terre, brick-reinforced pisé-de-terre, ashlar fabric, masonry fabric and brick fabric.

In the case of *lime-coated clay pisé-de-terre*, there are three different types: pisé-de-terre that still bears the original lime finish with a smooth surface produced by the moulding; pisé-de-terre without its surface finish, showing only the clay nucleus with thin layers of lime; and lime and gravel pisé-de-terre poured in some areas to reinforce or level the existing wall. This



**Figure 4.** Marqués de Caro Palace. Layout of the ground floor with the type of fabrics found shown in different colours

technique can be seen in the remains of the Islamic wall to which the first building was attached between the 15<sup>th</sup> and 16<sup>th</sup> centuries and which was expanded on successive occasions until it reached its current configuration.

There are two main types of brick-reinforced pisé-de-terre techniques: the first, probably dating from the 15<sup>th</sup> or 16<sup>th</sup> centuries, with a very fine-grained surface crust that denotes a painstaking surface finish to be left naked (See Figure 5); and the second, perhaps an imitation of the first made in an extension of the building carried out in the early 19<sup>th</sup> century, with a very thick-grained surface crust probably not intended to be left bare, or for less important areas of the palace.

There are few examples of *ashlar fabric*, which is only to be found in the two large arches on the ground floor of the house (See Figure 6), and *masonry fabric*, also only present on the ground floor and often used as a socle to place brick fabrics on top, to prevent the capillary action of rising damp.

The greatest variation is found in *brick fabric*, especially in the type of mortar used: aerial lime, hydraulic lime; lime and clay (different colours, depending on the proportions of adhesive and aggregate); lime and stone; lime, clay and stone; lime and gypsum; mud and straw; cement; cement and lime. There is also a very large variety of bricks, according to colour (yellow, orange, red, brown) and dimensions (from 13,5 x 15 x 3,5 to 24 x 12 x 4).



**Figure 5.** Detail of brick-reinforced pisé-de-terre techniques



**Figure 6.** Ashlar arch subsequently filled with brick fabric

In the Palacio del Marqués de Caro these brick fabrics cover a broad range of time that goes from the 16<sup>th</sup> to the 19<sup>th</sup> century, and this is the technique that has had the best survival rate over the centuries. However, the differences in the size of the bricks (Altarriba et al. 2002), their colour, the mortars used, the thickness of the joints and the surface finish provide interesting clues as to its chronology: from the oldest examples with very thick mortar and stone joints often as thick as a brick, direct descendants of brick-reinforced pisé-de-terre, to the more recent fabrics with smaller-sized bricks and lime and fine sand mortar to be rendered with a lime coating, not forgetting brick fabrics with finer and finer joints, bonded with mortars that evolve from a small amount of lime and a lot of clay for *zaboyado* treatments to a greater and greater lime content that required a lime finish.



### ***Buildings that made time stand still: the palaces in Calle Exarchs***

Another very interesting case to help understand the building methods used in Valencian brick fabrics is the palaces located in Calle Exarchs (See Figure 7). There is a row of noble palaces probably erected between the 15<sup>th</sup> and 16<sup>th</sup> centuries (Simó 1983) but transformed in the 18<sup>th</sup> century. By pure chance, these buildings were spared from demolition in the mid 20<sup>th</sup> century when the new course of the Avenida Barón de Cárcer was to go right over the place where these buildings stood. However, these demolitions stopped just before reaching these palaces, thus saving one of the few precious samples we have of 18<sup>th</sup> century Valencian architecture.



**Figure 7.** Rear facade of the Calle Exarchs palaces

The row of houses is formed by four palaces, of which only the first three, located respectively at numbers 3, 5 and 7, occupy the whole depth of the site with their main facade looking on to Calle Exarchs and their back facade giving on to Calle Belluga. These three buildings represent a real jewel in the architecture in the historic centre of Valencia between the 15<sup>th</sup> and 18<sup>th</sup> centuries, although ignorance of their existence has reduced them to a shameful state of neglect and disrepair.

The three buildings, made principally of brick fabric –some traces of brick-reinforced pisé-de-terre can still be seen at the top of the common wall of the palace at number 5– conserve on their facades some rare samples of the finish usually given to facades in the 18<sup>th</sup> century. In the case of the palaces situated at numbers 5 and 7 of Calle Exarchs, the original rendering is still conserved on the main facade (See Figure 8): a continuous lime coating with *false ashlar* where the edge of the joints are decorated with sgraffito and the joint bears a white wash to make it stand out against the yellow imitation-stone background.



**Figure 8.** Detail of the treatment of *false ashlars* on the palace main facade

The window bays are surrounded by white frames, whose edges are also decorated with sgraffito and which imitate the jambs, lintels and sills of the windows. This type of treatment



was obviously used to dignify the main facade of the palace. The back facades of this row of palaces clearly show the intention of creating a distinction between the front and back facades. The palace situated at Calle Exarchs number 3 has the best-conserved back facade with a *fake brick wash* treatment, one of the best-conserved examples of this sort of facade in the city (See Figure 9).

The fake brick wash technique is applied to facades to cover up brick fabric when it is not sufficiently regular. This method represents regular bonding by scratching the edge of the joint between bricks and colouring the joint with whitewash and the bricks with red ochre. In spite of the passage of time, the palace facade still conserves the characteristic chromatic contrast of this treatment, which was not only used to embellish the building but to protect the fabric, often made of poor-quality brick.



**Figure 9.** Detail of the *fake brick wash* treatment on the palace rear facade

The back facades of the other two buildings are made of naked brick fabric. The two facades probably had a surface finish, either *zaboyado* or *fake brick wash*, covering the many interventions that left their mark during the 18<sup>th</sup> century works. Besides, the brick fabric, with a weak lime mortar the same thickness as the brick, was primed to receive a protective coat.

### ***The traces of a city's history on the facades of its traditional buildings: Casa Raga***

The surface of architecture is the only visible part and therefore constitutes a vehicle for conveying historical, cultural, perceptive, sensitive and other messages. Whereas the finish of architecture is in many cases considered replaceable in monumental architecture, it is systematically replaced in the case of *minor architecture*. In the old centre of Valencia city the historic finishes of the buildings have almost completely vanished; for reasons of functionality, adaptation and embellishment, they have been renovated without performing any prior type of morphological, material documentation, not to mention stratigraphic studies.

In Casa Raga, located in the Plaza del Pilar in the Velluters district in Valencia (See Figure 10), the authors of this text had the opportunity to study and draw up a restoration project (Mileto, Vegas & Calabuig 2005) for a building that still boasts historic finishes on its exterior facades, which have not been eliminated in spite of refurbishment works. It is a building in the very heart of the city, first built in the end of 17<sup>th</sup> century and later expanded and altered in two interventions performed in the mid 19<sup>th</sup> and early 20<sup>th</sup> centuries.

Both the first construction of the building and the posterior expansion and refurbishment works were made with traditional local methods. The apparently homogeneous brick walls of the building have recorded all the interventions practiced over the years. The building

technique used initially was a load-bearing brick wall with lime mortar joints. The finish of the surface was made by covering the joint with a finer lime mortar to protect the structural joint and painting the bricks with red ochre to augment the red colour of the brick (See Figure 11).



**Figure 10.** Raga House in the Plaza del Pilar of Valencia

This finish typical of 17<sup>th</sup> and 18<sup>th</sup> century Valencian architecture, is conserved on most of the facade giving on to the square and the corner of Calle Roger de Flor. The building was restored in the mid 19<sup>th</sup> century. A new part was added on the side looking on to Calle Roger de Flor and the interior layout was changed, which involved opening some new bays in the facades.

The surface of the facade conserves the traces of this intervention. The fabric was rebuilt around the altered or added bays imitating the original fabric (See Figure 12): the same brick was maintained in an attempt to respect the original rows, but the fabric can easily be distinguished because of the gypsum mortar used.

At the beginning of the 20<sup>th</sup> century, during other refurbishment works on the interior, new bays were opened in the main facade and the whole facade was painted a uniform yellow colour covering the old finish, the 19<sup>th</sup> century fake brick wash and the new mortar of the last intervention. So in an apparently homogeneous, anonymous facade we can see three refurbishment works that provide interesting data regarding the building history of the end of 17<sup>th</sup> century surface finishes, the attempt to maintain them and integrate them in the 19<sup>th</sup> century and the attempt to homogenise them in the early 20<sup>th</sup> century.



**Figure 11.** Detail of the facades' original treatment



**Figure 12.** Imitation of the original treatment made during the intervention of 19<sup>th</sup> century

## **The conservation of built memory: the conservation and preservation project for Casa Raga**

While preparing the restoration project for the building situated in Plaza del Pilar in the Velluters district we had occasion to reflect about the importance of conserving the materiality of this architecture and fabrics that constitute an important document about the city's building history. The restoration project drawn up covers the whole ensemble of the building from the facades to the framework, the roof, woodwork, flooring, etc.

However, in this text it is especially interesting to concentrate on the restoration of the facade, since it represents one of the few examples of 17<sup>th</sup> century finishes still intact. In the project (Mileto, Vegas & Calabuig 2005), great pains were taken to reach a compromise between the requirements for the material conservation of the surfaces (with phenomena of gaps in the original brick joints and the opaque mortars covering the lintels added in the 20<sup>th</sup> century and erosion in the gypsum joints imitating the original surface) and decorum and the intention of conserving the materiality as a historical document (about the interventions carried out and the building methods used during the different stages, social and cultural aspirations, etc.) and as an expression of memory (one of the few buildings in the centre of Valencia that still conserves the old finishes) and the passage of time (the building is perceived as old and not rebuilt or copied thanks to the manifestations of aging in its materiality and the possibility of identifying the signs of the interventions practised on it).

The project proposes, therefore, to remove the thin layer of shabby, irregular yellow paint that makes the building look even more decadent, to consolidate the existing joints (by sticking back the old joints of lime mortar that have come loose), to fill in the missing joints only where the lack of material compromises the conservation of the wall. The possibility of filling in the missing parts of the joints without covering up the old ones makes it possible, on the one hand, to keep the signs of the different interventions on the building visible and, on the other, to maintain the texture of the eroded joint as a component of the building's expressiveness. In order to verify the viability of the project a series of restoration tests were carried out. In the first place, the firmness of the mortar joints was tested by means of the application of two different fluids: lime wash and ethyl silicate. In the first case, in order to achieve a satisfactory degree of consolidation, the lime wash was applied by spraying the whole surface once a day to make it penetrate and carbonate to the greatest depth possible. In general, depending on the type of mortar to be consolidated, at least twenty, thirty or forty successive coats of this kind of treatment should be applied. In the case of a mortar with a large percentage of lime, as in the case under study, twenty coats were enough, whereas in other cases (Mileto & Vegas 2005, 1), where the mortar had a much lower lime content and a much higher clay content, it was considered necessary to apply at least forty coats of lime wash. In the second case, consolidation was performed with a 50% solution of ethyl silicate applied in several successive coats, between five and ten at the outside, depending on the proportion of lime in the mortar. In this case five coats of ethyl silicate were applied to ensure a satisfactory degree of consolidation.

If we compare the two consolidation treatments, the application of lime wash is no doubt more compatible with the lime mortar present in the fabric, but the drawback is the number of



applications required (as many as forty) in order to achieve a suitable consolidation level. However, the application of ethyl silicate provides the same degree of consolidation with only five coats of the product, which involves a shorter intervention time and a saving in labour costs, although the product darkens the natural colour of the surface.

In the case of the restoration project for the facade of Casa Raga in Plaza del Pilar, the faster and more efficacious method of ethyl silicate consolidation was chosen after weighing up the advantages and disadvantages of both treatments.

Another type of essay consisted of a selective rejoining of the fabric. The loss of material in the joints of a brick fabric is inconvenient for its conservation because it lets water seep in and freezing and thawing can damage the fabric. Nevertheless, complete rejoining of the fabric, as we said above, endangers its conservation as a historical document and a source of messages. Therefore in this and other cases (Mileto & Vegas 2005, 1; Mileto & Vegas 2006), selective rejoining was carried out on the places where material was missing without covering the existing joints (See Figure 13 and 14). This way of mending the fabric entails a satisfactory level of consolidation and protection and ensures the decorum of the facade conserving, at the same time, the conservation of the building's character and entity as a historic document.



**Figure 13.** Selective rejoining made only in the vertical joints



**Figure 14.** Application of a selective rejoining

## Conclusions

The study of building techniques for brick fabric in the historic centre of the city of Valencia constitutes an important database about the building methods used in the city during the period under study and its development has made it possible to draw up an protocol analysis of brick fabric as a preliminary step in the application of a restoration process where the diverse variants suitable for each case help preserve and maintain this precious legacy of material culture that had previously gone unnoticed. Furthermore, the study has contributed to throw some light on the extraordinary richness of these fabrics, found not only in the city's important monumental buildings but also in more or less luxurious residential constructions.

Studying these documents of constructed memory in detail, making them known and demonstrating the possibility of conserving them is a step forward in the difficult process of conserving the as yet poorly celebrated culture concerning our built heritage.

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