Luciana da Silva Florenzano

Renata Hermanny de Almeida

Rômulo Simões Angélica

Architecture, matter, and historiography: interfaces between technological investigation and historical research based on ceramic bricks in the city of Santa Leopoldina [ES]

Abstract

Considering the potential of building materials as a tool for historiography, this article analyzes ceramic bricks in the constructive system of the buildings at the Santa Leopoldina Historical Site in the State of Espírito Santo - protected at the state level in 1983. Beyond the need for documentation of traditional Brazilian construction systems and the indispensability of technical support for intervention in the constructed heritage, we address the importance of technological research in understanding the building process. The adopted criteria are based on a physical and mineralogical analysis of a sample group as well as an interpretation of this analysis, considering the historicity of architecture as a knowledge tool for society. As a theoretical foundation, there is a need to understand the raw materials used in the bricks, as well as the typical methods employed in the 19th century for their production. Methodologically, the analysis involves laboratory tests for the physical and mineralogical characterization of the bricks. The results were correlated with the historical research on the production of ceramic bricks in Vitória, capital of Espírito Santo, between the 19th and early 20th centuries, and include considerations regarding the manufacture of ceramic bricks in Santa Leopoldina, helping to understand the constructive methods used by non-Lusitanian European immigrants who colonized the interior of the state from the second half of the 19th century onwards.

Keywords

Ceramic brick. Historical site. Santa Leopoldina-ES.

doi: http://dx.doi.org/10.11606/issn.2317-2762.v24i44p148-163

arquitetura, matéria e historiografia:
interfaces entre investigação tecnológica e pesquisa histórica, a partir de tijolos cerâmicos em santa leopoldina [es]

Resumo

Considerando a potencialidade do material construtivo como ferramenta para a historiografia, este artigo consiste em análise de tijolos cerâmicos presentes no sistema construtivo de edificações do Sítio Histórico de Santa Leopoldina, no Estado do Espírito Santo, Brasil, protegido em esfera estadual em 1983. Para além da necessidade de documentação dos sistemas construtivos tradicionais brasileiros e da imprescindibilidade de subsídios técnicos para intervenção no patrimônio edificado, aborda-se a importância da investigação tecnológica para compreensão do processo construtivo da edificação. O critério adotado parte da análise física e mineralógica de um grupo amostral e da interpretação desta análise, admitindo a historicidade da arquitetura como ferramenta de conhecimento da sociedade. Para fundamentação teórica, busca-se o conhecimento da matéria prima do objeto de estudo, bem como os métodos típicos empregados no século XIX, para a produção de tijolos cerâmicos. Metodologicamente, a análise compreende a realização de ensaios laboratoriais para caracterização física e mineralógica dos tijolos, cujos resultados são correlacionados à pesquisa histórica da produção de tijolo cerâmico em Vitória, capital do Estado, entre o século XIX e o início do século XX. O resultado consiste em considerações acerca da fabricação dos tijolos cerâmicos em Santa Leopoldina e contribui para a compreensão dos métodos construtivos utilizados pelos imigrantes europeus não lusitanos que, ao chegarem ao Brasil, a partir da segunda metade do século XIX, colonizam o interior do Espírito Santo.

Palavras-chave

Tijolo cerâmico. Sítio histórico. Santa Leopoldina-ES.

Introduction

Documentation of architectural and urban heritage is, above all, a technical and scientific study directed at the elaboration of methodological support and instruments of representation and intervention in a preexisting structure. However, knowledge of the constructed heritage is important not only for the preservation of the architectural and urban materiality and consequent artistic and technical value, but for acknowledging its historical dimension and the value of historical buildings in the preservation of memory. Oliveira (2005, p. 3) emphasizes this need:

> *To seek the constructive procedures and techniques of the past, besides recovering the memory of the "deed", allows a deeper knowledge of the constructive collection that has been left to us, so that we can better intervene in its conservation [...].*

According to Weimer (2005), until the last decades of the 20th century, the study of Brazilian constructive techniques focused on the analysis of erudite and monumental architecture, usually built with stone as its constructive system. Obviously, such studies do not cover the extent of the subject, since there have been several constructive methods used in Brazil since the 19th century, time period when construction methods and materials broadened due to the opening of the ports and the abolition of the slave trade.

One of the effects of the abolition of the slave trade and its closeness to the abolition of slavery is massive immigration to the Brazilian territory. In the state of Espírito Santo, the immigrants that arrived in the mid-nineteenth century are responsible for the occupation of the first urban centers in non-coastal regions. The city of Santa Leopoldina was the first hub of the central highland region, and was initially occupied by Swiss and German immigrants; it later became the central economic hub of the state of Espírito Santo, based on the production and commercialization of coffee. Through their monopoly control of coffee distribution from the central highland region to the capital, Vitória, the immigrants thrived and built an architecture using ceramic brick as the main constructive element of self-supporting masonry.

This architectural production is characterized by the Santa Leopoldina Historical Site, recognized as cultural heritage and registered by the State Council of Culture in 1983. The preserved buildings are remnants of the architecture built according to the technical-constructive know-how of European immigrants from other regions of Europe, in contrast to the technical-constructive knowledge applied in the construction of the state capital, Vitória, where Portuguese-Brazilians were the majority until the mid-nineteenth century.

With regards to ceramic brick masonry in Brazil, it is known that this material has been used since the first century of colonization, especially in state capitals such as Salvador and Recife (ROCHA, 2012). However, Weimer (2005) observes that the material only becomes available for large-scale use in 1850, becoming widespread in the last decades of the 19th century. Since then, buildings have been predominantly erected with structural masonry of massive bricks. This is the case of the buildings of the Santa Leopoldina Historical Site where the vast majority was erected with ceramic brick masonry, and, in some cases, with stone masonry on the ground floor of the houses.

However, in Espírito Santo there is still a lack of scientific studies aimed at understanding the constructive techniques and materials that were used by these builders. To fill this gap, Ribeiro (2009) developed research on historic masonry and mortar that includes studies on the remaining buildings of the 19th century in Espírito Santo and research on the constructive techniques employed in the historical buildings of the state, especially those of Portuguese tradition. However, very few studies focus on the knowledge of the constructive techniques adopted by the immigrants that colonized the interior of Espírito Santo, and there is no scientific material on traditional ceramic bricks masonry, which is also quite frequent in the buildings of other state-registered historical sites.

In light of the above, this article aims to raise hypotheses about the constructive process of the ceramic brick produced in the State of Espírito Santo between the second half of the 19th century and the first decades of the 20th century. On a specific scale, the goal is to undertake the physical and mineralogical characterization of a sample group of ceramic bricks from the Santa Leopoldina Historical Site, identifying the stages and particularities in the manufacturing of these bricks and establishing a link between technological and historical research,

The technological research consists of laboratory tests for the physical and mineralogical characterization of the collected material. Physical characterization analyzes the ceramic bricks according to porosity, specific mass, and mechanical resistance through tests measuring total water absorption, unit mass using a Hubbard pycnometer, and mechanical resistance to compression. The analysis of the mineralogical composition is conducted through the X-ray diffraction (XRD) powder method, enabling the identification of the minerals contained in nine collected samples.

The historical research addresses the ceramic bricks production process that takes place in the state capital, Vitória, in the mid-nineteenth and early twentieth centuries. The research analyzes texts by historians and researchers focused on this period in Espírito Santo, as well as newspapers of the time. The information collected is then correlated with the literature review on the construction methods used in the mid-nineteenth century for the production of ceramic bricks and the physical and mineralogical characterization of the bricks collected.

The linkage of the historical and technological research allows us to make considerations on the manufacture of the ceramic bricks used in the buildings of the Santa Leopoldina Historical Site. The results contribute to fill a gap in Brazilian historiography insofar as they promote the recovery of the immigrant builders' know-how in constructing the patrimony of Espírito Santo from the moment they first occupied the state's inland territory, in the mid-nineteenth century. The theoretical contribution consists in the linkage of scientific data on the physical and mineralogical composition of the bricks with the socioeconomic context of the state and the production of the ceramic material. Simultaneously, it documents the constructive system of the Santa Leopoldina Historical Site, and provides essential data for the restoration of historic buildings.

Architecture Archeology and Traditional Techniques of Manufacturing Ceramic Bricks

The adopted approach is analogous to the archeology of architecture, a method of analysis emerging from archeology and directed towards the constructed heritage, which consists of analyzing the building through the information obtained in or from its architecture. The archeology of architecture is classified as a historical discipline and adopts the definitions by Quirós Castillo (2002). In this way the criterion adopted refers to the analysis and interpretation of ceramic bricks in relation to the constructed environment, admitting the historicity of architecture as a knowledge tool for society (QUIRÓS CASTILLO, 2002).

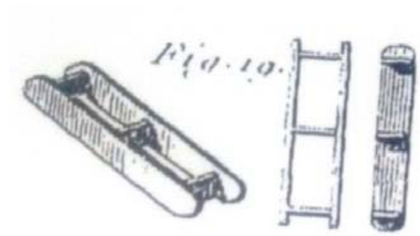
To this end, the effort is aimed at understanding both the brick's raw material and the typical methods of its production in the 19th century. In this sense, the brick's raw material, including clays and degreasers (PETRUCCI, 1975, p.2), is highlighted. Clay is a natural, earthy, fine-grained material, basically constituted of extremely small crystalline particles made up of a few minerals - known as clay minerals - and may contain other minerals (quartz, mica, pyrite, calcite, dolomite, among others), organic matter, soluble salts, and other impurities (SANTOS, 1989). For the production of ceramic, only clays of laminar structure are utilized, among which we find the kaolinite, montmorillonite, and the ilite groups (PETRUCCI, 1975). The kaolinites are frequent in the manufacture of porcelain and sanitary ceramics since they are the purest and most refractory. Torraca (1986) notes that clay porosity and resistance rates depend on the type of clay, the amount of sodium or potassium-containing materials that are added, and the cooking temperature.

With regard to the production of ceramic brick, Davey (1961) explains that this material has been manufactured over the centuries with the same methods and techniques and few modifications in the process; the major change was the introduction of continuous circular kilns in the early 19th century. Regarding the stages of ceramic production, Petrucci (1975, p.20) points out that the manufacture of ceramic products includes the following steps: 1) exploitation of deposits; 2) treatment of raw material; 3) molding; 4) drying; 5) burning.

As for the first two steps, it is worth emphasizing the variety of clays available and the importance of making the proper choice of clay for the production of bricks, an aspect that has been highlighted even by Vitruvius, in the year of 1 B.C. (VITRUVIO, 2007). Mateus (2002) observes that traditional criteria were restricted to the evaluation of the purity and plasticity of the clay itself. In the traditional methods, Leseigneur and Guilluy (1988) emphasize the preparation of the soil by removing all the impurities from the clay, such as stones and roots.

In traditional molding techniques, the pieces were molded on a wooden table sprinkled with sand, and in the artisanal method it was also common to put

(a)



(b)

Figure 1: (a) Molder Table; (b) Double molds.
Source: Duhamel (1763)

sand inside the mold to prevent the clay from sticking to the table or the mold (Figure 1). The molder then placed the clay in the molds and pressed it, compacting and spreading it to the corners. The excess material would be removed with a ruler and a spray of water or sand would be added to maintain moisture in the clay (ROCHA, 2012). The mold size was larger than that of the ready brick because after cooking retraction occurs once the clay loses moisture during the burning stage (SANTOS, 2012).

With industrialization, the molding stage became mechanized, incorporating new methods of kneading and raw material preparation; kneading machines were invented for this stage of the process. Machines were created to perform the repetitive task of molding through extrusion or brick pressing. The latter consisted of placing almost dry and very dense clay into the mold, which is then compressed by a press (CAMPBELL; PRICE, 2005). Santos (2012) emphasizes that pressed bricks were more precise due to less retraction during burning and lower porosity. In the 19^{th} century the extrusion method was invented, which involved introducing plastic-state clay into a nozzle and then pressing. The result was a uniform and continuous strip molded and cut with wires (CAMPBELL; PRICE, 2005).

With regard to the drying of the ceramic objects, Davey (1961) points out that the bricks were left in a bed of sand to harden until they could be treated in the kiln. Rocha (2012) notes that if the weather was rainy, the bricks were dried in an open space but covered; they were turned over at least once before the final burning stage. Leseigneur and Guilluy (1988) note the importance of drying the bricks, stating that if not fully dry they could crack during the burning.

The burning in the kilns is the final step in the manufacture of bricks. It is the main stage of ceramic manufacturing, since it guarantees the end product's strength and durability (SANTOS, 2012). Davey (1961) notes that kilns developed by primitive civilizations reached on average 600° C, which was not enough for producing resistant bricks and therefore few of these devices lasted. For the most rudimentary burns, Rocha (2012) reports on a type of kiln whose method consisted of simultaneously burning bricks and tiles in very rudimentary structures called medas:

The old kilns burned bricks and tiles simultaneously, and they were named medas. This is the kiln of Duhamel (1753) [...]. In it, bricks were arranged in interlaced rows spaced longitudinally and transversely, filled with combustible material. The pile was lined with clay and straw, a process known as jacketing, fire was set, and holes were gradually opened to stimulate the combustion (ROCHA, 2012, page 215).

Mateus (2002) observes that these kilns were built near the place where the bricks would be utilized because these ephemeral devices were not expected to last for many years.

[1] The goal of the comparison with samples of the Mother Church of Santa Leopoldina samples is to crossmatch historical information on the manufacture of the bricks, addressed in the final considerations.

Materials, Methods and Characterization of the Ceramic Bricks of Santa Leopoldina

The properties and characteristics of Santa Leopoldina's bricks are analyzed (Table 1) based on visual inspections and on collected samples from the three buildings that make up the historical site. The samples have different sizes according to the specifications of each test and with regard to the minimum values required. The mineralogical composition is obtained by X-ray diffraction and the samples were compared to each other and with two other samples from Mother Church of Santa Leopoldina, which used a mixed constructive system composed of stones and ceramic bricks, and whose construction period was about the same as the other three analyzed buildings[1] .

Table 1: Laboratory tests and characterization types. Source: Authors (2016).

PROPERTIES	TESTS	SAMPLES	METHODOLOGY
Physical	1. Total Water Absorption	12	NBR 12766
	2. Unit Mass (Hubbard Picnometer)	12	Italian Norm 4/80
	3. Mechanical Resistance	3	NBR 6460
Minerological	4. DRX	9	Powder Method

The buildings are located on the same street and at some points the constructive system is exposed, allowing for the collection of the ceramic brick samples (Figure 2).

During visual inspection, macroscopic analysis reveals fragments of quartz, irregular surfaces, and pulverulence (Figure 3).

Coloring: samples from Building 1 have lighter shades, which may indicate a lesser degree of burning as well as lower iron oxide content ($Fe2O3$). In contrast, Building 2 shows bricks of a more reddish color. The bricks from Building 3 are similar to those of Building 2, but with an even more reddish tone (Figure 4).

The macroscopic analysis also shows differences in the sizes of the samples, even among bricks laid in the same building, such as in Building 1. In the areas where bricks are exposed, variation ranges from 1 to 2 cm in length and

(a) (b) (c)

Figure 2: Research buildings – (a) Building 1; (b) Building 2; (c) Building 3.
Source: Authors (2016).

Figure 3: (a) Fragments of quartz in Building 2; (b) Brick of Building 2 and 3.
Source: Authors (2016).

(a) (b)

(a) (b) (c)

Figure 4: (a) Building 1; (b) Building 2; (c) Building 3.
Source: Authors (2016).

Figure 5 (a) and (b): Comparison between bricks laid in the masonry of the back facade of Building 1.
Source: Authors (2016).

(a) (b)

in height (Figure 5). From the sampling we were able to verify bricks with dimensions ranging from 21 to 26 cm in length, 13 to 15 cm in width, and 5 to 7 cm in thickness.

In relation to the physical characterization of the sampling, the full- to- empty space ratio is verified by means of total water absorption (%) tests and measuring unit mass (g/ m^3) with the Hubbard pycnometer (Table 2). The results indicate that the samples contain between 30.80 and 41.49% accessible pores, with specific mass ranging from 0.91 to 1.49 g / cm^3. The denser and less porous bricks are found in Building 3, and the most porous in Building 1; these also have a lower specific mass.

Table 2: Total Water Absorption and Unit Mass with Hubbard Pycnometer: Test Results and Sample Location in Building 1. Source: Authors (2016).

SAMPLES BLG. 1	TOTAL WATER ABSORPTION (%)	UNIT MASS (g/cm^3)
Sample 1	40.67	1.43
Sample 2	36.40	1.39
Sample 3	36.44	0.91
Sample 4	41.25	1.49

The results obtained in the mechanical resistance tests are compatible to those regarding accessible pores and specific mass: they indicate denser and less porous bricks in Building 3, with a high breaking load. In Building 1, the bricks are more porous, with a lower specific mass, indicating a lower breaking load (Table 3).

Table 3: Mechanical Resistance from Buildings 1, 2, and 3. Source: Authors (2016).

	Sample Dimensions	Breaking Load (Kgf)	Stress Load (Mpa)
Building 01 - nº 29	Length: 105.28 mm	820	1.48
	Width: 51.50 mm		
	Height: 76.20 mm		
	Area: 5,421.92 mm²		
	Sample Dimensions	Breaking Load (Kgf)	Stress Load (Mpa)
Building 02 - nº3	Length: 137mm	7,750	5.23
	Width: 106 mm		
	Height: 55 mm		
	Area:14,522 mm²		
	Sample Dimensions	Breaking Load (Kgf)	Stress Load (Mpa)
Building 03 - nº24	Length: 189 mm	16	7.28
	Width: 114 mm		
	Height: 51 mm		
	Area: 21,546 mm²		

As far as the mineralogical characterization, the possible compounds identified in all the samples are mica, quartz (SiO2), feldspars, hematite (Fe2O3), goethite (FeOOH), gypsum (Ca (SO4) • 2H2O), kaolinite (Al2 Si2 O5 (OH) 4), and palygorskite (Mg2Al2) Si8O20 (OH) 2 • 4H2O). The samples are grouped into three categories according to mineralogical similarity.

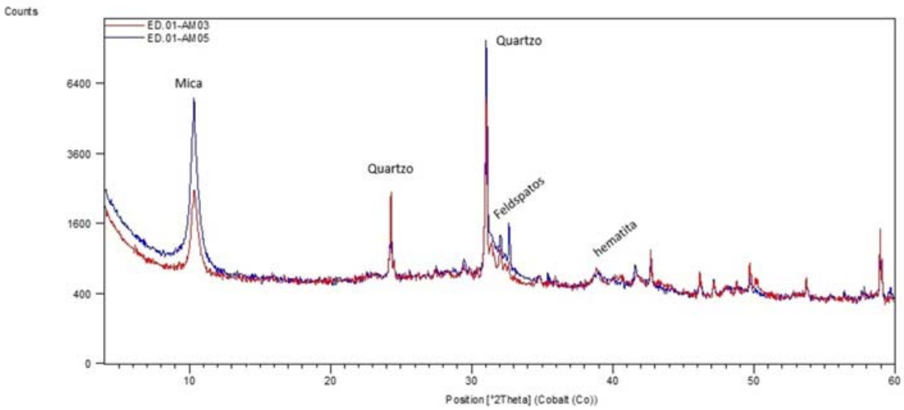


Figure 6: Diffractogram samples Group 1.
Source: Authors (2016).

Group 01

This group is composed of two samples from Building 1 (*AM03* and AM05), basically formed by quartz and mica (Figure 6), and to a lesser extent feldspar and hematite. Since there are no peaks of kaolinite and goethite, burning probably occurred above 550°C, destroying these minerals' structures. The presence of hematite may be the result of the transformation of goethite, since heating at temperatures between 250 and 350°C transforms this mineral into hematite.

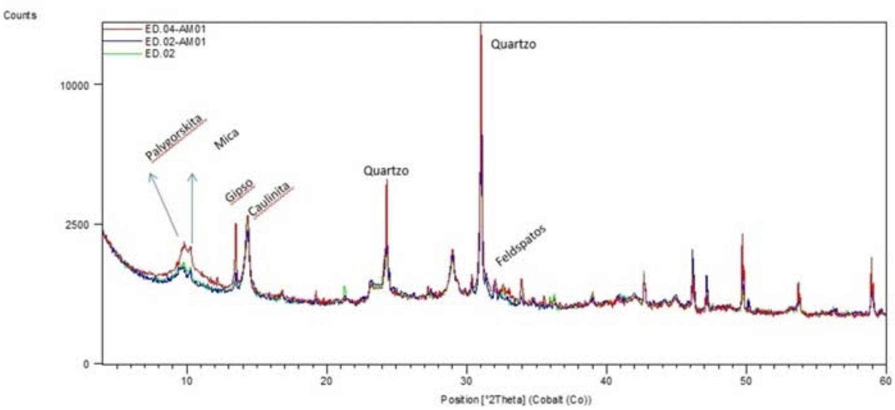


Figure 7: Diffractogram samples Group 2.
Source: Authors (2016).

Group 02

In this group there are two samples, one from Building 02 (*AM01*), and one from the Mother Church of Santa Leopoldina (Ed.04 - *AM01*) (Figure 7). The mineralogical composition indicates the presence of gypsum and kaolinite, as well as quartz, mica, feldspar, and palygorskite.

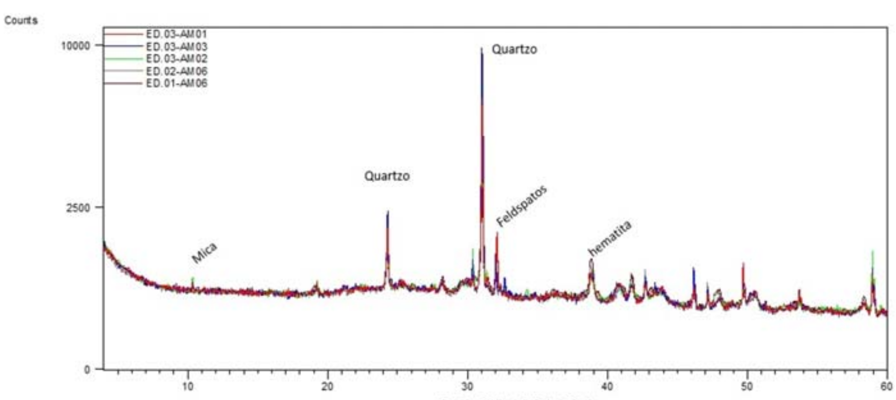


Figure 8: Diffractogram samples Group 3.
Source: Authors (2016).

Group 03

The samples from this group refer to Building 1 (*AM06*), Building 2 (*AM06*), and all the samples from Building 3 (*AM01*, *AM02* and *AM03*) (Figure 8). The composition of the samples is quite similar, with the presence of quartz, feldspar and to a lesser extent mica and hematite, and the absence of clay minerals.

Considerations on the Production of Ceramic Bricks in Santa Leopoldina (1880- 1920)

• Historical Investigation

It may be worthwhile to consider the effects of the Industrial Revolution in Brazil when significant imports of construction materials began entering the country in 1850; however, this did not apply to Espírito Santo in its capital or the immigrant settlements in the countryside. In this context, Alves (2015, p. 57) points out that in the capital city Vitória,*"few were the buildings that could count on the use of bricks, often brought from outside the province."*

BRICK YARD	
STORE	YEAR
Cia Brasileira Torrens	1894
Cia Brasileira Torrens	1896
Manoel C Madeira	1912
Dr. Manoel Silvino Monjardim	1912
Cypriano Cabral	1912

Table 4: Potteries in Victoria, registered between 1984 and 1912.
Source: Table drawn by the authors (2016) from Alves, 2015, p. 128.

J. MAIA.

PUBLICAÇÕES á PEDIDO

Matriz de Santa Leopoldina

AO EXM. SR. PRESIDENTE DA PROVINCIA

No orçamento da inspectoria de obras está calculado para a nossa matriz ser feita de pedra, mas d'aqui seguiu um felizardo que vae se propor á arrematação, por ser dono de uma olaria e quer por isso fazer de tijolo a nossa matriz.

O dito é protestante. Como será curioso um protestante construir uma egreja catholica !!!!

Porto do Cachoeiro, 6 de julho de 1888.

Olho vivo.

Figure 9: Publication in newspaper *A província do Espírito Santo.*
Source: (MATRIZ DE SANTA LEOPOLDINA, 1888).

With the arrival of non-Lusitanian European immigrants beginning in 1860, and with their participation in civil construction, other materials were adopted besides stone and clay. Ribeiro (2011) emphasizes that potteries were scarce in Vitória in the first half of the nineteenth century, noting the imports of tiles and bricks—unlike lime, which was in surplus and exported. But as of 1850, the scenario of ceramic production in Espirito Santo changes with the appearance of potteries and the arrival of immigrants. In fact, the development of potteries in Vitória (Table 4), from 1890 onwards, makes ceramic bricks more available for use in architectural works.

Therefore, considering that in Vitória brick was still an expensive material during the last decade of the nineteenth century, and noting that its use becomes more widespread, we believe that the material was probably being produced in the interior of Espírito Santo in a non-mechanized way, still using rustic and handcrafted production processes.

Grosselli (2008) states that the immigrant communities that inhabited the new settlements of Rio Novo, Santa Isabel, and Porto de Cachoeiro de Santa Leopoldina possessed technological know-how superior to the Luso-Brazilian settlers – which also indicates the possibility that the settlers produced their own construction material. In fact, in the published literature there is no mention regarding the introduction of ceramic bricks in the colony of Santa Leopoldina.

In the field of historiography, Grosselli (2008), corroborating the hypothesis of local production, states that Santa Leopoldina had four factories in 1880, even before the potteries registered in Vitória. Reinforcing this information, a note in the newspaper *Província do Espírito Santo,* from 1888 (Figure 9) mentions a pottery in Porto do Cachoeiro de Santa Leopoldina whose owner could supply the bricks for the construction of the Mother Church, to be built in 1903, and which eventually used mixed masonry of stone and ceramic bricks as its construction system.

• Technological Investigation

Observing the information from the technological investigation, it is verified that the results of the laboratory tests support important references that could be associated to the research on the production of ceramic brick in 19th and first decades of the 20th centuries in Santa Leopoldina. Regarding the physical characterization, the results reflect the manufacturing process, since the analyses of total water absorption and unit mass tests point to porous bricks with 37.29% and 1.37 g / cm^3 of specific mass (result average), which might reveal a handcrafted and non-mechanized production process. Although the high accessible porosity of the bricks could be due to the extent of their deterioration, it is more likely that these materials were handcrafted because their surface is uneven and the sample sizes differ from one another by a few centimeters, revealing an uneven pattern. It should be noted that, as seen, these characteristics are uncommon in processes like extrusion or pressing, which result in less porous bricks, more regular surfaces, and some level of standardization due to the significant decrease in retraction during burning.

As to the surface of the collected fragments, in Building 1 it is possible to verify that leaching takes place when the samples are in contact with water, indicating that burning might have been partial, possibly due to a rudimentary kiln or perhaps lack of expertise. It is noted that the quality of the clay and temperature control might have occurred empirically, since tactile-visual analysis revealed the presence of large fragments of quartz, implying that the clay was not properly treated before molding.

Regarding the mechanical strength of the samples, the values differ among the buildings. Building 1 shows a much lower resistance than Buildings 2 and 3. Although only one brick was examined per building, it can be inferred that bricks were not uniformly burned during manufacture. Considering that the buildings may or may not have been built in the same historical period, it is also likely that the bricks were made by different manufacturers, even though the same raw material may have been used in some cases. Therefore, considering the possibility that the same raw material was used in some samples, the bricks may present different mechanical resistance due to their state of conservation, or this may result from different manufacturing processes undertaken in artisanal kilns with irregular burning of the whole surface. So it is possible that the ceramic bricks of the Santa Leopoldina Historical Site may have been made in small potteries by different manufacturers.

The mineralogical characterization allows for more precise information on the burning process, since the identification of the minerals present in the samples provides data on the possible temperatures of kilns. Thus, in Group 1, which refers to the samples of Building 1, the absence of kaolinite peaks indicates temperature over 550ºC, since at this temperature and above kaolinite becomes amorphous metakaolinite (SANTOS, 2012). The lighter color of bricks in this group is probably an indication of lower iron oxide content. On the other hand, in the Group 2 samples, composed of bricks from Building 2 and the Mother Church, the presence of kaolinite[2] might indicate that the burning temperature did not exceed 550º. Also, since gypsum was found in this group - a mineral that does not withstand temperatures higher than 200ºC - it can be noted that

[2] On the presence of Kaolinite, Santos (2012) raises the possibility of a non-temperized, biodegraded sample where microorganisms that synthesize sulphuric acid can transform ceramic material into Kaolinit.

the samples were not calcined. In Group 3 there are samples similar to those of Buildings 1, 2 and 3, with burning temperatures above 550ºC, and the absence of clay minerals.

The mineralogical characterization also shows similar minerals in some of the samples, which might indicate that the same raw material was used in manufacture. The grouping of similar samples can also help establish the age of the buildings, since there are no records of their exact construction. Thus, Group 1, composed only of samples from Building 1 (*AM01* and *AM03*), may indicate that the masonry was built in a different period from that of sample *AM06*, in the same building, or, that the house was built in a different period than the other buildings, or that the raw material used here was not the same as that of Buildings 2, 3, and the Mother Church of Santa Leopoldina (Building 4). On the other hand, some samples from different buildings are similar from the mineralogical point of view, such as Buildings 2 and 4. Since Building 4 is the Mother Church, whose bricks were probably manufactured locally, it can be inferred that the same manufacturer also produced bricks for Building 2.

Still concerning the minerals, the presence of kaolinite stands out - a group of clay minerals uncommon in the manufacture of ceramic bricks and more widely found in porcelain production due to their refractory trait. Therefore, the samples were manufactured with white clay, and are likely to present high iron oxide content, as indicated by their red color[3]. Both goethite and hematite are iron oxide minerals, and may be responsible for the reddish coloration of the samples (SANTOS, 2012). The samples are also composed by palygorskite, a fibrous clay mineral that can be used as asbestos. Gypsum was also found, a mineral that is basically composed of hydrated calcium sulfate, which is found in clays and is considered an impurity[4].

Therefore, based on the technological investigation, correlated with the historical research and the literature review, it is believed that the bricks used in the Santa Leopoldina buildings were manufactured in the region, having been molded non-mechanically in a handcrafted process with temperatures variating in intensity according to the batch and the manufacturer. It is likely that the bricks were burned using different techniques, resulting in bricks with different patterns and traits.

With respect to the artisanal techniques of ceramic brick manufacturing and the methods used for its production in the Santa Leopoldina Historical Site, the analyzed samples display imprecise criteria regarding the choice of raw material, since some pieces contain fragments of quartz and minerals like gypsum and palygorskite. However, one cannot say that there was consensus on the production procedures adopted by the potters who manufactured the Santa Leopoldina bricks. Therefore, considering that the analyzed samples differ in their mechanical resistance and also in their appearance - some show certain pulverulence and some leach with water contact - there was probably no standardization in the choice and treatment of raw material and neither in the burning process.

[3] However, the lighter color can also indicate the presence of carbonates in the clay itself or added as a flux.

[4] The Gypsum could be a secondary reaction to the Sulphur.

Conclusions

In conclusion, with respect to the knowledge of traditional constructive techniques for the preservation of material and intangible patrimony, we once again are trying to understand the typical knowledge of the immigrants who populated the urban hub of the old colony of Santa Leopoldina. However, in addition to the Santa Leopoldina Historical Site, the pertinence of this study regards the effort to understand the history of construction, asserting the potential of constructive material as a tool for historiography. This analysis is even more relevant within the Brazilian context, where there are still vague studies covering constructive techniques by regions (GENOVEZ, 2012). To these gaps in the Brazilian historiography, one can add the lack of knowledge about civil and popular architecture, especially the Brazilian urban centers from the nineteenth century, although they are important testimonies of the ways of living and the peculiarities of each place.

In view of this, the interface between technological and historical research can be aligned with the archeology of architecture, in particular if one considers Genovez (2012) and his emphasis on this as a kind of path to find material documents that allow one to obtain data on the historical and technical character of the construction, and, on a broader scale, as part of the history of the societies that produced it (GENOVEZ, 2012, p. 40).

In fact, one cannot isolate the object, in this case, the building, from the context that produced it and, therefore, one cannot interpret material documents unrelated to the social and cultural facts of the constructed environment. That is, in the case of the technological research carried out on the bricks of the three buildings of Santa Leopoldina, the interface with the historical research of the urban hub and the ceramic production in Vitória is indispensable to reinforce the link between the construction of the *parts* and the history of the *whole*. The interaction between the two approaches promotes more solid considerations on the production of ceramic bricks in Santa Leopoldina and collaborates on the construction of the historiography of Brazilian constructive techniques during the transition between the 19th and 20th centuries.

In order to conclude in a more adequate manner and reduce the limitations on this historical interpretation, stratigraphic analyses of the surfaces constitute a tool for future approaches. Finally, it is worth emphasizing that to make considerations about unprecedented facts in historiography is surely a comprehensive phenomenon, involving multiple questions. The identification of facts and events will never be incontestable.

References

ALVES, Vanderson Moreira Silva. *A produção do espaço urbano de Vitória - ES pela construção imobiliária entre o final do século XIX e meados do século XX*. Master's thesis. Graduate Program in Geography, Federal University of Espírito Santo, Vitória, 2015.

CAMPBELL, James W. P; PRICE, Will. *Historia Universal do tijolo.* Portugal: Editora Caleidoscópio, 2005.

DAVEY, Norman. A History of building materials. London: Phoenix House, 1961.

DUHAMEL, M., FOURCROY, M.; GALLON, M. *L'art du tuilier et du briquetier*. Paris: s/ed, 1763.

GENOVEZ, Sarita Carneiro. *Análise Estratigráfica: uma contribuição ao projeto de restauro*. Master's thesis in Architecture and Urbanism – Federal University of São Paulo, São Paulo, 2012.

GROSSELLI, R. M. *Colônias imperiais na terra do café: camponeses trentinos (vênetos e lombardos) nas florestas brasileiras*: Espírito Santo 1874-1900. Vitória, ES: Public Archive, 2008.

LEISEIGNEUR, Annie, Guilluy, Françoise. *L'argile dans sous sés etats*. Elbeuf: Association pour La valorisation du patrimoine normand, 1988.

MATEUS, João Mascarenhas. *Técnicas Tradicionais de Construção de Alvenarias: a literatura técnica de 1750 a 1900 e o seu contributo para a conservação dos edifícios históricos*. Lisboa: Livros Horizontes, 2002.

MATRIZ DE SANTA LEOPOLDINA, *Newspaper Província do Espirito Santo*, Vitória, 6 jul 1888. Available in: http://bndigital.bn.gov.br/hemeroteca-digital/.

OLIVEIRA, Mário Mendonça de. *Restauro Estrutural: Intuição e cálculo*. In DAMSTRUC - 4rd International Conference on the Behaviour of Damaged Structures, João Pessoa, 2005.

PETRUCCI, Eládio. *Materiais de construção*. Porto Alegre: Editora Globo, 1975.

QUIRÓS, CASTILLO, J.A. *Arqueologia de la Arquitectura en España*. Revista de la arqueologia de la Arquitectura, Universid del País Vasco, nº 01. Available at: http://arqarqt.revistas.csic.es/index.php.arqarqt/article/view4/4. Acessed in: jan 2016.

RIBEIRO, Nelson Pôrto. *Alvenarias e Argamassas. Restauração e Conservação*. Coleção Artes e Ofícios. Rio de Janeiro: In-Fólio, 2009.

RIBEIRO, Nelson Pôrto. *Atores da Construção Civil no Espírito Santo do século XIX*. In: A Construção da cidade portuguesa na América. Rio de Janeiro: Editora POD, 2011.

ROCHA, Isabel. *Tijolo por Tijolo: Construindo Alvenarias no Vale do Paraíba do Sul*. PHD Thesis. Graduate Program in Architecture, Federal University of Rio de Janeiro, Rio de Janeiro, 2012.

SANTOS, Larrissa Acatauassu Nunes dos. *A Arqueologia da Arquitetura e a produção de tijolo na Bahia do século XVI ao XIX.* PHD Thesis. Graduate Program in Architecture and Urbanism, Federal University of Bahia, Salvador, 2012.

SANTOS, Pérsio de Souza. *Ciência e Tecnologia de argilas*. 2ª Ed. v. 1. São Paulo: Edgard Blucher, 1989.

TORRACA, Giorgio. *Materiaux de Construction Poreux:* science des matériaux pour la conservation architecturale. Roma: ICCROM, 1986.

VITRUVIO, *Tratado de Arquitetura*. Martins Fontes, 2007.

WEIMER, Gunter. *Arquitetura popular brasileira.* São Paulo: Martins Fontes, 2005.

Author's note

This article is an integral part of the master's dissertation of author Luciana da Silva Florenzano, advised by Prof. Dr. Renata Hermanny de Almeida, with the collaboration of Prof. Dr. Rômulo Simões Angelica, and defended in May 2016. The research was funded by CAPES in partnership with FAPES.

"FLORENZANO, Luciana da Silva. *Conservation of Ceramic Brick in Historic Masonry: Supports for Restoration of the Historical Site of Santa Leopoldina*. 2016. Dissertation (Graduate Program in Architecture and Urbanism) - Federal University of Espírito Santo, Vitória, 2016".

Editor's note

Submitted: 12/26/2016
Acceptance: 08/26/2017
English revision: Lina Rosa

Universidade Federal do Espírito Santo (UFES). Centro de Artes. Vitória, ES.
lucianaflorenzano@gmail.com

Renata Hermanny de Almeida
Universidade Federal do Espírito Santo (UFES). Centro de Artes. Vitória, ES.
renatahermanny@gmail.com

Rômulo Simões Angélica
Universidade Federal do Pará (UFPA). Instituto de Geociências. Belém, PA.
rsangelica@gmail.com