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Conservation and Restoration of Brazilian Colonial Architecture

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ABSTRACT: In this paper we examine the principal conservation problems and challenges in the restoration of buildings of the Brazilian colonial period. This era cover the years from 1500, the year of the Brazil's discovery, until 1822, the proclamation of independence from Portugal. Even prior to independence, a French cultural mission arrived in 1816 with the aim of spreading the neoclassical style throughout Brazil, contributing to the abandonment of traditional colonial building techniques. The Portuguese settlers encountered construction techniques and materials used by the native Indians, such as wood, clay, and palm leaves, that were later to be incorporated into their own constructions. From this emerged the traditional Brazilian building system, based on lath-and-plaster, adobe bricks, rammed earth, and rows of brick and stone work bound with lime plaster whitewash.

1 INTRODUCTION

During the colonial period, many coastal cities such as Salvador (Bahia), São Luís (Maranhão), Belém (Pará), and Rio de Janeiro sprang up; they were characterized by a regular outline and an urban nuclear development centered on a large square, around which state and religious buildings were arrayed. After the discovery of gold in the state of Minas Gerais in 1698, many cities known as "vilas do ouro" (gold towns) made their appearance, characterized by a particular plan which did not conform to the traditional urban organization found in the other regions of Brazil. According to Sylvio de Vasconcellos, the organic and linear configuration anticipated the type of urban development presently known as conurbation, that is, the creation of a city from the merging of many neighboring areas. Examples of this phenomenon are the cities of Mariana, São João Del Rei, Diamantina, and Ouro Preto, which came into being through the linking of many settlements created by the discovery of gold.

The vast territory of Brazil with its diverse climate and topography imposed the adoption of techniques that varied from region to region. For instance, rammed earth was used in the state of São Paulo, stone and brick masonry in the north and northeast regions, and lath-and-plaster in the state of Minas Gerais. There predominated the use of stone masonry in the foundations, wood for autonomous structures, and lath-and-plaster or adobe for walls. This building system, also known as hand lath-and-plaster ("taipa de mão" or "taipa de sopapo"), employs interwoven wooden sticks or rods, bound with rope or leather strips, and that are filled in with clay. This technique was widely applied to construction in Minas Gerais, due to its appropriateness to the declivities characteristic of the region. Monuments and stately buildings were usually built in stone set with lime. Internally the use of wood in floors, ceilings and frames predominated. Roofs were also made of wooden structures covered with clay tiles. Both interior and exterior walls were finished with lime plaster whitewash. Wood was widely used during 18th and 19th centuries, even in the structures of buildings. In Minas Gerais, these structures are formed with vertical pieces (supports) and horizontal elements (master beams), bound by dividing walls and

diagonal pieces (“Saint Andrew’s Cross” or “French quotation marks”). In these cases, walls are made of lath-and-plaster or adobe bricks. Stone or brick masonry set with lime is found in most of the ground floors in houses, forts, religious or stately buildings. These methods also predominate in residential construction in the north and northeast regions of Brazil.

Figure 1 : Lath-and-plaster wall, Casa da Baronesa, Ouro Preto - State of Minas Gerais (Source: IPHAN’s collection).

Figure 3 : Rammed earth wall under rebuilt, Casa Cora Coralina, city of Goiás - State of Goiás.

Figure 2 : Stone masonry, Church of São Matias, Alcântara - State of Maranhão (Source: IPHAN’s collection).

In the following sections we will examine the main problems and technical solutions in the conservation of the Brazilian colonial architecture:

- humidity and the ways of treating it;
- the diversity of xylophagous insects and fungi and ways of exterminating them;
- the use of techniques and materials compatible with the consolidation of old structures;
- heavy vehicular traffic and suggestions for reducing its impact on the buildings.

We will also examine the difficulties in the filling of cavities in lath-and-plaster or adobe walls, taking into account the recommendations made by the Cartas Patrimoniais (official publication of IPHAN, the National Institute of The Historical and Artistic Heritage of Brazil) in order to distinguish a modern intervention from one involving an original architectural object or element. Technical, theoretical as well as methodological issues will be briefly examined, focusing on the challenges in their application according to the modern principles of restoration of Brazilian colonial buildings.

2 HUMIDITY

Brazil is a large country of approximately 8,500,000 square kilometers (5,283,000 square miles), and characterized by a predominantly warm climate, a relative humidity of between 70 % and 80 %, and seasons of abundant rainfall over most of its territory. These climatic features, together with the materials used in traditional Brazilian architecture, such as wood and clay, make humidity one of the principal factors in the deterioration of buildings. Many types of

humidity are found: capillary attraction, when buildings are in direct contact with humid surfaces; water infiltration through leaks in the roof or pipes; condensation through thermal inertia or insufficient thermal and hygroscopic protection.

Interventions with inadequate materials that prevent respiration of traditional materials, the existence of closed and non-ventilated spaces, as well as the use of cooling systems that create significant temperature variation between internal and external surroundings all contribute to the presence of humidity.

The continual action of humidity results in the complete deterioration of the original construction materials. This causes wooden structures to rot, facilitating infestations of xylophagous insects and fungi and resulting in the physical deterioration and consequent instability of the structure. The loss of structural elements in the building leads to new non-distributed forces, generating unanticipated loads that result in collapse. Excessive humidity causes mineral salt crystallization on wall coatings, which fall down and expose the structures to the elements.

Our experience has demonstrated that simple actions, as routine structural checks, as well as the reinforcement of coverings, including roof guttering, flashing and edging, can prevent most of the potential damage that humidity causes to buildings. In addition, appropriate use of the building and interventions made according to criteria that take into account the characteristics of the building are important factors in preservation. For instance, the maintenance of natural ventilation and the use of materials compatible with the original must be considered. In this regard, the use of plaster and lime whitewash or mineral tints, instead of cement and PVA-based or acrylic painting, allows the original materials to breathe and prevents the accumulation of humidity internally.

Figure 4 : Air chamber under the floor, Magazine, Fort São José de Macapá - State of Amapá (Source: IPHAN's collection).

Those problems which are hard to solve are related to permanent sources of humidity such as those resulting from the direct contact of old building materials with humid soil. The solution adopted for wooden floors involves the revival of the use of air chambers consisting of a ventilation space between the wooden floor and the soil. This solution, widespread in traditional Brazilian architecture, is usually ignored in inappropriate restorations and interventions that set wooden floors directly onto the pavement, leading to wood-rot and infestation of xylophagous insects in the structure. In the case of structures in direct contact with humid surfaces underground or supporting structures in hilly places, the solution has been to provide natural ventilation, and, on occasion, even separate the floor from the walls in order to reduce effects of humidity.

In the case of humidity in the vaults of São José de Macapá Fort, in the state of Amapá, the slope of the upper earth embankments was altered so as to prevent rainwater accumulation at certain points, and a new covering made of lime whitewash was applied. Due to excessive humidity, the original coating had deteriorated significantly, leaving the brick masonry exposed and subject to the continual actions of humidity from the soil.

3 THE ACTION OF XYLOPHAGOUS INSECTS AND FUNGHI

Xylophagous insects and fungi, which find optimal conditions for reproduction in the warm and humid climate of Brazil, are the major cause of deterioration in wooden structures. The most commonly found are dry-wood termites, soil termites and borers.

Dry-wood termites restrict their nests to the interior of the wooden pieces they have infested, and their presence can be confirmed through the existence of dry flakes of wood nearby. The "underground" or soil termites make their nests in soil or in any permanent source of humidity. Their infestation can be identified through the existence of underground galleries or earth-covered tunnels on the walls. Exterminating this type of termite is quite difficult, as it does not restrict itself to the infested piece, but continually moves its shelter. Borer is the common denomination for xylophagous beetles, whose infestation can be identified through the existence of a fine yellow powder and small holes in the piece of wood. Fungi change the color of the wood; their infestation is characterized by the appearance of mold or mushrooms and the softening of the piece.

The most common immunization methods used in Brazil consist of application of chemical substances with a clorpirifos, permetrine or deltametrine base, by brushing, spraying, dusting, fogging, injecting or immersing. For new pieces, preventative autoclave sterilization is employed.

Applications by brushing or spraying have been more prevalent as they are more economical and easier to apply. However, they offer lower protection since their action is restricted to the surface.

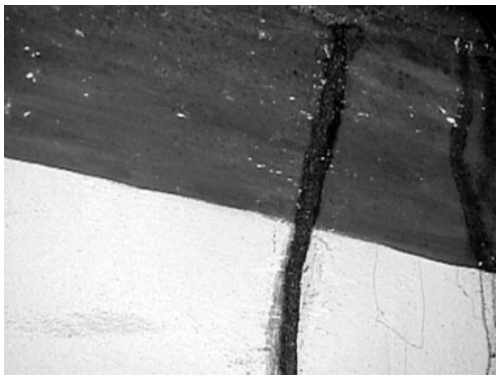

Figure 5 : Xylophagous insects in the Church of São Francisco de Paula, Ouro Preto - State of Minas Gerais *(Source: IPHAN's collection).*

More efficient methods are the use of chemical barriers and immunization by immersion, but they are highly controversial since they can contaminate soil and freatic groundwater. The chemical barricade method consists of isolating the building from the termite colony with termiticides. Immunization by immersion consists of soaking the pieces in tanks containing the same chemicals.

Another method little used in Brazil is the setting of attractive cellulose traps around the building that are later replaced by bait with delayed-effect insecticide or substances that interfere with growth of the insects and that are taken as food into the colony.

Preventative measures against xylophagous insects and fungi by making wooden parts embedded in walls impermeable include the following:

- surface carbonization, producing a coal layer that repels insects. This technique has been used in the bases of supporting structure directly placed in the earth, as well as in the interior of religious sculptures;
- application of asphalt and bitumen products;
- isolation of the wooden piece by use of another material, such as metal sheeting.

Prior identification, under the supervision of specialists, of the insects and fungi encountered is very important in determining the treatment to be adopted. Unfortunately in Brazil this practice is not widespread, and in the majority of restorations immunization is made by dusting, failing to undertake any prior study made to identify the focuses of infestation.

4 TECHNIQUES AND MATERIALS COMPATIBLE TO THE CONSOLIDATION OF OLD STRUCTURES

The experience acquired in many restoration works in Brazil has demonstrated that correct analysis of a problem is essential in order to avoid expensive, complex interventions. The consolidation of old structures can only proceed after taking into account the physical features and original materials of the building. An investigation of the causes of structural instability may begin with the identification of physical modifications that may have occurred within the structure, such as the raising of freatic groundwater levels or leaks from public or neighboring drainage networks which may cause changes in soil resistance. As the foundations of buildings built in the Brazilian colonial period were generally made with stone masonry, bricks and lath-and-plaster, the treatment will depend on a correct diagnosis of the problem, in the majority of cases caused by inappropriate use or poor conservation of the buildings.

Figure 6 : Lime mortar coating, Fort São José de Macapá - State of Amapá *(Source: IPHAN's collection).*

The ground is usually consolidated and/or stabilized by mixing earth with cement or lime, and then compacted. In foundations and structures made with stone masonry, the wall is rebuilt with the same material, while the joining and filling in of gaps, known as breaches, is sufficient to stabilize the structure. In lath-and-plaster structures, the reconstitution of material, repaired using the same soil together with injections of lime in the layers, has proven adequate in consolidating the structure. Adequate rain-water drainage must also be ensured, as in the case of the restoration of the Matriz de Santo Antônio in Tiradentes, Minas Gerais.

5 VEHICULAR TRAFFIC

Damage to building structures caused by the traffic of heavy vehicles is common in historic Brazilian cities, leading to the instability of buildings, which can be verified by noticeable, long and permanent cracks.

This problem has been solved by projects that organize the traffic, prohibiting heavy vehicles from historic centers; this includes buses outside of peak hours.

Figure 7 : Square in front of the Church of São Francisco de Assis, Salvador – State of Bahia *(Source: IPHAN's collection).*

The use of squares as parking areas decharacterizes historic places, prioritizing vehicles instead of pedestrians. The solutions usually adopted in Brazilian historic cities, aiming at returning public spaces to pedestrians are as follows:

- Prohibiting the traffic of vehicles in some streets and the creation of parking areas near the historic centers, as in São Luiz (state of Maranhão) and Salvador (state of Bahia);
- Placing curbs in the center of squares, preventing vehicles from parking; a solution to be adopted through the Program Monumenta-BID- in Ouro Preto (state of Minas Gerais).

6 FILLING GAPS

Maintaining both the distinction between old and new materials on the one hand and keeping the unity of the structure on the other is easy in some cases, but difficult in others. Wooden structures are usually restored through immunization and reintegration of the autonomous structure by completing the damaged area with similar materials, after removing those parts which are compromised. To fill in small holes, one uses wood powder with the same color as the original piece and PVA glue or resin; large gaps are filled in with dry wooden pieces similar to the original ones, which are embedded by using pins and glue. In those cases where the structural piece has been completely destroyed, it is usually replaced by one that is new and trimmed to the same dimensions as the original. This technique has become increasingly difficult as the sale of certain types of high-quality wood, compatible with the original materials, is now restricted. For floors and ceilings, one generally uses the original pieces in prominent rooms while employing replacements in rooms of lesser importance.

This approach is frequently not an option when recoating mortar. Therefore a sand-granule type is used for the differentiated new coating, taking care to ensure that this is not noticeable on the surface. In enclosed spaces we usually encounter significant loss of materials due to humidity and xylophagous insects. The filling of cracks and gaps is difficult, as the addition of new materials must take into account their physical properties together with the final appearance of the assemblage.

Figure 8 : Reintegration of coating cavities, Centro Cultural da FIEMG, Ouro Preto - state of Minas Gerais *(Source: IPHAN's collection).*

The restorations in the texture of lath-and-plaster walls use those pieces that are well-preserved, concentrating them in same section of the wall in order to achieve an interpretation of the preserved assemblage. In these cases, the original clay is reused, being mixed with water and reapplying it into the weave. When filling in cage-like structures, it is almost impossible to achieve this distinction, since the mixture must be homogeneous to prevent new clay from shrinking with time.

7 CONCLUSIONS

Interventions for the conservation of Brazilian colonial architecture have demonstrated that rigorous research into the causes of damage and accurate diagnosis are essential to achieve adequate restoration and the eventual preservation of the objects' cultural authenticity.

The construction materials currently in use in Brazil, like baked-clay bricks, concrete structures, cement mortar, plastic mass, acrylic, latex or PVA-based paints etc., when used in old structures, make them degenerate since these materials are generally incompatible with those originally used in the Brazilian colonial architecture.

In Brazil there is some resistance to the use of traditional construction materials and building systems. Lath-and-plaster and the use of lime plaster in painting or in coating mortar are perceived as low-quality construction methods, since they are used by poorer, rural populations. We have encountered the replacement of lath-and-plaster by hollow bricks, wooden structures by wooden-covered concrete (aiming at imitating the original), the recovering of stone pillars with concrete and then with regular-cut stones – idiocies aimed at disguising incorrect interventions. Such slap-dash techniques are practiced by professionals who ignore traditional construction techniques and use improvised methods such as covering brick vaults with asphalt, a solution used for paving modern building, that in fact accelerate the degeneration of original materials.

This does not mean a return to the exclusive use of historic techniques, as some technicians opposed to the use of traditional materials and techniques, such as that of hydrated lime mortars in restorations, would imply. In fact, it is a matter of finding adequate, modern materials and techniques appropriate for historic buildings. As an example, we can point to the use of silicate-based mineral painting, instead acrylic or PVA-based paints, which is as beneficial to the original materials as whitewashing with lime plaster.

Our experience has demonstrated that simple and routine actions such as cleaning, roof maintenance, whitewash, systematic inspection for termites, and repairs using construction materials and systems compatible with the original ones have been efficient.

Considering humidity as one of the most serious degeneration agents in old buildings in Brazil, since it attracts xylophagous insects into wooden pieces, especially structural ones, leading to their collapse, we believe that some traditional architectural techniques and solutions may not be forgotten or ignored in order to avoid historical buildings' degeneration. We for instance mentioned the air chambers under the ground floors and the easy-to-make water-drainage systems in places where water runs down, like windowsills. Wood, as a highly hygroscopic material, while under continuously humid conditions, will get rotten, attracting xylophagous insects and leading to a possible infestation throughout the building.

Architectural solutions that reduce humidity in buildings and wooden structures are extremely important to their conservation. Therefore this conservation depends precisely on the use of techniques and materials from the Brazilian colonial architecture.

With the conservation actions above mentioned, it is frequently possible to avoid certain complex techniques with questionable results, such as chemical barriers, the insertion of superstructures and application of high-technology products without either taking into account the original structures or being sure of the real efficacy of those techniques for the old materials.

We have observed that in places where the materials were not affected by weathering or human action, the building system – even those made of earth and, thus, the most vulnerable – remains intact and well preserved.

An exhaustive investigation of damages, with a detailed diagnosis of the causes for degeneration, has resulted in both careful and successful interventions, with no loss of the intrinsic features of the cultural objects.

We finally conclude that knowledge of and respect for the traditional building techniques of Brazilian architecture, combined with the adoption of new materials compatible with the physical/chemical properties of the original and consideration of the final appearance of the complex, may be the fundamental premise underlying the preservation of the Brazilian colonial architecture. Generally traditional building technology does not involve high costs. This is a positive feature since economic aspects are crucial in a context where the financial resources available are insufficient for preserving the invaluable cultural collection of a continental-size country such as Brazil.

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