CASARÃO DO CHÁ RESTORATION AND RESCUE OF A JAPANESE WATTLE-AND-DAUB BUILDING TECHNIQUE IN BRAZIL

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Abstract

The technique of building with earth in Japan, especially wattle and daub, is one of the most advanced in the world. For more than a millennium, both the technique and the materials have been improving, adapting to the nature of the locale, including earthquakes, weathering, and temperature differences, among others. Such is the cultural consolidation of this technique that by referring to Japanese wall, wattle and daub is directly inferred. In Brazil, wattle and daub (*pau-a-pique*) is used in several regions; its implementation was present in buildings in rural areas, in coffee plantations and in colonial architecture. Despite this, the technique is currently undervalued.

The house of tea (*Casarão do Chá*) was built in 1941 of wattle-and-daub and eucalyptus-log structure. It is the first Japanese building declared architectural heritage in Brazil, and is currently being restored. The aim of this work is to confront the differences and similarities between the construction technique of the *Casarão do Chá* walls in relation to the Japanese technique; analyzing the techniques and materials used that replaced the Oriental materials. As a research method, it was necessary to save the original process that was used in this building, from the study of the Japanese plot as theoretical framework. Also the materials and construction methods were analyzed, permitting verification of adaptations to the set of procedures for conducting the restoration work. This work not only promotes the improvement of the Brazilian technique, it also creates an identity for the society with the declared heritage assets.

1. INTRODUCTION

Casarão do Chá (house of tea) was built in 1942, by Kazuo Hanaoka, a carpenter whose initial purpose was to develop a tea factory. The world was facing a period of war and exports of products from Asian countries had suffered a series of sanctions, which became attractive for some agro-industrial sectors in Brazil (Handa, 1987). At that time, the agronomist Furihata was the representative of the enterprise in Brazil called Katakura Gomei Gaisha, which had appointed Kazuo Hanaoka for the construction of the tea factory in the district of Cocuera, in the eastern rural area of the city of Mogi das Cruzes. The first migrants settled there in the 1920s, which was a time of great agricultural development for the Japanese colony. Many families went to this region in search of land for farming. After the arrival of the first immigrants, who initially came as workers for the coffee culture, the area of Barrio de Cocuera was basically composed of smallholders working in the cultivation of land with various products, such as vegetables, fruits and root vegetables (Saito, 1961).

For the construction of *Casarão do Chá*, the master carpenter had locally sourced materials, such as some varieties of eucalyptus for use in the main structures, rounded wood of smaller diameters for secondary structures, and bamboo to build the framework, which would be filled with earth mixed with straw. The roof used French-type ceramic tile, which relied on small beams of eucalyptus logs.

From its launch, the factory operated for 24 years. It was called Tokio Tea Factory *[Fábrica de Chá Tókio*], and all its production was directed towards the international market. The inner space arrangement was based on tea production, from the arrival of raw materials, dehydration, rolling, fermentation, drying, and packaging to the shipment of the goods.

2. *CASARÃO DO CHÁ* AND THE FACTORY SPACE

Casarão do Chá was built on two levels; the plan of the first floor was 35.50 m x 15.40 m, enclosing an area of 547.70 m²; and the second floor with its pink mahogany flooring had an area of 250.00 m². The upper floor was intended for the wilting of tea leaves, which was the first stage of the manufacturing process. Long net-

Fig.1 *Casarão do Chá*, Mogi de las Cruzes, Brazil (credits: Eduardo Gamboa, 2007)

a) b)

Fig.2 a) Japanese roofing structure – Nijubari Koyagumi; b) Western roofing structure - truss (credits: Mokuzoujikugumihou, Wikipedia.jp, 2011)

like fabrics were extended in several layers, so that the collected leaves aired until humidity was reduced to 65% (Almeida, 1957). This first phase could last from one to three days, depending on local weather conditions. After this stage, the leaves were sent to the first-floor level through tissue pipelines to continue with other operations, such as pressing for breaking the cell wall, sorting, fermentation (1), drying, roasting, storage and packaging (2).

The construction system adopted is similar to the Japanese traditional construction system. However, it differs in the structure of the roof, which used Western-style trusses. A system of beams and pillars is utilized in Japan to structure the walls, and horizontal and vertical elements (*hari, tsuka Bashira*) (3) make up the roof structure. The principle of using diagonal bracing elements is not part of the traditional Japanese construction system. According to Matsuura (4), vertical and horizontal elements in the structure, allow the construction's malleability.

Timber preparation encompassed the cut of eucalyptus parts, which were then submerged in a lake next to the building, following a leaching process contributing to the preservation of wood. Larger size and difficult to transport timbers were covered with a wet tissue, taking due care to keep it constantly wet for four weeks (5). The bark was manually removed using care to avoid marking the wood, and then the pieces that made up the entrance porch and other special elements were polished (Kuniyoshi and Pires, 1984). Once the wooden structure and the roof were assembled, the walls were made of the Japanese wattle-and-daub technique with a bamboo framework.

The origin of Japanese architecture comes from China and Korea, from which construction techniques were introduced in the Middle Ages during the period when Japan was isolated from the rest of the world. At this time, the technique was perfected through alterations in the original layout, with a more complex bracing system, which was also optimized during this period. The curving of the eaves was subtly adapted to the Japanese taste.

The peculiarity of the construction of *Casarão do Chá* is the fact that the carpenter, Kazuo Hanaoka (6), used un-dimensioned wood, utilizing the trunk and its branches in structural and aesthetic composition. This is the case of the main entrance pillars, where the branches from the main trunk aids in the support of the wooden beam that distributes the weight of the roof on the wall, permitting a roof cantilever of approximately 2.30 m from the column. The segment functions as a bracket, and at the same time it is elegant and its curvature assists in the façade's composition. In a similar way, other parts of the building also adopt this principle.

The use of wood in its natural state, as applied in *Casarão do Chá*, is also known in Japanese architecture. However, the plan of both tearooms, Chashitu and Sukiya (7), that comprise the teahouse, have somewhat limited space. The abundant use of these elements in the construction of *Casarão do Chá* is owed to the company administrator, Katakura, who allowed carpenter Hanaoka to freely use these elements. Hanaoka developed several spontaneous and creative works, for example the railing to the upper level, the division of compartments, and some roof structures. Moreover, the carpenter also included some elements of the traditional Japanese architecture, such as Irimoya, karahafu, and oogidaruki (8), resulting in a building composed of Eastern and Western elements and techniques.

3. WATTLE-AND-DAUB IN JAPAN

Despite having the basic materials, such as wood, earth and straw, Japanese wattle-and-daub structures differ from the wattle-and-daub method typically used in Brazil. Some of these differences relate to the structure of the framework, preparation of earth, and method of its application. Optimization of the Japanese technique developed over millennia, reaching its apex in relation to the dominant idea that it was a healthier, more sophisticated and comfortable wall, known as Tsuchikabe (9). This concept is the opposite of the image that the Brazilian population generally attributes to this technique.

Several tools were designed during the evolution of the Japanese technique, especially in the Middle Ages. In turn, experience with various materials developed based on earth, straw and other plant fibers, such as mitsumata (10) and the asa (11), as well as the use of resins from marine algae, virgin lime, and the combination of these elements in varied dosages, due to the peculiarities of each region.

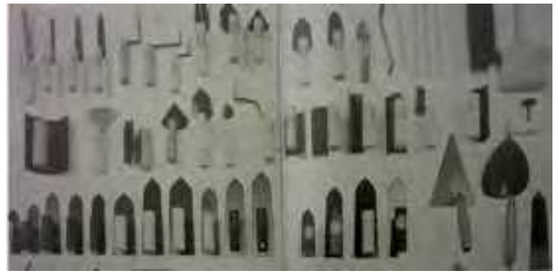

Fig.3 Llanas, trowels and other tools for building a wall (credits: Yamada, 2007)

The various properties of soil that serve as a basis for the preparation of earthen plaster and mortar, were already formulated through experience for use on walls, in order to resist the climatic conditions of each region. For example, in the region of Kochi (12), wattle-and-daub walls were finished in Tosashikkui (13), a milk-colored treatment characteristic of the region. It is applied to the last layers of wattle-and-daub walls. This provides weatherproofing, as well as, resistant to temperature variations and strong winds. The composition of the material for this finish was based on lime mixed with very fine plant fibers that prevent micro-cracking, giving greater stability to the applied material. Different types of adhesives were also added, such as those that were based on algae, which helped to improve the walls' resistance to temperature variations, also ensuring its durability and waterproofing over time (Yamada, 2007).

4. THE JAPANESE WATTLE-AND-DAUB OF *CASARÃO DO CHÁ*

The wattle-and-daub used in *Casarão do Chá* is quite simple if compared with the more sophisticated techniques used in Japan, and there are a number of technical and material adjustments used. However, the structural principles were preserved: the load distribution of the wall is given, not only at its base, but also in the setting of the entire peripheral structure.

In *Casarão do Chá*, the original material used in the structure's frame was solid wood and not bamboo, though the framework was of bamboo, split into strips of about 3 cm, which were largely tied with annealed wire. The substitution of solid wood for bamboo was the result of the abundance of this material in the working environment. The split bamboo is the original form, which was also used in the restoration. The earth applied on the framework was carried out in four stages: a) arakabe (gross wall); b) nakanuri (intermediate rendering); c) uwanuri (plastering); and d) shiague (finishing) (14). These stages occur as the previous stage is consolidated, and it starts with the application of the first layer on one side of the wall. The preparation of the earth for the gross wall is made at least three months before its application. The clayey soil is submerged in water for at least two days. This procedure hydrates the earth and stabilizes the organic matter and microorganisms that are present in the soil.

After this stage, chopped straw of about 10-cm long is placed. In the original wall, a straw called Sapê was used (15), whereas in the refurbishment, rice straw was utilized, which is the material most commonly used in Japan. This selection of vegetal fiber is due to the fact that Sapê was not available in the region, since it is collected in the autumn. According to the local population interviewed, the earth preparation was carried out in the spring. The ancient inhabitants of the region are important carriers of knowledge to augment the selection of materials, and the correct period for their collection, as they know the appropriate moon, as well as the seasons favorable for planting and cutting of trees. Despite the fact that several of these concepts became legends, knowledge was based on their own personal experience, as well as the experience of the population, in general.

The mixture of straw with earth was gradually prepared for three months. The chopped straw was distributed over the earth and compressed homogeneously to mix well with the earth. The amount of straw varies greatly, depending on the type of earth. According to some data, both from Japanese literary sources and the experience of professionals in the area, for every 1 m^3 of earth, between 15 kg and 60 kg of straw is added. During this three month period, the mixture of straw and earth goes through a fermentation process, altering the color of the earth because of the decomposition of the straw, as well as biological and chemical processes that increase the binding capacity of the earth by improving its plasticity and ultimate strength, enabling its ease of application on the wall.

In addition to discoloration, the odor is quite strong and the temperature rises during fermentation. These indicators are observed when the mixing process is manually accomplished. Therefore, there is no single standard that defines the proportions of the various materials in the mixture. According to information obtained by specialists on the subject (16), verification is based on experience and know-how, as the base material itself, earth, differs from one place to another. The differences in the percentage of clay, silt, sand, and organic matter, among other intrinsic soil characteristics, is what determines the ideal dosage of the different elements, in order to develop a wall with a good level of performance.

After preparing the earth, the first application is made from the inside out, so that the inside layer dries quickly, taking around 15 days. After that, the outer layer is applied. Some of the variables to be taken into account for the application and drying are: a) individual method of the person performing the 'seasoning of the earth'; b) wet or dry weather periods, because in dry periods the wall cures faster; and c) the orientation of the building in relation to the incidence of sun, wind and rain, as for example in the application of layers during the rainy season causing delays, where the application of the next layer cannot be performed for months. On the other hand, constant sun and strong wind exposure can accelerate the dehydration of the earth, causing significant cracks and curvature of dry earth.

When the first earthen layer is applied on both sides and its dehydration and curing environment is favorable, the wall acquires strength and endurance. Fixing the earth of the first application to the bamboo is accomplished with excess earth squeezing out on the opposite side of the application. These irregular earthen protrusions become mechanical keys that assist in the cohesion of the different materials. Cracks appearing from drying shrinkage vary from a few millimeters up to 1.3 cm; these are relatively high if compared to Japanese examples (17). A high percentage of clay in the earth used at *Casarão do Chá* resulted in an increase in the strength of the wall. However, cracking also increased, demonstrating that the relationship of the grain-size distribution of the earth must also be taken into account.

The principle of application by layers is specifically to ensure resistance of the first layer, which provides the structure for the wattle-and-daub wall. Gradually, the following layers are less resistant and, therefore, more stable. Clayey earth is mixed with sand and lime, and chopped straw can gradually be used up to the second layer, with lengths ranging from 5 mm to 12 mm, to assist in the deformation of the cracks caused by the first layer. The straw mixed while preparing the earth of this layer should be chopped into smaller pieces, about 2 cm to 3 cm. The third layer is applied after the drying of the previous one. It is, therefore, necessary to hydrate the substrate for the application of the next layer, as application on a dry surface may cause an accelerated dehydration resulting in cracks and/or good adhesion between layers may not occur. As the more stable materials are gradually applied, the wall is prepared to receive the next layer. The sequence of increasingly less thick layers is applied externally. In Japan, this process can include up to nine layers depending on the desired finishing.

Retraction manifests itself differently, depending on the thickness of the applied earth to the outside of the wall. The surface with the smaller cracks corresponds to the lesser thickness of the layer applied over the surface of the column, which is inside the wall. To allow a better adhesion to the surface of the column, sisal ropes are placed vertically and secured with nails. The distance between the ropes is about 3.3 cm (18) and approximately 70cm between the nails.

In the case of the walls of *Casarão do Chá*, and because it is a building erected for tea production, there was no need for a more sophisticated finish. However, it was necessary to create a white wall without porosity for reasons of cleanliness and maintenance.

5. THE FRAMEWORK OF THE WALL

The wall framework is the base on which the earth is placed. The closure of the openings between the studs is performed in two stages. The first is the construction of frame that is structured with bamboo logs with an approximately 4-cm diameter, in a pattern of about 40 cm x 40 cm distance. The bamboo is tied with straps to form the framework. Bamboo straps are tied onto both sides: vertically on the inboard side and horizontally in the outboard side. There is actually no criterion defined with respect

a) b)

Fig.4a) Shrinkage fissures resulting from drying of the first earthen layer; Fig.4b) Appearance of the inboard side (credits: Akemi Hijioka, 2010)

to the direction of the bamboo straps (19). However, in the case of the refurbishment of *Casarão do Chá*, the logic used was as follows: by applying the earth on the inboard side, the surplus that extrudes to the outboard side could be better embedded and supported if the bamboo straps were placed horizontally.

Three types of bamboos (20) were used in *Casarão do Chá*. The bamboo is selected based on function (choice of diameter) and age. The driest period for cutting bamboo influences its durability, minimizing the attack of termites and other xylophages. Bamboo of around 5 cm in diameter was divided into six longitudinal portions, obtaining strips of 2.5 cm to 3 cm width. Length varies depending on the span. In the case of *Casarão do Chá*, the three types used included 600 units of the first type of bamboo, 600 units of the second type, and 500 units of the third type, totaling 1,700 pieces of varying lengths.

The original walls built in 1942 were largely in good condition. However, the deterioration of the wooden structure of the building led to the decision for the removal of the wall. For the structure of the frame, buxom wood of various species was used, secured with bamboo straps and tied with annealed wire. In parts, the frame structure was destroyed by attack of xylophages but the earth was still intact, creating small tunnels inside the wall. The wall panels were in good condition. However, all wood structural elements, such as columns and beams were affected. So, although the earthen wall had not been harmed, it was necessary to remove it to change the columns and beams.

The frame structure is embedded in the peripheral structure through 2.5 cm ties made at the columns and the beams. Thus, besides a proper connection, the wall load is also distributed along the periphery of the structure. This also allows the removal of the walls in a practical way, because the dovetail (cuts on wood) makes it possible to remove the panels without interfering with the structure of the building.

6. CONCLUSION

The use of earth and wood is a principle of traditional Japanese architecture. Great temples and palaces have lasted for centuries, such as the building, Horyuji, which is 1,300 years old.

The *Casarão do Chá* is a building that imparts some of the principles of traditional Japanese architecture. It does not embody a simple transfer of technology, but it has implications for the understanding of the know-how manifested in every detail of its construction.

Knowledge was transformed into know-how through adjustments, alterations and adaptations to the new environment and new materials; and all of these changes are embodied in the building. The renewal allowed the deconstruction of the construction process that brought to light technical and historical information to be analyzed for the preservation of the building over time.

The optimized evolution of the technique occurred gradually and was consolidated in Japanese culture as a noble material, healthy, safe and refined. Contrary to the concept established in the East, wattle-and-daub in Brazil, for most people, is associated with insecurity, poverty, poor health, and improvisation, among other negative connotations.

By reviving the technique of Japanese wattle-and-daub applied in *Casarão do Chá*, it is possible to explore the current application of this technique, effective for use in the construction of more sustainable housing, and that contributes to change the negative concept still associated with it. This restoration experience also raised several questions that are in the process of being addressed, through data collection and systematization.

Notes

(1) This phase is described in most operations as fermentation; however, it is actually oxidation.
(2) Vicente Unzer Alemeida from the School of Sociology and Politics of São Paulo describes the tea-manufacturing phases in a study on the occupations of Ribeira Valley.
(3) Hari refers to the horizontal element, and tsuka or tsukabashira to the vertical piece of the roof structure.
(4) Shoji Matsuura in Miyadaiku Sennnen's "Te to Waza" analyzes the construction elements of wood in relation to flexibility from their positions and functions. He also claims that excessive rigidity resulting from the locking system is against the nature of the exertion demanded, and to which the building is subjected.
(5) Kuniyoshi, C. and Pires, W. in Casarão do Chá, an interview with the carpenter's family, recounts the sequence to prepare the wood for use in construction.
(6) Master Carpenter, from the Province of Nagano. He arrived in Brazil in 1929 as an emigrant invited by the company administrator Katakura Gomei Kaisha, Furihata.
(7) The Sukiya (数奇屋)-style house adopts some principles of the art of the tea ceremony or ikebana.
(8) Designations on the drawings of the Japanese roof.
(9) Tsuchikabe (土壁) is composed of the ideogram for earth and wall, meaning a wall with earth relating to various techniques, including bahareque with bamboo attachments, as well as rammed earth.
(10) Vegetal bush (Edgeworthia chrysantha) used as a raw material in papermaking, composed of malleable and resistant, fine fibers. There are records that Mitsumata was used since the 16th century, and in some literature, even earlier.
(11) Vegetal bush (Cannabis) used since ancient times by Japanese agricultural culture. Its fiber was used in the manufacture of fabrics, ropes and utensils, as well as its seed, which was used for oil production.
(12) A province located on the island of Shikoku in the Pacific Ocean. Strong winds blow from the sea.
(13) Tosashikkui is the name of the finishing technique. Tosa is the ancient name of the province of Kochi, and Shikkui is the final lime-based finish layers.
(14) This sequence is commonly used in the implementation of Japanese wattle-and-daub; the initial three layers are typical of Japanese bahareque walls. Generally, the difference is in the final layer of the finish.
(15) A plant of the grass family (Imperata brasiliensis) whose leaves and stems are widely used for roofing of rustic houses.
(16) Communication with Professor Nakao, from the Tajima Technical University in the province of Hyogo, who through the model specialist, Prof. Seiji Yoneda, sent information about the process of preparing the earth for Japanese wattle-and-daub walls.
(17) The Japanese examples suffer minor rebound only. Cracks in the first layer vary no more than 0.5 cm (5 mm), according to information from the previous source.
(18) A measurement corresponding to 1 Sun (寸), the Japanese unit of measure, and the canon adopted for all measurements in Casarão do Chá.
(19) Information obtained from literature research, and from meetings with Japanese specialists on the topic, such as Sakan (a professional specialized in walls) and Prof. Nakao, Tajima Technical University.
(20) The first type was peasant bamboo, then Hachiku bamboo (Japanese species of compact fibers with good strength and workability), and finally the ones of smaller diameter used as fishing poles. These three types of bamboo form the supporting structure.

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CORNERSTONES COMMUNITY PARTNERHIPS (USA) ASSISTS COMMUNITIES IN PRESERVING THEIR EARTHEN ARCHITECTURAL HERITAGE

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Theme 9: Education, Dissemination and Outreach
Keywords: Training, community, partnerships, volunteerism

Abstract

In 2011, Cornerstones Community Partnerships celebrated 25 years of outreach: disseminating information and educating Southwest communities about the regional heritage of earthen architecture. Cornerstones began when a conditions survey of over 300 adobe churches, missions, and moradas took place, resulting in the 1986 formation of Churches: Symbols of Community, whose mission was to strengthen communities by assisting in their preservation of historic buildings and cultural traditions. In 1994, Churches became Cornerstones Community Partnerships, a non-profit corporation.

Initially, work focused in northern New Mexico, home to a unique patrimony of vernacular-earthen architecture; Cornerstones has now built a national and international reputation for the creative use of historic preservation as a tool for community revitalization, the affirmation of cultural values, and the training of youth in traditional-building skills and sustainable-construction methods.

The largest aspect of this work has been the dissemination of skills and methodologies used for centuries to maintain and perpetuate earthen architecture. Cornerstones' goal has been to educate communities and others about the benefits of traditional building, while also taking into account the very real situations of each work site and community. To this end, different strategies are employed concerning community volunteerism and outcomes. These strategies have also pushed Cornerstones' staff to develop new outreach materials and partnerships. An examination of past and present projects (Pajarito, Socorro, San Miguel, and Santo Domingo) demonstrates these processes of education, strategies, and developments, and the paper concludes with a commentary about the future.

1. INTRODUCTION

In 2011, Cornerstones Community Partnerships celebrated 25 years of outreach: disseminating information and educating Southwest communities about the regional heritage of earthen architecture. Cornerstones has assisted over 260 communities in their preservation efforts on over 300 structures. In reviewing this achievement, we are reviewing our past and planning the future, celebrating successes, focusing on challenges, and continuing to learn.

2. THE FIRST 25 YEARS

Cornerstones began during the 1980s, when a statewide assessment of over 300 adobe churches, missions, and moradas took place, resulting in the 1986 formation of Churches: Symbols of Community, whose mission was to strengthen communities by assisting in preservation of their historic buildings and cultural traditions. In 1994, Churches became Cornerstones Community Partnerships, a non-profit corporation. Initially, work focused in northern New Mexico, home to a unique legacy of vernacular-earthen architecture, but has extended throughout the southwest and into Mexico.

2.1 Community support and cultural revitalization

Communities in the Southwest are particularly rooted in traditions and customs relating to all aspects of life. In Pueblos, feast days bring back family members from all over the country to dance, cook and eat together, and renew family bonds. In small villages, the annual clearing of the acequias (irrigation ditches) for spring and summer farming and the renewal of adobe plaster on the community church have helped keep communities together. Sadly, due to the passage of time, demographics affecting community and the onset of 'modern practices', many of these rich traditions and skills have weakened or have been forgotten. As a result, when historic buildings need repair, there may be no one with the knowledge to accurately assess and repair damage; and there may be no one strong or young enough to begin and complete the necessary work. Cornerstones has sought to fill