Architecture Integrated to Nature: the Use of Timber by Severiano Porto in Brazilian Amazon

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ABSTRACT: The establishment of a close relationship between nature and architecture consists, among other things, in the search for a proper use of natural resources, in the adjustment to local context and environment, in the use of passive systems of acclimatization to obtain comfort. Severiano Porto was the pioneer architect to actuate in the Amazonian region by using these principles, diffusing new ideas of space treatment according to the environment and giving attention to important aspects of the regional architecture. The idea of bioclimatic architecture frequently appears in the architect's works, and comprehends adjusting the building to the region's climate, materials, processes, local conditions, showing a concern with the integration between construction and nature. This paper analyses Porto's architectonic production in timber in the Amazonian region, on the purpose of showing his contribution to the development of a less aggressive architecture, more attentive and integrated to the environment. It presents the architectonic solutions used to adapt his buildings to the hot and humid weather of the region, by the study of two of his main works, where the use of timber was esthetic and structurally explored: the architect's residence, of 1971, and the Balbina Centre for Environmental Protection, of 1983-88.

Keywords: bioclimatic architecture, timber, Amazon

1. INTRODUCTION

Bioclimatic architecture is a conception created to describe the architecture that satisfies comfort needs of human beings, is attentive to climatic conditions, uses techniques and materials available in the region and tries to integrate as most as possible the building with the surroundings.

This is a recent concept – remains to the 1960s – that has been incorporated and discussed in specialized literature. It appeared as a form to stimulate the production of an architecture adequately introduced in the social and cultural context of the site, in harmony with the topography that uses natural resources of the region and seeks thermal, luminous and acoustic comfort.

The expression is strongly related with the construction of spaces of high energy efficiency, where the most important task is to work in harmony with what the environment offers, adapting as most as possible a building to the local climate, always trying to reduce the necessity of mechanical systems to achieve this aim.

1.1 The Architect Severiano Porto

Severiano Porto, with his work in the Amazonian region, integrates the group of Brazilian architects that diffused a regionalized architecture by the country's territory, in the 1960 decade. Together with his partner Mario Emilio Ribeiro, he built most part of his works in Amazon, especially in the city of Manaus, where he lived and worked during 36 years.

The region, which has plenty of native forest, demanded a close relation with the environment. It was by trying to establish this relation that Porto searched, since the beginning of his work, for a deep contact with climate, society and local culture, which enriched enormously his production.

"[...] without excluding his own background, the architect began a long and loving apprenticeship of the Amazonian way of life." [1]

Great part of this involvement was resulted by the contact Porto established with local population, named "caboblo". Based on empiric knowledge, they had a lot to teach about local materials and construction methods.

The bioclimatic issue was always a priority in his work, since he was dealing with a delicate site of intervention. That is why his architecture is called "Amazonian", because it is an architecture that searches how to deal with all the peculiarities of the region, mostly of resources and specialized labourers.

In Porto's definition of architecture this intentions become clear: "Architecture is a group of factors that are interlaced and grouped according to the needs of a program, the **specific conditions of a site**, the **resources of its region**, its **environmental conditions**, **technology** to be used, ancient, **regional**, and all other existent in the epoch, financial possessions, etc. All the factors transformed in space in a sensible, logical, technical and beautiful manner." [2]

1.2 Use of Timber

When Porto arrived in Brazilian Amazon, the region had very few professionals in the construction area and the idea of adapting the building to local conditions was almost nonexistent. The architect put

in question the architecture that was being produced in the epoch, which followed the Modern of magazines and was distant from local reality. He started to introduce new patterns and construction methods, always searching for a better way to integrate architecture and nature.

When Severiano left the city of Rio de Janeiro, where he lived and worked, to go to Manaus, his first preoccupation was to adapt all his background to the new situation. In other words, adapt his production to the presented technology, the existing materials and the knowledge of local labourers.

The use of timber in the Amazonian region was, thus, a natural consequence of the intention of using proper materials. It is easy to obtain, easily manipulated by local labourers and adequate to thermal conditions.

Figure 1: Severiano Porto's caricature, related to his significant work in timber [3]

It was observing the habitants in their own habitat that Severiano noticed the importance of giving more value to timber and local techniques, more adjusted to the specific circumstances of the area.

By the moment Porto started working with timber he found some difficulties, due to the prejudice of local population with the material. Until then, timber was directly related to the precarious construction of popular habitation. However, the architect started to show the people that it is a noble material, adequate to the climate and the local reality, and that can be used in buildings with quality. He proved this by constructing his own house in timber, in an epoch it was seen with many restrictions.

"We must adopt solutions that consider solar radiation, wind, rain, our labour conditions, the building material and there we include the timber, plenty and abundant in our forests." [4]

In spite of being known as an architect that worked exclusively with timber, Porto and his partner Ribeiro produced significant works in other materials. Anyway, the exceptional way they used timber – not just esthetically but also by adapting to the climate and environment – turns important this research.

Two of his main works were chosen to be analysed here, with a discussion of the architectonic solutions presented, emphasizing the strategies created to achieve thermal comfort. They are the architect's residence, of 1971, and the Balbina Centre for Environmental Protection, of 1983-88.

2. ARCHITECT'S RESIDENCE, 1971

The facility of constructing in timber in Amazon made Porto choose the material to build his own house. The house needed to be built rapidly (in about six months) and with low costs. Timber was appropriated to these intentions, because it was a cheap material, easy to obtain and well known by local labourers. The architect could reduce the price of the construction in 25% in relation with houses that were being built by the COHAB (houses built by the government to poor families) of the epoch. [5]

An important guideline for the project was the intention to cause a minimum impact in the environment, by considering, since the beginning, the specific conditions of the site, and searching for maximum integration with the surrounding vegetation. The terrain was situated near a rivulet and maintained its original vegetation.

The two-storey house has its structure in "sucupira" and "maçaranduba" timber (local species), concrete is just used in the structure of bathrooms. Ceramic and timber covers the two floors. The roof is covered by asbestos-cement tiles.

The living room and the stairs are around an internal garden, opened in the ceiling, which organizes the entire layout. The second floor contains two bedrooms and an office. There is a strong integration with the outside area, provided by an open planning that gives the sensation that the house and the terrain are a unique element.

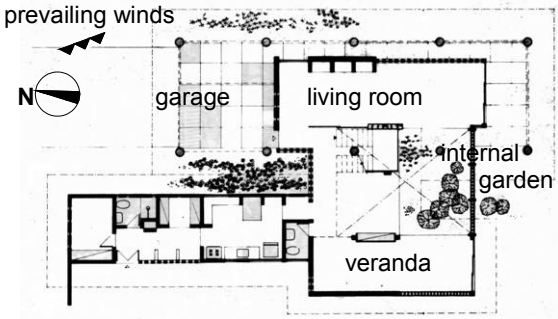

Figure 2: Ground floor plan [6]

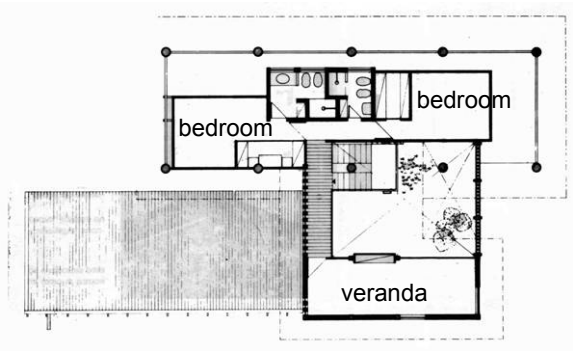

Figure 3: First floor plan [6]

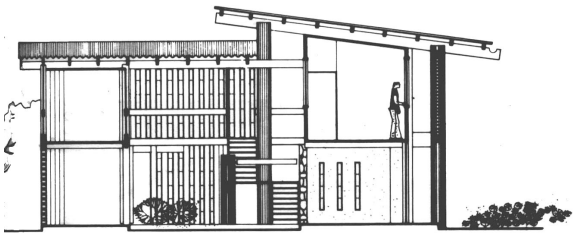

Figure 4: Transversal section [6]

2.1 Bioclimatic Strategies

The house presents creative solutions that intend to adapt the construction to local climate and provide thermal comfort. The use of large overhangs and verandas in the west façade attenuates the unfavourable orientation. A fixed panel made of horizontal shutters above the garage is a shading device that helps to obstruct the solar radiation and the rain, without obstructing the air circulation. Perforated panels also ventilate all the attic space, that is composed by a timber ceiling and the asbestos-cement roof.

Figure 5: View of north and east façades [7]

The existing vegetation of the terrain was well preserved and helps to maintain a more stable microclimate, with lower wind temperatures. It also helps to reduce the solar radiation that reaches directly on the roof. The asbestos-cement tile gets darker in a short period of time, due to the hot-humid weather and fungal growth, resulting in a higher absorption of solar radiation and consequent transmission of heat, by radiation, to the ceiling and the indoor area.

"Lightweight roofs, covered with tiles or sheets of asbestos-cement or aluminium, are preferable in a warm-wet climate owing to their low heat capacity. But such roofs, which are externally usually dark in colour, or at any rate, not whitewashed, are heated by solar radiation and may cause heat stress during the daytime." [8]

The protection from solar radiation by vegetation is of great importance, and contributes to improve the internal microclimate of the residence. The internal garden also contributes to this matter.

Some outside walls are made of concrete perforated elements – like windows that cannot be closed – to provide natural ventilation. These are characteristic devices of Brazilian Modern architecture, called "cobogos", and help the house to always be opened to the northeast prevailing winds. The ground level also has vertical windows with yellow glass that provide more luminous comfort to the interior. The result is a permanently ventilated space around the internal garden.

Figure 6: Internal garden, surrounded by concrete perforated elements and vertical windows [9]

In the bedrooms, horizontal shingles made of wood and adjustable shutters are satisfactory shading devices that constantly controls heat gains and allows cross ventilation.

Outside walls are made of timber, which ensure a low heat capacity to the building and prevent heat accumulation during daytime, according to Givoni: "Because of the permanent ventilation requirements and the small outdoor diurnal temperature range characterizing the warm-wet climate, it is not feasible to utilize the heat capacity and resistance of the walls as a means of reducing the daytime temperatures to those below the outdoor level." [8]

Inside, there are some walls made of stone, a heavyweight material, of high effusivity and low diffusivity. This material can be appropriated to internal spaces in hot-humid climates, since it can absorb part of the thermal energy of indoor air and improve indoor thermal conditions.

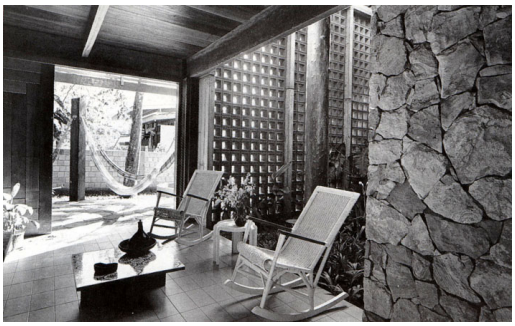

Figure 7: Inside area, with wall made of stone [1]

The residence received a prize from the Brazilian Architect's Institute (IAB), for using timber in an appropriate manner, according to the climate and the environment, becoming an example of architecture

harmoniously introduced in the regional context. "[…] excellent idea from the author, consistent, elaborated with Brazilian vocabulary […] without being alienated by the contemporary techniques." [10]

3. BALBINA CENTRE FOR ENVIRONMENTAL PROTECTION, 1983-88

The Balbina Centre for Environmental Protection is situated in the city of Presidente Figueiredo, near Manaus. It is a remarkable work, considering the exceptional place it occupies in Brazilian architecture. Inside this context of study, it presents singular and creative solutions; timber was worked in a peculiar form, either esthetic and structurally. This is why Balbina is considered a building where the regional character was greatly refined.

"Severiano Porto and Mario Emilio Ribeiro's work is remarkable for many reasons, but mostly for the sensitive and sophisticated use of wood in all its potentialities and for the easy elegance with which the various spaces are arranged under the beautiful continuous roof." [11]

Balbina is a hydroelectric power station built in the 1980 decade, to provide energy to the city of Manaus. At this time, Porto was called to do the project of a centre for environmental protection, which would be responsible for studying the effects of the hydroelectric power station on the eco-system, taking into account the environmental impacts such undertaking would cause in the forest, climate, fauna and flora, etc. The centre would be responsible for studying ways to reduce the damage from the environment to a minimum.

Since a very large area would be flooded, part of the forest would be drowned, so the architect had the liberty to use as many wood as he wanted in the construction, from various species and types.

Porto worked with timber, in this building, in a completely free way, using it in several different forms: trunks, rectangular columns and beams, planks and boards.

The building's program includes two blocks: a research centre, with laboratories and spaces to collect data; and a lodging area. Only the research centre was built.

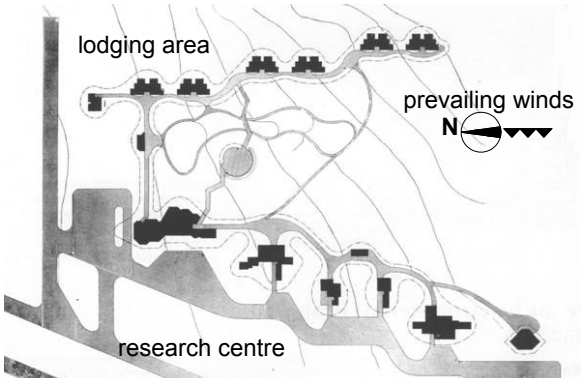

Figure 8: Site plan [11]

Figure 9: Perspective view of the complex [12]

3.1 Bioclimatic Strategies

Severiano used, to cover the roof, a regional type of tile called "cavaco" – shingles made of splintered wood, produced on the spot by local labourers. According to the architect, the "cavaco" gives a great formal liberty, much more than common ceramic tile, since it can support any kind of design and curves. It also has advantages in comparison with the straw – a material frequently used in the region – because of its higher durability. It gives good answers to the climatic conditions, since it is a lightweight material, of low heat capacity.

Figure 10: General view [13]

The roof is a continuous and unique surface that covers the whole complex, varying in form, height and width, providing wide protection from solar radiation and rain. Under this envelope, the building is adapted to the natural declivity of the terrain. Spaces are located in different levels, connected by ramps, all of them independent from the roof and protected by a wide overhang. They are located in regard to the prevailing winds of the site, which are east-west.

Figure 11: Covered pathways [13]

Vegetation follows the sinuosity of the roof, helping to absorb solar radiation and to provide lower temperatures for the pathways through the building.

Brick walls and timber ceilings compose the closed spaces under the roof. Some laboratories, which demand the control of temperature and humidity, are closed and have air conditioning. These rooms have skylights, where the structure of the roof can be observed. The other rooms count with cross ventilation, guaranteed by openings located in both the windward and the leeward sides of the building.

Between the roof and the ceiling is a ventilated attic space that ensures better thermal comfort to indoor areas. The distance between roof and ceiling can reach eight meters at the higher parts. Some indoor spaces are opened in the ceiling and have only a protection against the intrusion of insects.

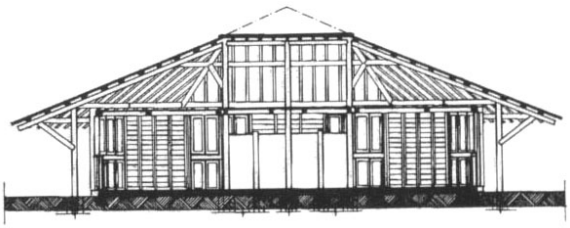

Figure 12: Longitudinal section - storage [11]

Nowadays, the centre does not work for its original function, it is only used for tourism activities. The Balbina hydroelectric power station does not produce sufficient energy to supply the city of Manaus, and is considered an undertaking of high ecological impact to the environment.

5. CONCLUSION

The two buildings chosen for this analysis show strong characteristics of Severiano Porto's architecture: the choice of materials in consequence of the peculiarities of the site and the availability of the region; the integration with the surroundings and the environment as a way to reduce the impact of the intervention; the careful attention to the thermal comfort issue, priority in a hot-humid weather; the attention to the prevailing winds, always making use of natural ventilation.

Along his career, Porto produced almost 200 projects, great part from the 1970 and 1980 decades. After Balbina, his two main works are the Ponta Negra urban intervention (Manaus' suburbs), of 1992, and the "Aldeias Infantis SOS" village (Manaus), for homeless children, of 1994-97.

The establishment of a close relationship between architecture and nature is well expressed in Porto's work, each building in a different way. These constructions are main examples of bioclimatic architecture in Brazilian Amazon until nowadays.

After 36 years of work in the Amazonian region, Porto left Manaus in 2001 and returned to Rio de Janeiro. Nowadays he is retired, and received a title of honour from the University of Rio de Janeiro (UFRJ), where he eventually gives some classes and explains about his techniques.

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