WCTE 2014 Quebec City Canada August 10-14
World Conference on Timber Engineering

WOODEN STRUCTURES IN BRAZIL: PRESENT SITUATION AND PERSPECTIVES

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ABSTRACT: The use of wood for construction is increasing every year in Brazil. This paper gives an overview of the use of wood in Brazil with a short historical and geographical introduction followed by a number of examples of works by Ita Construtora, which will illustrate the market developments during the last 34 years of its existence.

KEYWORDS: Timber construction in Brazil, WCTE 2014, House Hélio Olga, Haras Polana

1 INTRODUCTION

Brasil has almost 50% of its territory covered by the Amazon Rain Forest in addition to big forests planted with eucalyptus and pines. However, the use of wood in civil construction, especially in structures, is still much reduced. In recent years we have noticed a resumption of the use of wood. Due to environmental issues, relatively low costs, facility to be obtained, appearance and comfort, wood arouses each day more the interest of engineers, architects and consumers.

Our purpose is to give you an overview of the use of wood in Brazil with a short historical and geographical introduction followed by a number of examples of works by Ita Construtora, which, as of the 80s, have been a roadmap to better understand the changes that have come about. From a start point of traditional constructions using wood from native forests, we moved on, in the 90s, to the execution of contemporary architecture works of more complex structure. This rich collection of experimentation will be the base for a new leap. Since 2008 we have started the production of glue-laminated eucalyptus timber. The freedom of form and the big dimensions of the parts change the way of thinking structures.

The home of Hélio Olga, designed in 1987 by the architect Marcos Acayaba and the Haras Polana, designed in 2009 by architect Mauro Munhoz, the most representative works of these two last periods, will be presented in detail, among many others that well illustrate the evolution of constructive process.

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2 THE WOOD IN BRAZIL

The name of Brazil comes from the first raw material exported by the country: the wood of a tree called *pau-brasil* (*Caesalpinia echinata Lam.*, Figure 1), used to dye fabrics in Europe.

Figure 1: *pau-brasil tree (Caesalpinia echinata Lam.)*

2.1 A LITTLE BIT OF HISTORY

Wood is a material widely used in construction in Brazil because it has a relatively low cost and it is easy to process (does not require expensive equipment or hand labor very specialized).

Since the early Portuguese colonization was widely used in construction and shipbuilding, furniture, the frames, tools and as a source of energy. It was easily found all along the Brazilian coast (Atlantic).

Throughout the occupation of land by the expansion of agricultural activity process, the wood was a major byproduct. The southern region, the largest grain producer in the country, had the largest pine forest in Brazil, Araucaria, covering virtually all of its territory.

Figure 2: *Araucária tree (Araucaria angustifolia)*

As the frontier expands, the logging activity moved together till it reached the Amazon.

Despite the clear vocation for forestry and extraction of the region in the late '60s, with government support, large agricultural projects initiated destruction that lasts until today. Only a small part of the wood was processed, while most were burned to open pastures that after a few years began to decline.

Figure 3: *Former forest area transformed into pasture*

2.2 PRESENT SITUATION

In older areas logging is based on reforestation for production of cellulose. The timber is becoming an increasingly important byproduct, and through own sawmills or as suppliers of logs to third parties, paper manufacturers are allocating areas for the extraction of timber for construction and furniture.

Regarding Brazil's natural forest resources, we cannot fail to mention the Amazon. The area occupied by the so-called Legal Amazon area represents approximately 33% of the national territory, or 2.8 million km². The current timber reserves are estimated at 50 billion cubic meters, distributed in more than 4000 tree species, according to CALIL [1].

Figure 4: *The Legal Amazon*

It is estimated that the forest has already lost around 20% of its original vegetation, and recent data point unfortunately for an increase in deforestation in 2013, contrary to what was happening until 2012, which was a declining trend. Among the factors of the increase, the two most important and known: land speculation and the effect of infrastructure works without proper environmental safeguards.

Extensive cattle ranching in the Amazon suffers from increasing degradation of pastures by fires and erosion. In some areas, usually more difficult to access in abandoned farms, the forest is recovering naturally favored by heat and humidity and some experiences of reforestation with native species present good results. The natural recovering process is accelerated and directed toward the production of more valuable woods.

Today, only 1% of the timber produced in the Amazon comes from managed forests, certified by international organizations (“green seal”). The remaining production is done without control, often clandestinely.

2.3 NATIVE FORESTS VS. PLANTED FORESTS

2.3.1 Native Forests

IMAZON [2] says that in 2009, 2.226 logging companies were identified in operation in the Amazon and extracted around 14.2 million cubic meters of wood in native log, the equivalent of 3.5 million trees. The estimated timber industry gross revenue in 2009 was approximately U.S. $ 4.94 billion. The consumption of wood logs has been decreasing every year from 1998 to 2009, especially between 2004 and 2009. That fact can be explained by 3 major causes: 1. Substitution of tropical timber by

competing products (PVC ceilings, aluminum window frames, MDF used in furniture, planted forests in general); 2. Increase in surveillance and; 3. 2009 Economical World Crisis.

State	Number of Companies	Consumption of wood logs (thousands of m³)	Processed production (thousands of m³)	Jobs (direct + indirect)	Gross Revenue (R$ million)
Acre	24	422	193	4.641	181,96
Amapá	48	94	41	1.516	32,10
Amazonas	58	367	142	6.525	115,19
Maranhão	54	254	90	3.975	59,00
Mato Grosso	592	4.004	1.795	56.932	1598,36
Pará	1.067	6.599	2.550	92.423	2177,61
Rondônia	346	2.220	925	34.825	713,49
Roraima	37	188	70	2.865	62,66
Amazon	2.226	14.148	5.806	203.702	4.940,39

Figure 5: *Number of companies, consumption of wood logs, processed production, jobs and gross revenue in the Amazon in 2009*

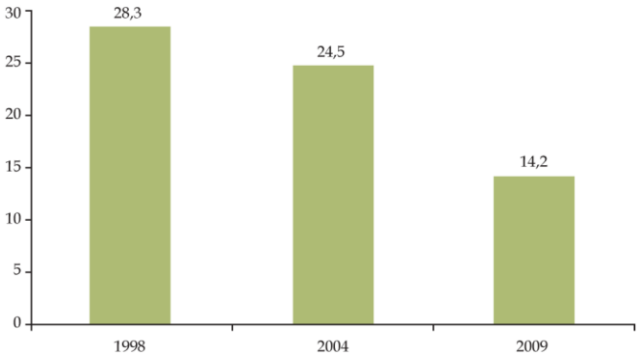

Figure 6: *Consumption of wood logs - evolution in the Amazon in 1998, 2004 and 2009 (thousands of m³ log/year)*

2.3.2 Planted Forests

According to the Brazilian Association of Forest Plantation Producers, ABRAF [3], between 2004 and 2012, cumulative growth in area planted with Eucalyptus by ABRAF member companies was 50.4%, continuing an eight-year trend. With regards to Pine plantations, growth was 1.3% compared with 2004. Nevertheless, cumulative growth of area planted with Pine has fallen over the last two years.

In 2012, the area planted with Eucalyptus and pine plantations in Brazil reached 6.66 million hectares, a growth of 2.2% in relation to 2011. Eucalyptus plantations account for 76.6% of the total area, and pine plantations for 23.4%.

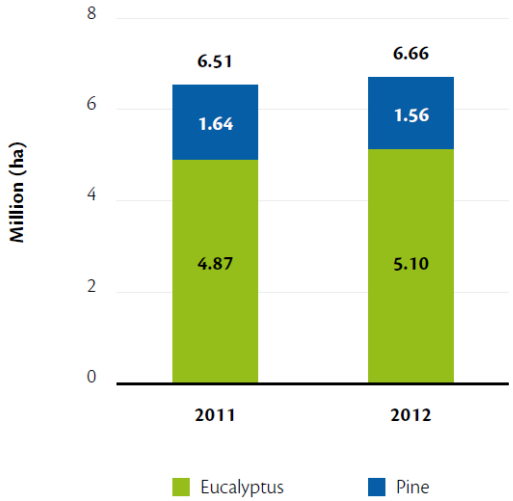

Figure 7: *Distribution of forest plantation area in Brazil by genus, and area of Eucalyptus and pine plantations in Brazil, 2011-2012 [ABRAF]*

3 WOOD ARCHITECTURE IN BRAZIL

Brazil was originally covered by forests, almost untouched. The first use of the wood in architecture was done by the Indians that used it on their *Ocas*. With the arrival of the Portuguese colonizers in 15th century, the wood started to be used in their buildings, but with the same indigenous techniques. Buildings were basically made of wood.

Figure 8: *Indigenous Oca*

Over time, wood has become an important source of energy and ceased to be used in construction for a long period, to be used only in secondary applications. Wood appears on architecture again with the second phase of colonization in the 19th century, with the arrival of the Germans, Italians, Swiss, Austrian, and Polish among others, to the south of the country.

Figure 9: *Log home - Polish colony*

Between 1920 and 1960, wood segmental-lattice vaults were often used, introduced by an Austrian engineer named Erwin Hauff. Also during that period, some companies started to produce glulam made of araucaria pines, mostly.

Figure 10: *Wood segmental-lattice vaults, made by Hauff in 1927*

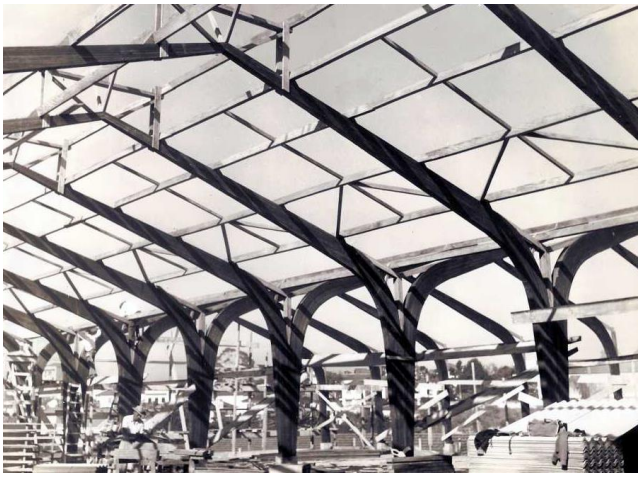

Figure 11: *Glulam structure, made by Laminarco in the 70s*

Around 1950, the peak of the absolute predominance of the reinforced concrete in Brazilian buildings was the construction of the new country capital, Brasília, projected by the duo of architects and city planners, Oscar Niemeyer and Lucio Costa. Brasília has become known internationally, therefore the project edifications became a model for the entire new generation of contemporary architects. The material plasticity combined with the cheap and abundant labor and the easy acquire of the raw material provided and manufactured by a highly qualified technical staff turned Brazil into a vanguard position of that type of construction.

The forest along the coast (Mata Atlântica) was almost destroyed and today remains less than 7% of the original area. The great forest of pines (Araucaria), in the south of the country, was also explored on a predatory way. The wood was used in particular for concrete forms and shoring system.

In early of 1970 the architect José Zanine Caldas, referring the tradition constructive techniques inherited from the Portuguese colonizers, has initiated a process of rationalization and industrialization of timber structures and others buildings elements. He developed several “case study houses” in Rio de Janeiro that has become a landmark in the resumption of the timber construction in Brazil. Consequently, in 1980, ITA was founded after participated of the construction of three houses designed by Zanine Caldas, that aroused great interest such as in 1984 ITA began to dedicate exclusively to the timber construction.

Figure 12: *Herrmann House designed and built by Zanine Caldas*

3.1 ITA - CHRONOLOGY OF WORKS

3.1.1 1980-2008: The work with native wood

Timber construction thirty years ago was a complete adventure in all the ways. The means of transportation was partly fluvial however the biggest distance was essentially by road (cargo truck), approximately 4.000 kilometres.

Initially as small as its name, Ita was run from a modest 40-square-meter office in Sao Paulo, assembling structures that came from Bahia, designed by Zanine.

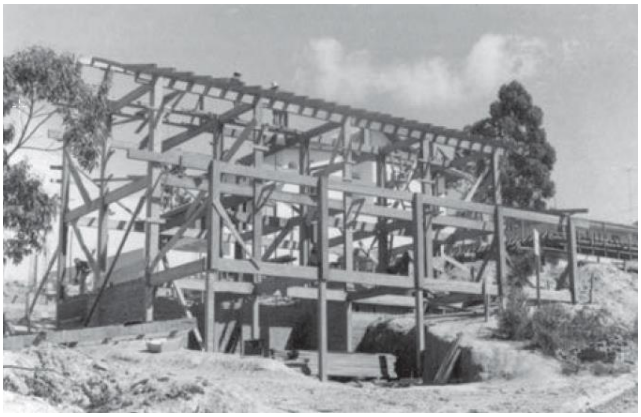

Figure 13: *One of the first houses built by ITA, designed by Zanine in 1982*

Without a proper place to store and process timber, in the first houses built the wood was delivered to and cut right at the site. By 1984, this problem was reduced when it moved to Rio Pequeno where the first wood cutting machines were installed. In 1987, Ita expanded its facilities moving the workshop and office to the old family country ranch in Vargem Grande Paulista.

Figure 14: *ITA Facilities, 1987*

Technical developments allowed gradually the constructive process gain higher quality and better finishing. The investment on an automatic planer machine has increased the accuracy and the assembling speed.

Figure 15: *ITA Facilities, 1990*

The partnership with the architect Marcos Acayaba, in the late eighties, was a base for a new leap compared with the earlier works. The Hélio Olga's house wasn't designed to be an application model of environmental sustainability. The house is indeed a successful architectural project suitable to the Brazilian reality and to the challenges imposed by the steeply sloping site. With only six support points that maintains full permeability of the soil, the house is built as an inverted pyramid, takes advantage of the cantilever symmetry of the upper floors to balance him lightly on the land, anchored to the main access block. The structures sections and pieces were elaborated with equal lengths. The use of still in braces and cantilevers accentuates the lightness of the set and provides a constructive clarity.

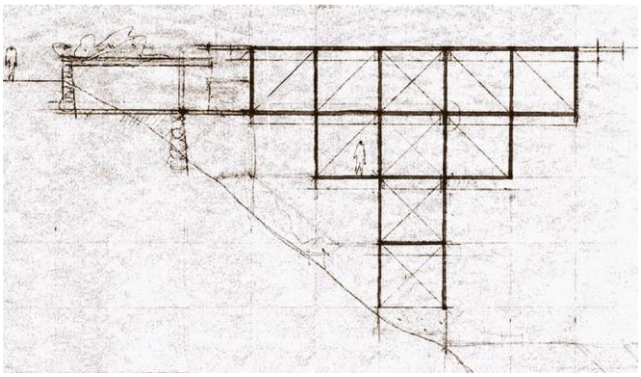

Figure 16: *Hélio Olga's house, designed by Marcos Acayaba*

This work was a turning point for ITA once that revealed for the engineers and architects that timber is a contemporary material with many technical and aesthetic qualities potential to be explored.

Figure 17: *Hélio Olga's house*

Figure 18: *Hélio Olga's house, wood x concrete detail*

After the Olga's house, ITA has developed two more houses in partnership with M. Acayaba, both situated in littoral steeply site and support by a "tree" shape structure composed by triangular modules.

In this period the wood still largely being extracted from areas where the forest was replaced by agriculture and industrial activities or with inadequate forest management, even with the country hosting a major international forum on the environment, the Rio Eco92.

The international pressure and the environmental organizations influence the government to increase the supervision e punish irregular deforestation of the Amazonia forest. At the nineties begin the first explorations with sustained and certificated forest management.

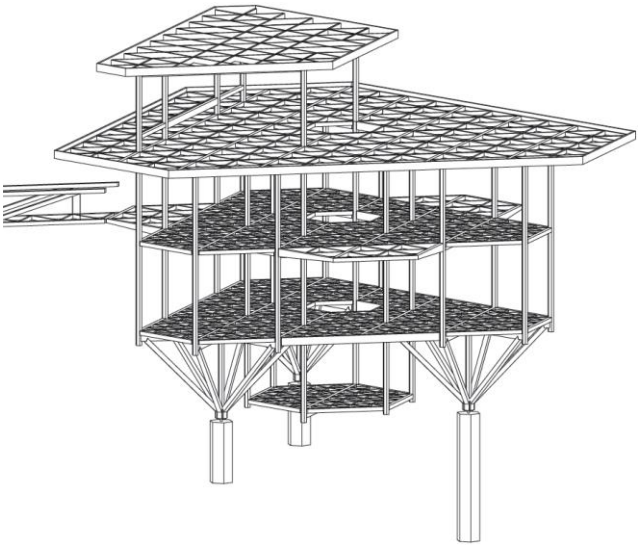

Figure 19: *Acayaba´s house, designed by Marcos Acayaba*

In addition, a whole generation of young architects designed timber projects that became known through the several publications on the specialized media. By this time, the wood is no longer a material from the past, at least in technical terms, to become a material of the future. Besides the evident technical and aesthetic qualities, it became clear that the extractions of wood could be made with low environmental impact and still generate benefits such as ensure the carbon sequestration.

Figure 20: *D'Alessandro´s house, designed by Andrade&Moretin*

The first experience with the wood of planted forests was Aflalo's house, designed by architects Marta and Marcelo Aflalo, entirely performed with eucalyptus by making use of nailed laminated beams. Deployed on a plot equally steep, the house incorporates many of Acayaba´s design concepts but reverses the structural solution of the work in which the wood is fully protected by a cellular concrete skin. Designing with eucalyptus planted forests meant a completely different approach of Amazon native wood: with smaller diameter logs and maximum length of 4 meters, the structural and constructive reasoning becomes the combination of elements creating composite beams and pillars, either working as lattice either working as porticos. Again, the project didn't focused on the environmental issue directly but rather the waste of 30%, on average, characteristic of traditional building techniques inherited from the Iberian colonial culture. Two findings from this experience: the quality and durability of that tropical wood, which in Brazil is not to be considered as a noble wood.

Figure 21: *Aflalo´s house, designed by Marcelo & Marta Aflalo*

Figure 22: *Aflalo´s house, 3D model*

In 2006, in partnership with the architect Cristina Xavier, ITA has developed a construction system consisting on floor and wall panels that was use on the construction of eights houses in a private condominium located in the São Paulo suburb, where the environment issues had a decisive influence on the technology and on the aesthetic language adopted. The Vila Taguaí presents several project specifications based on the existent environment peculiarities such as low impact master plan, solar water heating, water reuse and maintenance of the native vegetation. In terms of the architecture, the project consists in "wood boxes" with opened façades that provides cross-ventilation e natural illumination. The wood and floor panels were designed in order to optimize the wood manufacturing.

Figure 23: *Vila Taguaí, designed by Cristina Xavier*

Figure 24: *Vila Taguaí, detail of wood panels*

Even with sustainable forest management and an optimized system for the logs exploration, the distance between the production amazon zone and the south of the country where it is used, considering that the raw material is essentially transported through cargo trucks which demands a massive consumption of fossil fuel, reduces the environment benefits. Furthermore, the supply of the material is not reliable – six months of intensive rain combined with a precarious infrastructure. Considering the observed facts, planted forests are essential to develop a timber construction industry that requires a large and constant amount of wood.

3.1.2 2008-nowadays: The work with glulam

Today large areas in the South and Southeast regions are covered by planted forests, mainly of eucalyptus, an Australian tropical wood that has adapted very well to the Brazilian climate. These forests were developed to provide raw materials for the paper industry and more recently began to produce wood for sawmill industry.

The beginning of the eucalyptus glue laminated production, in 2008, was a natural and logical achievement, inevitable within all aspects. The Glulam enables the production of parts that allows the architects to

create and design non-conventional forms previously unfeasible with the native wood standards.

Figure 25: *Glulam press at ITA facilities, nowadays*

The distance between the planted forests and ITA's factory it is approximately 200 to 1.000 kilometers. Considering the supply increase, currently it is possible to purchase large amounts of raw material with delivery time and quality guaranteed.

The adoption of glue-laminated wood has opened a new market. Gradually the summer homes, far from urban centers and considered eccentricities of the wealthy are being accompanied by other types of construction. Symptomatically, the first major work in glue-lam was a public work, the Library of Sao Paulo.

Figure 26: *Library of Sao Paulo, designed by Aflalo&Gasperini*

In 2010 the owner of Haras Polana, who had hired Mauro Muñoz architect and our company for various projects in native wood, commissioned a large cover to house auctions and other activities. At first we thought we could support the coverage into pillars that would emerge from the sand track. Thus would lead to very high pillars, greater interference on the ground and would undermine the view from the bleachers to the valley, so we had the idea to make a 12 meters cantilever.

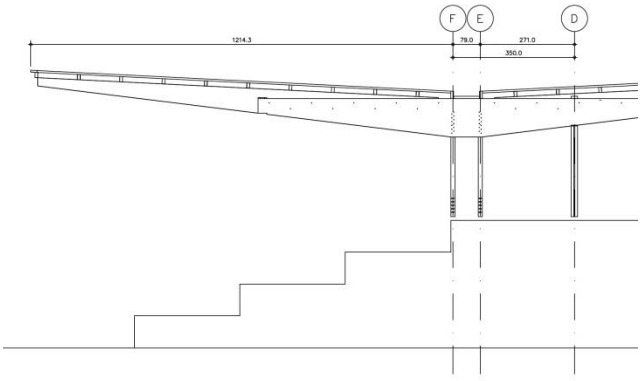

Figure 27: *Haras Polana, designed by Mauro Munhoz*

This project became an example we needed to show the beauty and versatility of the glulam.

Figure 28: *Haras Polana, glulam beams at work site*

Figure 29: *Haras Polana, 12m cantilever*

The timber construction demands a qualified labor and along those 32 years ITA has trained several teams of carpenters and buildings crews. However, nowadays in Brazil, this particular kind of labor is essentially expensive and scarce.

Within this picture, the purchase of a numerically controlled machine Hundegger K2 allowed a great increase in production and the quality of the final product. Today we produce 100m³/month of glulam and we should reach a production of 250m³/month in a year or two. Our biggest problem is the scale of the projects - as we produce few, our cost is still high.

Figure 30: *Hundegger K2*

The 32 years of our company are somehow a picture of wood construction in Brazil. We went from a mode of production of a traditional architecture to reach the glue-laminated wood through the participation with other engineers and architects of the recovery of contemporary production of wooden structures. Our biggest challenge now is to increase the production and spread the use of wood, which is still very small in Brazil.

Figure 31: *Iporanga Convention Center, designed by Mauro Munhoz*

4 CONCLUSIONS

The building material of the future is wood. It has the best performance on the major issues of this century: energy and the environment. Timber production depends only on land availability, as the efficiency of agriculture increases and the population growth reduces, and the sun, inexhaustible source of energy.

Managed forests and reforestation protect the soil and fight the "greenhouse effect" (produce oxygen and remove carbon dioxide from the atmosphere). Any production residues and the wooden demolition material can be recycled into other uses, burned to obtain energy or broken down to fertilize the land.

The outlook for Brazil in the area is excellent. Reforestation has a very high yield due to favorable climatic conditions. Moreover, we have the largest rainforest in the world that well managed can generate large amount of high quality wood.

Combining the high increment per planted area/year and certified forest management area, Brazil can supply all domestic and foreign demand with competitive prices.

Even nowadays the concept of timber as a contemporary construction material isn't sufficiently disseminated once the utilization still associated with the vernacular construction. The biggest challenge will be to change the profile of exports. Today, we continue to send timber overseas, a slightly level of industrialization above the wood logs sent by the colony Brazil.

ACKNOWLEDGEMENT

The dedication of many researchers, engineers and architects is allowing for the refining of traditional techniques, the adoption of new technology and the deployment in the country of an industry focused on the construction in wood.

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