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Constructive Process of using plates OSB (Oriented Strand Board) in sustainable structural systems in a Residential building in the city of Manaus - AM

Raul Barbosa Gonçalves dos Santos[1], Daniel Feliciano da Costa[2], Livia da Silva Oliveira[3] David Barbosa de Alencar[4], Camily Murrieta Vasconcelos Oliveira Bezerra[5], Igor Felipe Oliveira Bezerra[6]

[1,2,3]Academic department, University Center FAMETRO, Manaus-AM, Brazil
Email: rbgs1988@gmail.comp, felicianodaniel9602@gmail.com, oliveira.livia@gmail.com
[4,5,6]Research department, Institute of Technology and Education Galileo of Amazon – ITEGAM, Manaus-AM, Brazil
David002870@hotmail.com, camilymv@hotmail.com, igorfelipe.dss@hotmail.com

Abstract— *The use of reforestation wood in civil construction plays an important role in the sustainable development of the world, as is the case with oriented wood strip panels. Coming from continuous technological advancement, which adds quality to the material and creates new constructive solutions, OSB (Oriented Strand Board) panels appear as an effective alternative for society. This work aims to broaden the knowledge about the use of OSB boards in the building system (CES), due to their function and application in wall, slab, roof and roof sealing, based on a case study of the construction process of a residence. in the city of Manaus. Advantages and disadvantages of this system were compared when compared to the conventional system, and its use (OSB / CES) has been shown to meet the sustainability criteria, as it is ecologically viable, being a clean, lean process; economically viable, fast, cheap and inclusive as it generates local employment. Further studies are needed to understand the importance of using clean technologies for construction, capable of reducing impacts on the environment, without compromising the development of the site.*

***Keywords*— construction, oriented strand board, sustainability.**

I. INTRODUCTION

Nowadays the ecological consequences of our actions have promoted, in the world architecture, the view that we must use the available raw materials carefully and economically. In industrialized countries, this concept has led the logging industry to rediscover the timber-built building, promoting quality material for construction companies.

With the growth of environmental awareness and, mainly, after the ISO 14.000 Standard was instituted, the logging activities became more controlled, with this, the wood from sustainable management gained some notoriety. Oriented Strand Board (OSB) is designed to meet an unmet demand for common plywood panels: mechanical strength for structural purposes (RAMPAZZO; SPONCHIADO, 2000) [1].

In the Brazilian market, the OSB is still a little known panel, lacking greater disclosure of its characteristics and possibilities of use, especially in civil construction. Although shy, its application already occurs in floors and partitions, roofs and temporary works such as siding and housing(FERREIRA, 2003) [2].

The finitude of non-renewable natural resources and the development of the construction sector generated the need for adaptation to the problem of scarcity of some materials, such as native woods, natural aggregates, among others. And the use of alternative techniques and materials, as is the case with OSB, arise as a response to the problem..

This work aims to share scientific and practical knowledge, demonstrating the construction process of OSB plates in the CES (Sustainable Energy Building) system, employed in a single family residence in Manaus - AM. The case study in question highlights some technologies applied in the current market, their respective advantages and disadvantages.

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II. THEORETICAL REFERENCE

2.1 The use of reforestation wood as a sustainable alternative in civil construction

Civil construction has always been linked to the economic and social development of societies, however, its construction methods converged to a continuous state of conservatism in which materials and labor were little changed and nature functioned as abundant stock for such Sector. Fortunately, this scenario has been changing. Research in the most diverse fields of science is looking for clean materials and technologies capable of meeting the needs generated by man.

Wood is a natural and renewable material with many positive aspects in various construction applications, such as wood panel which can present a functional, constructive and economical solution, competing with traditional sealing systems. The panels can be used both for external sealing and for partitions inside buildings, as wood can easily adapt to certain requirements and possibilities. It also has less weight, facilitating the transport and workability of the work (SUENAGA;BITTENCOURT;TERNI, 2002) [3].

Wood panels arose from the need to decrease the anisotropy and dimensional instability of solid wood, lower its cost and improve the thermal and acoustic insulation properties. Additionally, they fulfill a recognized need in the use of lumber which is to extend its useful surface by expanding one of its dimensions (width), thereby increasing the field of application.

According to Stungo (2001) [4], the most common wood construction system in the world is the lightweight structure. Although it originates in the Scandinavian countries, the high production of the lightweight structural system is very popular in North America. On the other hand, in Brazil, the use of reforestation wood in civil construction faces greater prejudice than other types of wood. Largely used only for concrete forms and struts, we have the notion that this type of wood is fragile, not being considered "noble".

In this context, comparisons of the advantages and disadvantages of the analyzed systems support the choice of the system to be used in the intended construction project, being noticeable the implications and cost-benefit brought in the use of wood oriented boards, for example.

2.2 OSB - (Oriented Strand Board)

Brazil is very incipient in the production of OSB, began to produce panels only in the year 2002 compared to factories of other wood composites that are already quite consolidated, such as plywood that began in 1940, followed in 1966 with the chipboard, in 1995 with the fiber sheets and in 1997 with the MDF (MENDES, 2001; DEL MENEZZI, 2004)[5][6].

Oriented Strand Board (OSB) is designed to meet an unmet demand for common plywood panels: mechanical strength for structural purposes. Its structure is composed of three to five layers of particles or bundles of fibers (figure 1), united with phenolic resin, oriented at an angle of 90 degrees with each other and pressed for consolidation. This arrangement gives the panel mechanical strength and moisture resistance.

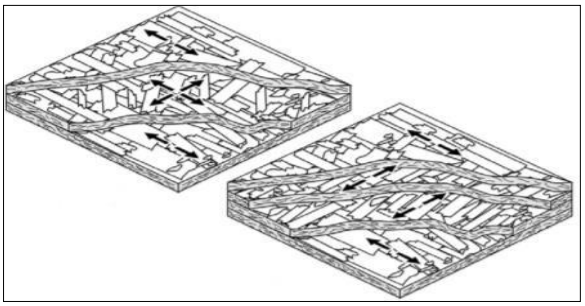

Fig. 1: Panel Oriented Cores OSB
Source: MCTIGUE, (2011)[7].

They are characterized by ISO 16894: 2009 “Wood Based Panels - Oriented Strand Board - OSB - Definitions, classification and Specifications”. Brazilian Standard ABNT NBR 14810-2: 2006 describes wood particle boards as a panel-shaped product, ranging from 3 to 50 mm thick, consisting of wood particles agglomerated with natural or synthetic resins, fixed under pressure and heat action.

The properties and quality of OSB panels are influenced by several factors, including those inherent to wood, such as species, density, chemical factors; and those inherent in the process such as panel density, compaction ratio, panel composition, adhesive, paraffin, particle geometry and orientation, particle moisture content and press cycle(MOSLEMI, 1974; MALONEY, 1977; MENDES, 2001; SURDI, 2012) [8] [9][5] [10].

Particle geometry, homogeneity, types of adhesives, density and manufacturing processes may vary for the production of suitable products.

Because it is produced with wood from lower quality logs, OSB is lower in cost than structural plywood, and the fact that it uses less noble raw material does not diminish its quality, as its production technology determines its performance(RODRIGUES, 2006) [11].

2.3 Application of OSB boards in building systems

2.3.1 Light Steel Frame building system

The construction system in Light Steel Framing is a strategy that focuses on the use of simple and stiffened

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profiles, assembled and fixed, forming a structural skeleton and ensuring rapid construction elevation as well as weight reduction. This impacts the final budget of the work and also its sustainability(PENNA, 2009) [12].

It is composed, according to Brazil (2012) [13], of frames formed by cold-formed light steel profiles, which receive metallic corrosion protection by the continuous hot-dip process, either with zinc or aluminum-zinc alloy.

According to Oliveira (2013) [14], the Light Steel Frame has about 50% less time on site, which is the reason for the increase in productivity, due to the speed of execution and the lower employment of existing labor. Thus, with the same labor that would be used in a masonry construction, it is possible to complete twice as many housing units in the same time frame and at similar costs.

2.3.2 SystemCES

The CES (Sustainable Energy Building) System comprises the Wood Frame and Steel Frame building systems. It is widely used in developed countries such as the United States and Canada, where most homes are built on "sustainable energy construction".

The main feature of this system is the use of a lightweight steel frame or wood frame structure, braced with LP OSB Home structural plates, which together work together, giving the building rigidity, shape and support.

2.3.3 Function LP OSB

In the CES System the main function of OSB Building Products (LP) is to brace and seal the structure of walls, floors and roofs. LP OSB plates and structural profiles work together, giving rigidity to the building, so that the structure as a whole acting monolithically. In addition, on the inner walls, LP OSB Home boards can be applied behind plasterboard as a reinforcement for drywall walls. It also allows the attachment of suspended loads such as planned furniture and frames anywhere in the wall, without the need to find the risers, as the OSB is a high strength structural plate.

III. METHODOLOGY

For the work were used the methods: case study, bibliographic research and documentary research - within the qualitative approach. In this one there is not a great concern with the numerical representation, but with the deepening of the comprehension of a social group, of an organization, etc. Regarding the bibliographic research, it was performed by collecting theoretical information already analyzed and published in written or electronic media (books, scientific articles, websites, among others). As for the case study, it took place in a single family residence, located in the residential condominium on Avenida Carlota Bomfim - Ponta Negra, Manaus - AM.

It is necessary to explain the steps of the construction process and the use of OSB boards used in the construction execution.

3.1 Construction Process Steps

3.1.1 Foundation

Freitas, Crasto and Santiago (2012) [15], emphasize that, due to the weight of the LSF system and the size of the structure, the foundation will consequently be smaller in relation to other structural systems. As the load is distributed linearly across the panels, the best option for the foundation is the radier system and the running shoe system.

To begin the construction, some basic preparations were made among them the clearing of the ground that was in the bush. After cleaning, the foundation began. Because it is a Light Steel Frame technology construction that allows any type of foundation and own weight lower than the conventional construction. By considerably reducing the loads on it, the most common Radier type foundation was chosen, made of reinforced concrete to receive loads through columns (in this case LSF structure), distributing them evenly to the ground.

3.1.2 Structure

The structures of the walls, slabs and roof are made of lightweight cold-formed galvanized steel profiles. It can be seen in Figure 2, that there are three types of profiles for use in Light Steel Frame, and in the present project we used the three.

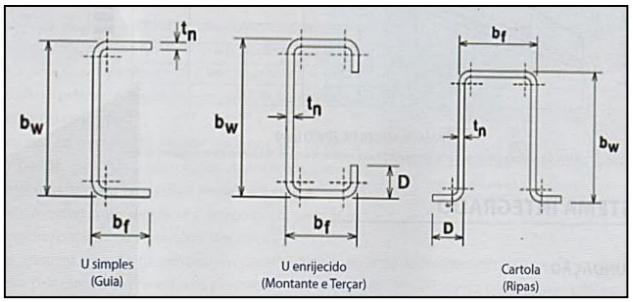

Fig.2: Perfis Light Steel Frame
Source: GOMES; UJIIE, 2015[16]

Main structure

Formed by the structural frames of the walls, upstream type and guide. We can see in figure 3 that the structure of the first and second floor is erected, and the first floor is sealed in OSB structural plates.

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Fig.3: Metallic Structure: first and second floor
Source: Author (2019)

Roof Structure

They are made up of scissors consisting of uprights and guide profiles with dimensions of 90 mm, 140 mm. Figure 4 shows the roof structure already mounted on the metal walls.

Fig.4: Mounted Roof Structure
Source: Author (2019)

In figure 5 we can see the external view of the roof in already installed top steel thermoacoustic tiles, which reflect up to 75% of the sun's rays and absorb up to 85% of the rain sound, offering greater thermal comfort to the building.

Fig.5: Outside view of the roof
Source: Author (2019)

3.1.2 OSB structural wall sealing and cladding system

The LSF system allows the application of various coatings, but in this residential project was used the structural OSB plates for sealing and structural reinforcement thereof. In addition to the structural function, the plates have the function of facilitating the roof support.

Outer Seal

It presents the closure of the external face of the first floor wall made with structural OSB plates. They were fixed directly to the mullions and guides with trumpet head screws, drill bit (ST 4.2 mm x 32 mm), following the same procedure for floor up. The plates used in the sealing design are 11.1 mm thick according to the technical specifications.

External Coating

On the outside the OSB plates were protected by a waterproof membrane that acts as a barrier against water, wind and dust, promoting the ventilation of the walls and at the same time allowing the internal humidity to escape from the panel (figure 6). It was then coated with cementitious plates ensuring high mechanical strength and weather resistance. Finally, the base coat was applied, providing greater surface resistance and unparalleled thermal insulation.

Fig.6: Hydrophobic Membrane Application
Source: Author (2019)

Inner Fence

Assim, como a face externa o fechamento das faces internas foram feitas com placas OSB para maior reforço estrutural da edificação. Podemos observar na figura 7, as placas já instaladas sobre os perfis.

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Fig.7: Inner face sealed with OSB boards
Source: Author (2019)

Internal coating

After the application of the OSB plates on the profiles, the coating process was started, made with plasterboard screwed on them, which have adequate composition for each application of the residence. In dry areas was used gray / beige Stantard (ST) and for wet areas such as kitchen, bathroom and services the green was used - Moisture Resistant (UK).

In relation to the ceiling, they were constituted by plasterboard according to the respective areas, being fixed by bolts in steel structure. The dry areas were covered with plaster and treatment boards, such as: dry mass, joint tape and angle for leveling the small imperfections due to the joining of the boards, generating a smooth and seamless appearance.

For greater visibility and clarity of OSB inner seals on metal profile and coatings applied thereon; we can see figure 8, which shows the profile of the beams and columns in detail.

Fig.8: Profiling with Detailing
Source: Author (2019)

3.1.3 Slab

For panels, slabs and roofs, basically the same principle is used, ie galvanized profiles whose function is to support the loads that are subjected.

To compose the residential structure, the slab chosen was of mixed type. Starting from the same principle of the walls: the slab was made with the sealing of OSB plates applied over the metal framework, followed by the 5 cm reinforced subfloor lining.

3.1.4 Electrical, Hydraulic, Acoustic and Thermal Installations

Being an LSF system, the electrical and hydraulic installations were performed following the same principles and materials used in conventional construction. Due to the internal void of walls and ceilings and the presence of holes in the mullions, it was possible to perform quickly and without breaking.

We know that thermal and acoustic comfort is of paramount importance in a residence, providing great quality to the environment. The Steel Frame system, together with the use of OSB sealing plates, made it possible to use various types of insulation installed on the interior and exterior walls, ceiling and roof as required. We even witnessed some technologies during the presentation of the construction process. And one of the main products used for design is the glass wool blanket: which significantly reduces the transition of sound and heat between environments.

3.1.5 Finishes

At this stage of construction, it is the moment when the house loses its basic workmanship and begins to become clearer, giving the impression of being almost completed or nearing completion as seen in Figure 9.

Fig.9: Internal area in finishing phase
Source: Author (2019)

It can be seen in figure 10, the residence with windows placed and all applied coatings, including vinyl paint that gives greater impermeability. Only need painting in some parts for finishing.

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Fig.10: Residence facade
Source: Author (2019)

IV. RESULTS AND DISCUSSION

Through the observations made through the present work, there was a perception of the lack of information, studies, research and Brazilian standard directed to the design and use of OSB plates application for sealing effect in structural system, in civil construction, leaving the professionals of the area depending on the product manufacturer's technical manual which are based on foreign standards.

The residence built within the CES System (Sustainable Energy Building), boasted a range of technologies, among which we can mention: TopSteel Thermoacoustic tiles, Water Membrane, Glass Wool, Cement plates, OSB and Steel Frame, which together work together, giving rigidity, shape, building support, unmatched temoacoustic comfort and environmental responsibility as the materials used emit low CO2.

In addition to the above results, it was observed that the use of OSB structural plates in the Light Steel Framing system results in buildings that look similar to traditional systems, but is a superior process in finishing, shortened lead time and so on. Table 1 shows a comparison between the systems described in the study.

Tab.1: LSF Conventional System Comparison

Conventional system	LSF System - Use of OSB Cards
Benefits	
Uses products that degrade the environment: sand, brick, gravel tec.	Environmentally friendly system. One of the most recycled products in the world.
Durability over 300 years.	Durability over 300 years.
Placement of pipes and conduits with breakage of walls, waste of materials and work.	Laying pipes and conduits without waste and without work.
Dirty construction site.	Clean and organized construction site.
Thermal insulation is minimal. Allows heat to pass through.	Thermal insulation is maximum. It makes the passage of heat difficult.
Long and inaccurate lead time.	Up to 1/3 shorter and more accurate time.
Great use of water in the construction process.	Minimal water is used in the construction process.
Difficult maintenance requires time. It requires breaking and closing with mortar, as well as finishing.	Easy maintenance, coating removal, immediate location, repair, and coating retouching.
Fire resistance.	Fire safety - does not burn.
Paint made with undulating and imperfect surface.	Painting done on flat and smooth surface.
Structure partially subject to insects.	Insect resistant structure.
Low skilled labor.	Skilled labor.
Difficulties in locomotion of materials.	Ease of movement of materials for being light.
Lower long term profit.	Higher long term profit - about 30%.
Disadvantages	
Easy to find manpower.	Difficulty finding skilled labor.
Total cost of the work immediately lower.	Immediate total cost is increased by about 6%.
Limit set according to design calculation.	Floor Limit: Up to 5 floors.

Source: Author (2019)

V. CONCLUSION

Wood is a natural and renewable material with numerous positive aspects in various construction applications. Reforestation came to fill the gap left by hardwoods and has been applied in several segments, especially in construction. However, it was found through this study that there is low knowledge of the potentialities of this material, by the vast majority of professionals in the area, making it inappropriately used. In this context, the disclosure of the benefits brought by the use of this material enables a functional, constructive and economical solution for society, as it becomes competitive with traditional fencing systems.

In this study, the OSB were incorporated into the CES system, being used in the bracing and sealing of the walls, floors and roofs in the light steel profiles (Steel Frame), in which the union of this set resulted in the rigidity, shape and support to the building. In addition, the project used the slabs on both external and internal faces, ensuring greater structural reinforcement to the building. Not only as a structural reinforcement, the application of the plates behind the plasterboard in the internal areas of the residence allows the fixation of suspended loads such as planned furniture and frames anywhere in the wall,

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without the need to find the mullions, since the OSB It is a high strength structural plate.

At the end of the presentation of the construction process, it was observed that the building results in an aspect similar to conventional masonry, but with superior final finishes. However, by joining the metal structure, sealing plate and its appropriate technologies applied within the CES system, several advantages were obtained; Among them, the following stand out: thermal / acoustic comfort, reduced execution time and the others. Finally, the system integrates technology, strength, sustainability, durability and agility, making it an excellent option for housing development.

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