Administrative Headquarters of the Forestry Foundation: A study of the design process, construction technique, structure and environment

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ABSTRACT

Studies with an environmental context are of great importance, such as the analysis of the Administrative Headquarters of the Forestry Foundation with the intention of the architects to contribute to the sustainability and regeneration of the surrounding areas, especially with the use of wood and the incorporation of CO_2. This is carried out during the growth of trees as it is a renewable material. The objective of the work is to study the design and construction process of this work. As a methodology is the case study and the form of analysis of the design process, construction, and structure through graphic analysis.

Keywords: Sustainability, Modularity, Glued Laminated Timber (CLM), Diagram.

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INTRODUCTION

Architecture and urbanism, in the context of the built environment, mirror cultural and social values through construction techniques, resulting from the convergence between humanity and its surroundings. The city is made up of buildings and public and private spaces, and is related to the behavioural and value systems of the inhabitants (Ghione, 2012).

The aspects of this relationship between the human being and the environment apply in several areas of knowledge. When these are fragmented, there is a greater professional difficulty in understanding multidisciplinarity. Consequently, such fragmentation diminishes the possibility of a broader and more integrated investigative process (Elali, 1997).

Based on the importance of multidisciplinarity and the relationship between man and city, this article aims to analyze the integration between architectural design, sustainability, construction technology, design processes, with the study of the Administrative Headquarters of the Forestry Foundation, of the Forestry Foundation of the State of São Paulo.

Brook; Masini (2014) study works that evaluate the design process with emphasis, what was analyzed, type of diagrams and the means of representation among the authors highlight the works of Francis Ching Architecture-Form, Space and Order (2002) Roger H. Clark, Michael Pause, Architecture: themes of Composición (1983), Peter Eisenman. Diez edficios canónicos 1950–2000 (2011) and his doctorate, Ana Maria Tagliari (2012), with the thesis entitled "The unbuilt residential projects of Vilanova Artigas in São Paulo".

The project of the Forestry Foundation will be discussed through graphic analyses, according to Tagliari (2009, p.1) this "comprises a set of items that allow the investigation of the organization of forms in space" and the analyses seek "formal and spatial aspects of the projects and their organization." The study investigates these "principles through diagrams of practical and clear understanding".

This type of analysis "can reveal hidden aspects in the drawings that we could hardly reach only by textual resources", so it is a relevant tool that can "be applied in the reading of works of architecture" to understand the formal aspects that "are part of the architectural proposal, whether of an aesthetic, constructive or conceptual nature" (TAGLIARI, 2008, p.4).

Tagliari; Florio; (2010) argue that this is a "means of a process of extraction and separation of attributes, diagrams facilitate the organization of ideas in a visual way." Researchers can "analyze, and graphically compare specific characteristics of the building or the architectural artistic artifact, detaching the parts from the whole", seeking to understand the design and construction process.

As a methodology, a single case study will be applied with emphasis on the Administrative Headquarters of the Floresta Foundation, applying the concept of diagrams by lines, contours and geometric figures. The authors Tagliari; Florio (2010) recommend the redesign of the

"axonometrics", based on executive projects associated with photographs. We reinforce the fundamental reference of the method in this study was discussed in Florio *et al*.(2002), as well as for the analysis of the case study, the parameters of the authors Roger Clark and Michael Pause, whose book title is "Precedents **in architecture:** Analytic diagrams, formative ideas and parts", published in 2012, will be adopted.

In the analysis, the context of the work, structure, natural light, section and plan, circulation and uses, repetition of forms, modulation, symmetry, addition and subtraction will be valued. In addition to the topics of graphic analysis, a survey of other aspects pertinent to the project will be made, with the decomposition of the work into form and structure, the description of the construction process, understanding of the materiality, the structural system, the fences, and the means of protection of the wooden structure.

CASE STUDY PROJECT: ADMINISTRATIVE HEADQUARTERS FUNDAÇÃO FLORESTAL 23 SUL ARQUITETOS YEAR: 2016

The context of the insertion of the project of the administrative headquarters of the Forestry Foundation takes place in the middle of an Atlantic Forest reserve near the coast in the city of Barra do Una in the state of São Paulo, the area "is part of the socio-environmental recovery program of the Serra do Mar and the Atlantic Forest Mosaic System" (23 SOUTH, 2019). The project was the subject of a public bidding in 2016, the architects of the São Paulo office 23 Sul were the winners to design the "Administrative Headquarters of the Mosaic of Conservation Units of Juréia-Itatins (MUCJI) and the Bases for Coexistence and Monitoring of Sustainable Use Reserves (RDS) and Ecological Parks (PE)" (23 SUL, 2019, p.1).

In the search for sustainability in order to expand the life cycle, "the entire process", ranging from design and construction to the operation of buildings, was designed "to generate the least possible environmental impact, considering the difficulty of access and the absence of drinking water, sewage and electrical network infrastructure" (23 SUL, 2019, p.1). The construction system was designed in light materials, both structure and fences, as an American system, seeking to "minimize waste in construction". The work was carried out by Rewood.

According to Green (2012), wood is a renewable material and constitutes a structural element with potential in relation to the impacts of climate change of anthropogenic action. In addition, sustainable development in architecture requires measures to reduce carbon and greenhouse gas emissions into the atmosphere.

A forest represents a large carbon reservoir, as it removes carbon dioxide (CO_2) from the atmosphere and stores carbon in vegetation and soil; when properly maintained (Green, 2012). When

wood is used in construction, the carbon dioxide, absorbed during the growth of the tree, remains stored for tens and hundreds of years (Müller, 2005).

The efficiency of removing carbon dioxide (CO_2) from the atmosphere and transforming it into oxygen (O_2) depends, from sustainable forestry, to the management of wood products at the end of the life cycle of the building (Green, 2012). Materials such as steel and concrete consume a lot of energy and emit high rates of carbon dioxide in manufacturing processes. Concrete corresponds to 5% to 8%, and steel corresponds to 4% of greenhouse gas emissions for the planet (Giorgi, 2020).

Therefore, the use of glued laminated wood (CLM) in the project of the Forestry Foundation Administrative Headquarters in the structure is due to the factors highlighted above and because it is a light, industrialized material, relieving the weight on the foundations". In the enclosures, architects applied "modular partitions in a self-supporting system, with standardized wooden frames, honeycomb polycarbonate and MDF enclosures, thermoacoustic tiles and Wall panel floors." (23SUL, 2019, p.1)

Glued Laminated Wood (CLM) is composed of wooden lamellae (boards), joined by gluing and arranged parallel to each other, that is, the fibers of these boards are positioned parallel to each other. It had its advance simultaneously with the efficiency of the glues, which are fundamental for the proper structural use of the material (Calil, 2011).

According to Ino and Silva (2008), the classification of construction systems based on the prefabrication method is an appropriate classification criterion for wooden structures.

Figure 1: Classification of construction systems based on the prefabrication method

Construção em entramado ou esqueleto	Formada por um esqueleto portante, contraventado por diagonais e fechamento em capa dupla ou maciça
Construção com painéis compostos	Paredes portantes formadas por painéis sanduíche ou placas compostas

Source: Ino e Silva (2008).

According to the table in figure 1, the classification of the project's construction systems by the prefabrication methodology would be construction in intersection or supporting skeleton; with MLC column and beam system.

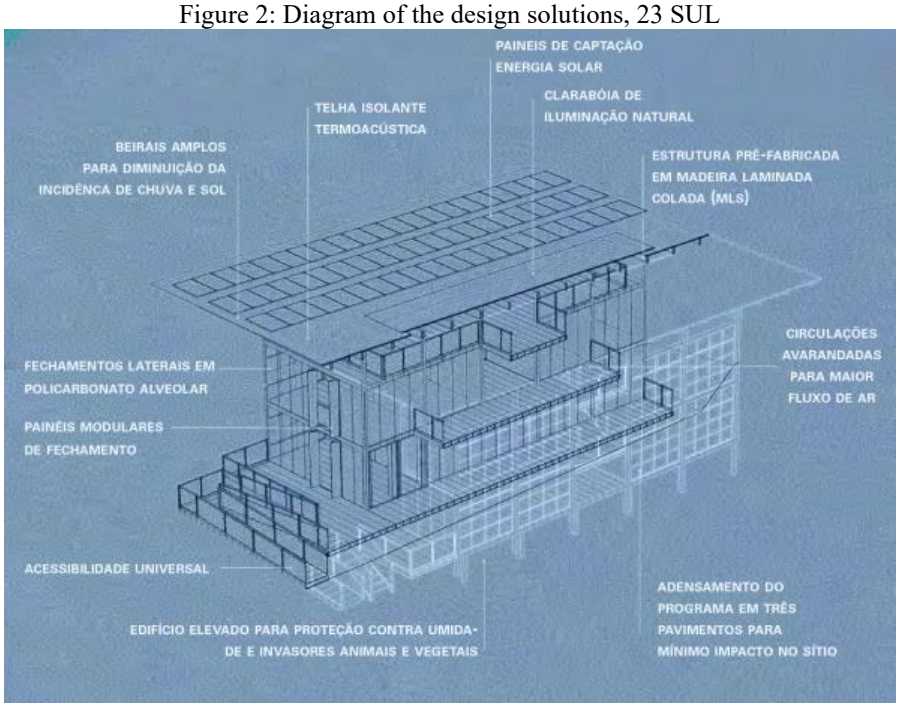
The project sought solutions of high energy efficiency and environmental comfort, in addition to "electrical self-sufficiency with photovoltaic panels, the reuse of rainwater, effluent treatment and waste control". The building raised from the ground due to "the tropical climate with prolonged rains" and for the protection of the wood, "a roof with large eaves, facades with thick honeycomb polycarbonate, natural cross ventilation and circulations and balconies" were planned.

In the center, the main uses are the "operational and legal" and this is "responsible for the management of the conservation units of the Mosaic, in addition to centralizing educational and

scientific research actions." This program was housed "on three floors, minimizing the impact on the terrain" (23SUL, 2019, p.1).

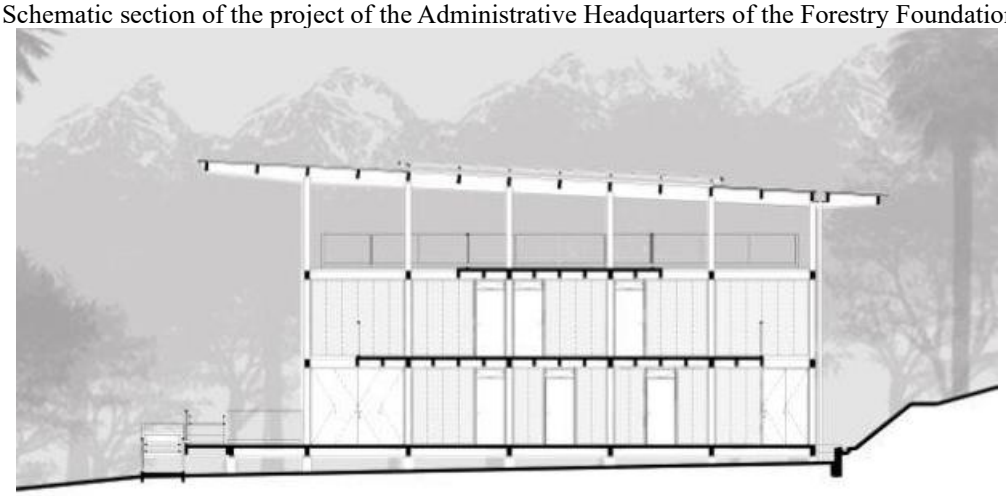
In this way, the proposed project presents itself as a social and sustainability reference equipment, especially for the "communities that historically inhabit Brazilian natural reserves" (23 SUL, 2019).

Figure 2: Diagram of the design solutions, 23 SUL



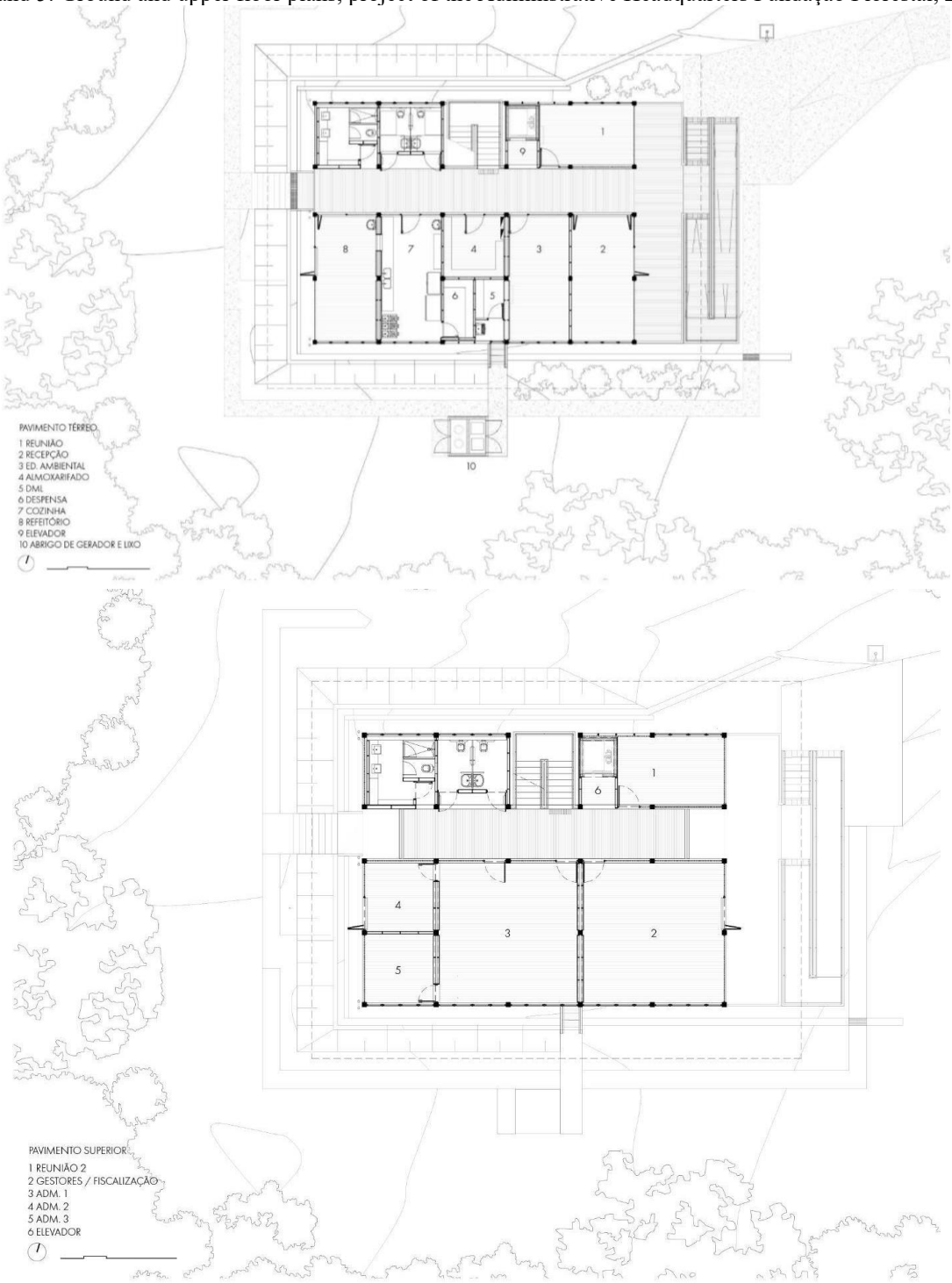
Source:https://www.archdaily.com.br/br/973978/sede-administrativa-fundacao-florestal-nil-jureia-itatins-23-sul-arquitetura

Figure 3: Schematic section of the project of the Administrative Headquarters of the Forestry Foundation, 23 SUL



Fonte: http://www.23sul.com.b

Figure 4 and 5: Ground and upper floor plans, project of the Administrative Headquarters Fundação Florestal, 23 SUL



Source:https://www.archdaily.com.br/br/973978/sede-administrativa-fundacao-florestal-nil-jureia-itatins-23-sul-arquitetur

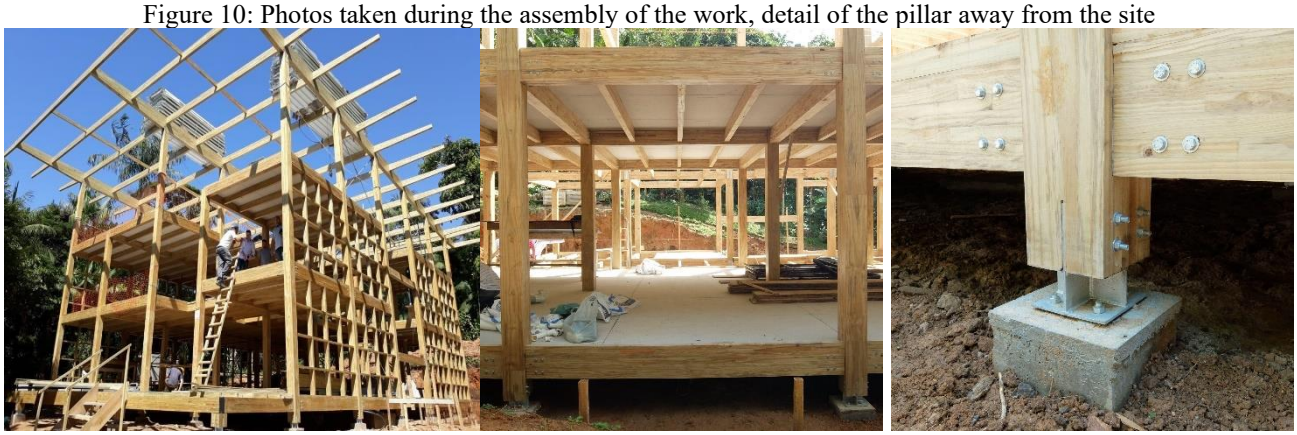
Figure 6: Photo of the side façade, Author: Pedro Kok, 2018

Fonte: http://www.23sul.com.br/

Figure 7: Photo of the internal and lateral façade, Author: Pedro Kok, 2018

Fonte: http://www.23sul.com.br/

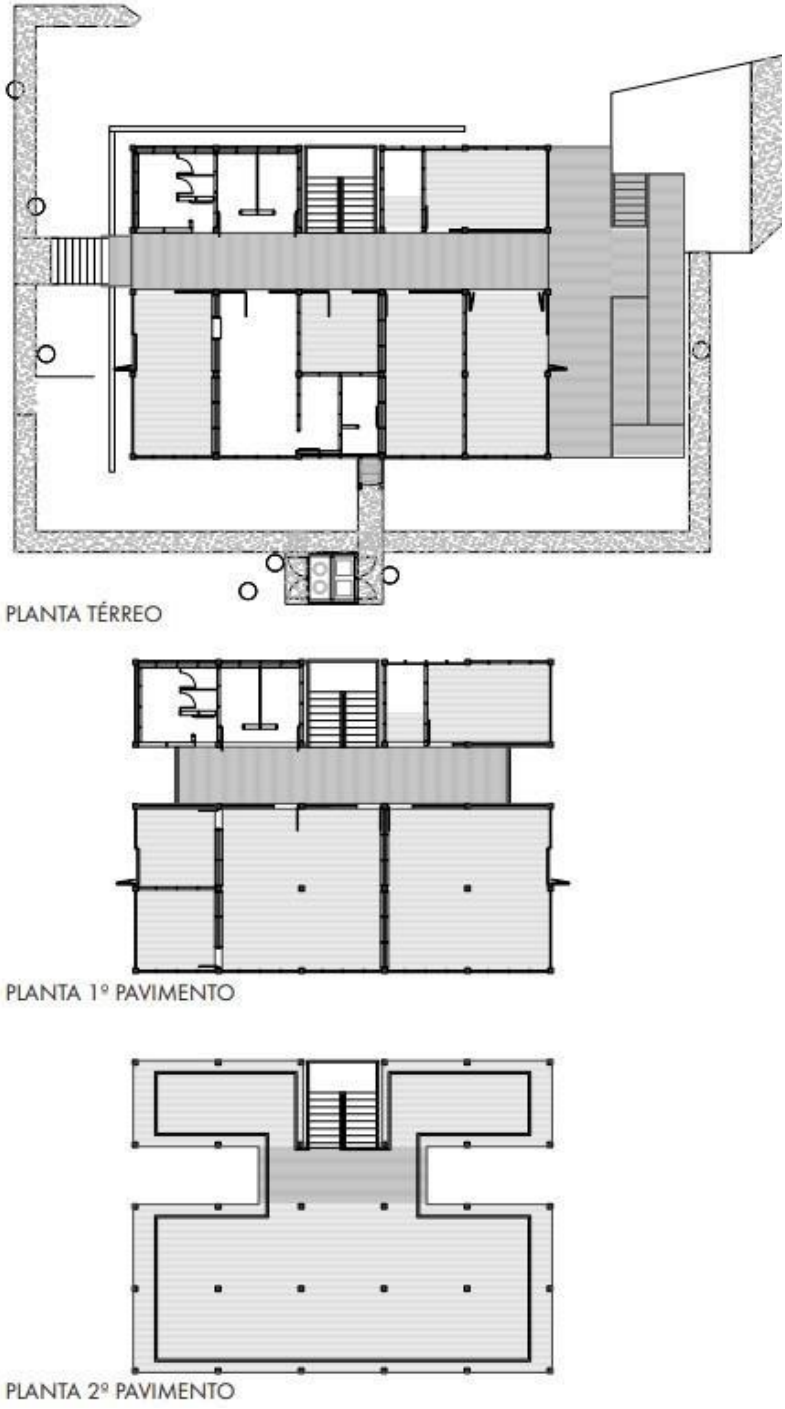
Figures 8 and 9: Photos taken during the assembly of the work, shows the grid structure of the MLC
Figure 10: Photos taken during the assembly of the work, detail of the pillar away from the site



Fonte: http://www.23sul.com.br/

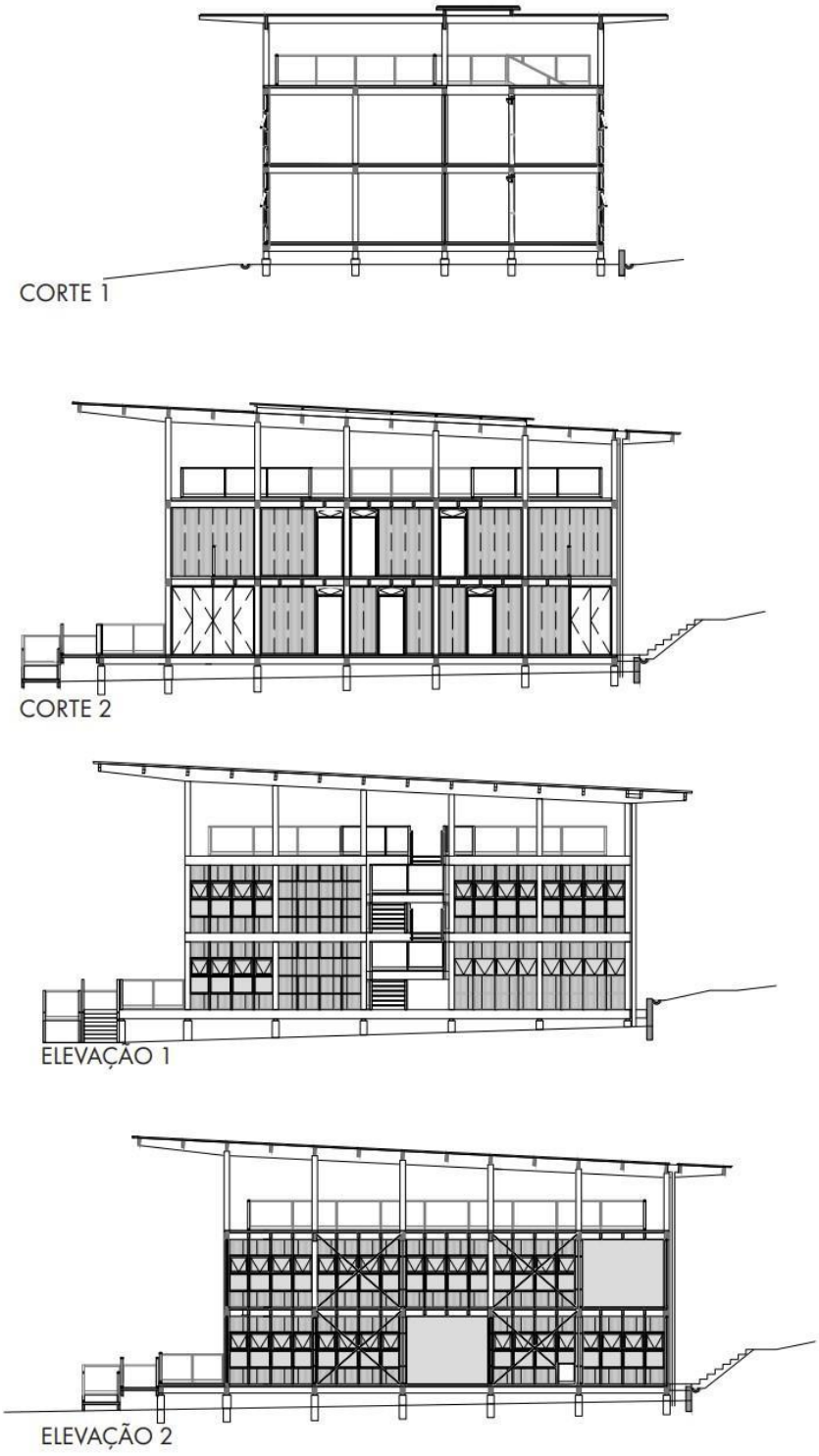
PROJECT: ADMINISTRATIVE HEADQUARTERS OF THE FORESTRY FOUNDATION, 2016

Figure 11: Redesign of pavement plans, Forestry Foundation project



Source: author

Figure 12: Complete redesign of the project in Archicad with plans, sections, and elevations

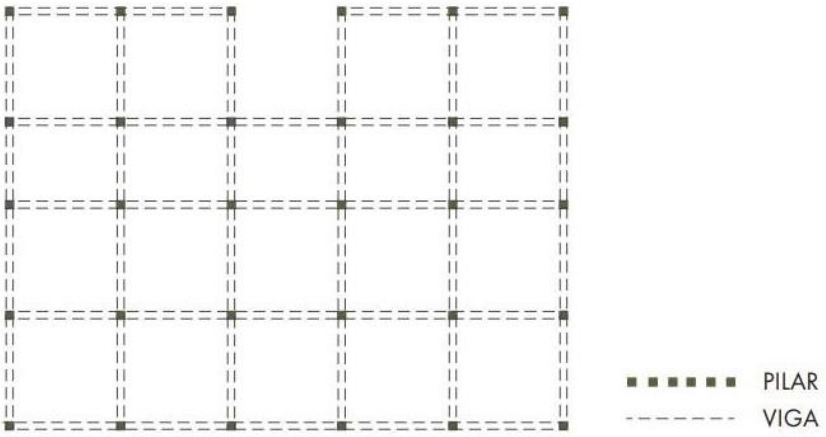


Source: the author

ANALYSIS DIAGRAMS

PROJECT: ADMINISTRATIVE HEADQUARTERS OF THE FORESTRY FOUNDATION, 2016

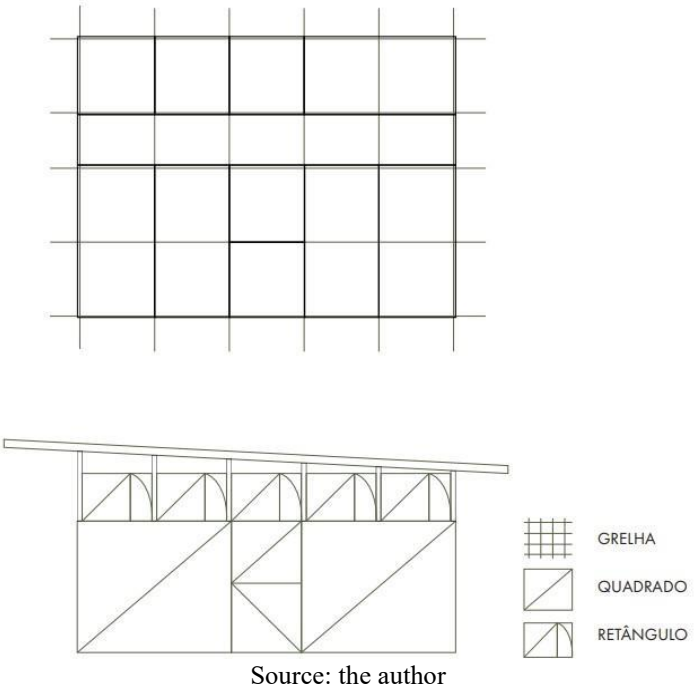
Figure 13: Structure diagram



Source: the author

The structure shows the modularity of MLC pillars and beams, with the formation of a grid and the square geometry in plan.

Figure 14: Geometry diagram

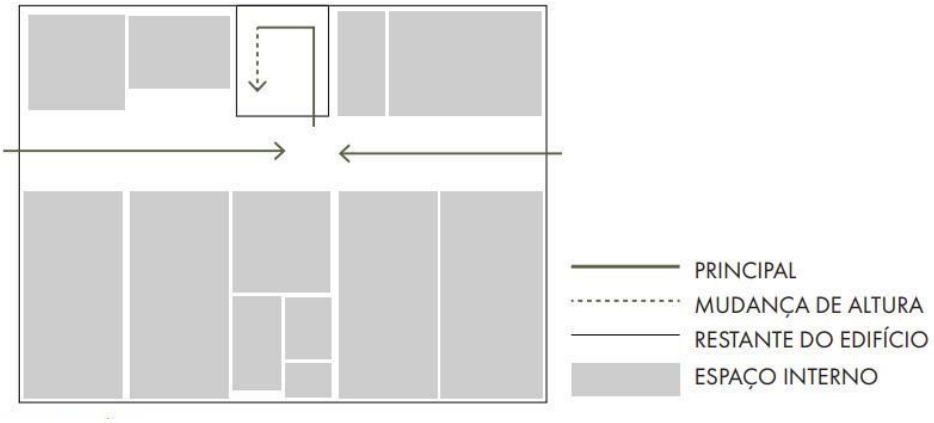


Source: the author

In the diagram of comparison between plan and section, the square geometry found in the plan is repeated in the modulation of the façade panels in larger proportions and rectangles are created between the structure and the roof.

In the analysis of the main circulation axes of the project, it is possible to notice in the plan a displacement of the main access in relation to the symmetry aspect of the building, which results or can be the former of internal spaces with varied dimensions to meet the uses of the program of needs.

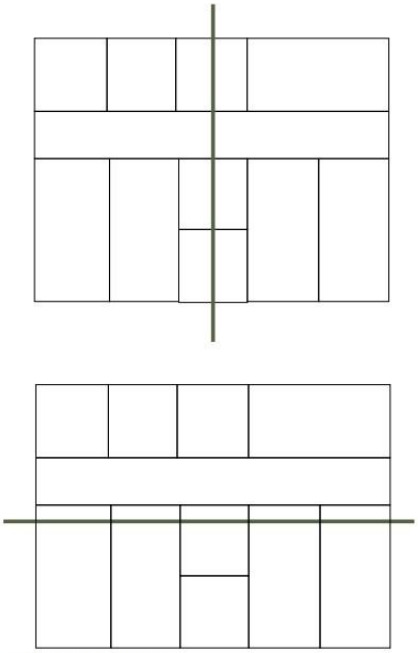
Figure 15: Circulation diagram



Source: the author

In the symmetry aspect, this displacement of the main circulation axis is clear in relation to the main façade, generating a certain imbalance in the plan, while the circulation axis on the side facades appears in perfect symmetry and balance.

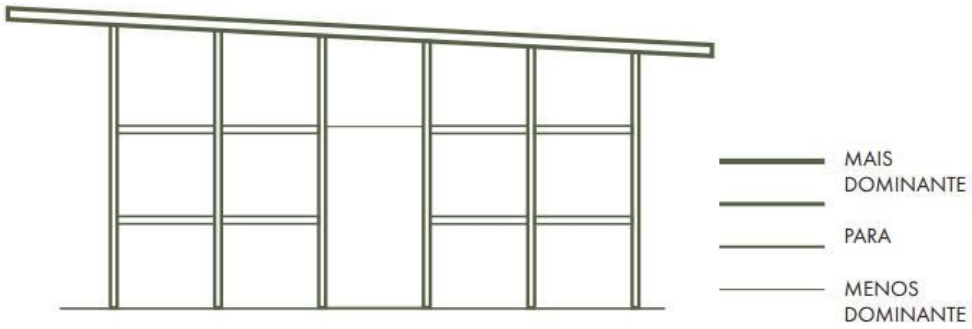
Figure 16: Symmetry and equilibrium diagram



Source: the author

The hierarchy was evaluated in view, where the roof stands out as the largest element of the building and for its distance from the main body brings greater notoriety in the context. The other dominant layer in the façade hierarchy are the pillars and beams, with their modularity and repetition, they have a certain dominance.

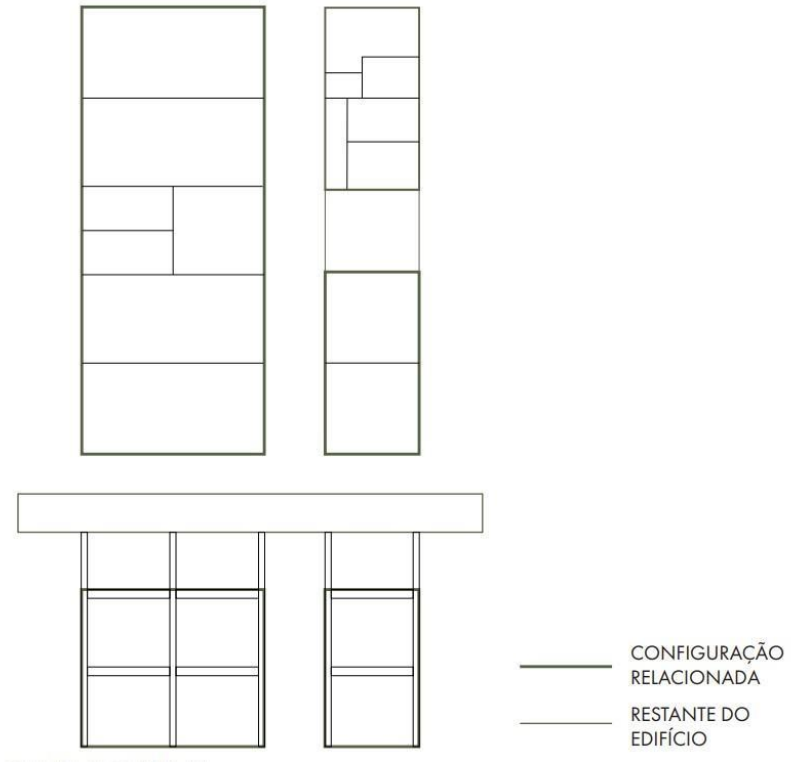
Figure 17: Hierarchy Diagram



Source: the author

In the configuration between plan and façade, the proportion of the internal environments in plan can be seen with the same dimension in relation to the modularity of the facades, this is due to the design of the structure of beams and pillars forming a grid.

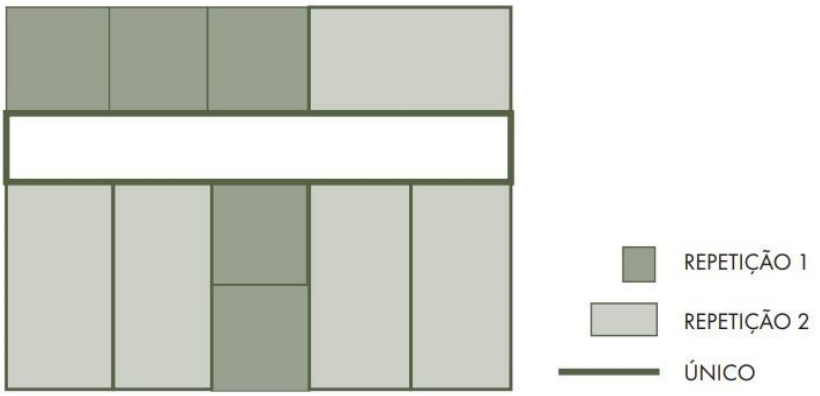
Figure 18: Diagram of Related Shapes



Source: the author

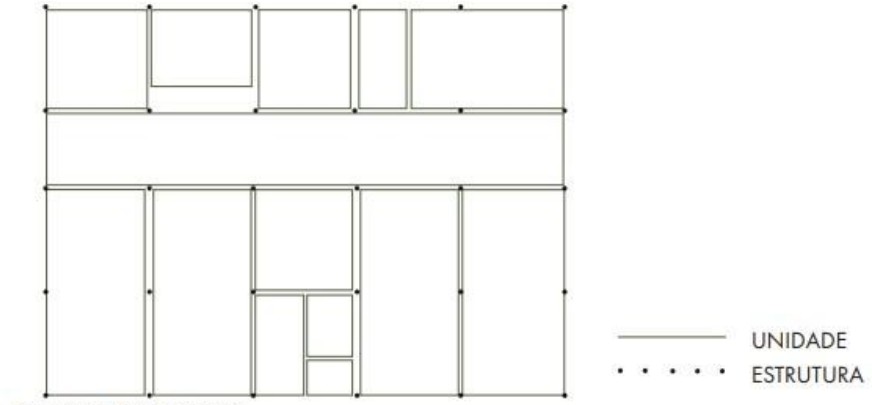
When evaluating the internal environments due to the modularity of the structure and the façade closing panels, room volumes and compartmentalization are created with great repetition and little variation. What appears as a divergent and unique element, circulation.

Figure 19: Repeat diagram



Source: the author

Figure 20: Whole and part diagram

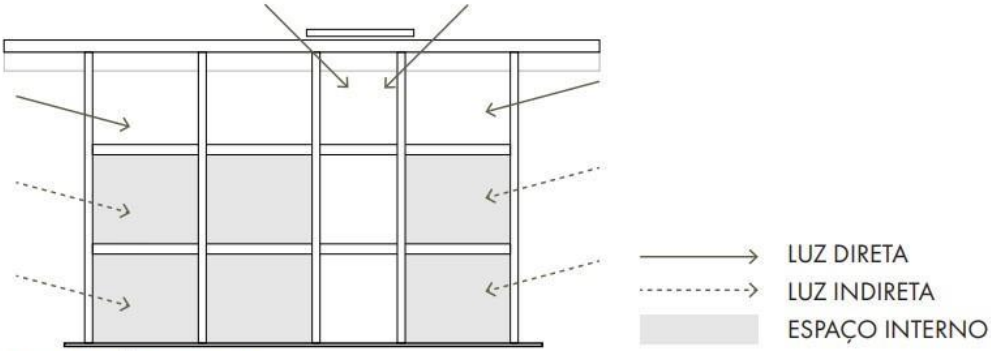


Source: the author

When evaluating the internal environments due to the modularity of the structure and the façade closing panels, room volumes and compartmentalization are created with great repetition and little variation. What appears as a divergent and unique element, circulation.

The natural lighting diagram indicates a potential for direct light falling on the entire circulation axis of the project given its balcony character, which adds to the distance from the roof and the creation of a patio that functions as a viewpoint on the top floor. Facades have different materials and opacities, influencing the passage of natural light to the internal space, when the use of polycarbonate filters direct sunlight and creates indirect light panels internally.

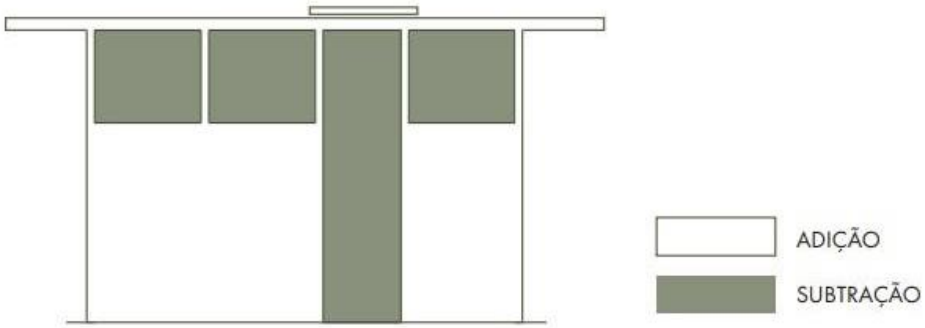
Figure 21: Daylighting diagram



Source: the author

Finally, the addition and subtraction diagram demonstrates the full and empty of the building. The removal of sealing elements in the horizontal and vertical circulations, in the stair block, is evident in the graphical analysis. Another notable subtraction is the large observation deck on the top floor where the roof seems to float under the volume of the building.

Figure 22: Addition and subtraction diagram



Source: the author

By analyzing the project graphically, it was possible to notice the strong influence of Gropius' and Bauhaus' thought by the modularity and uniformity of the solution, without ornamentation. The grid or grid structure created modulations in the facades, with linear pillars and beams in MLC and enclosures that function independently of the building structure.

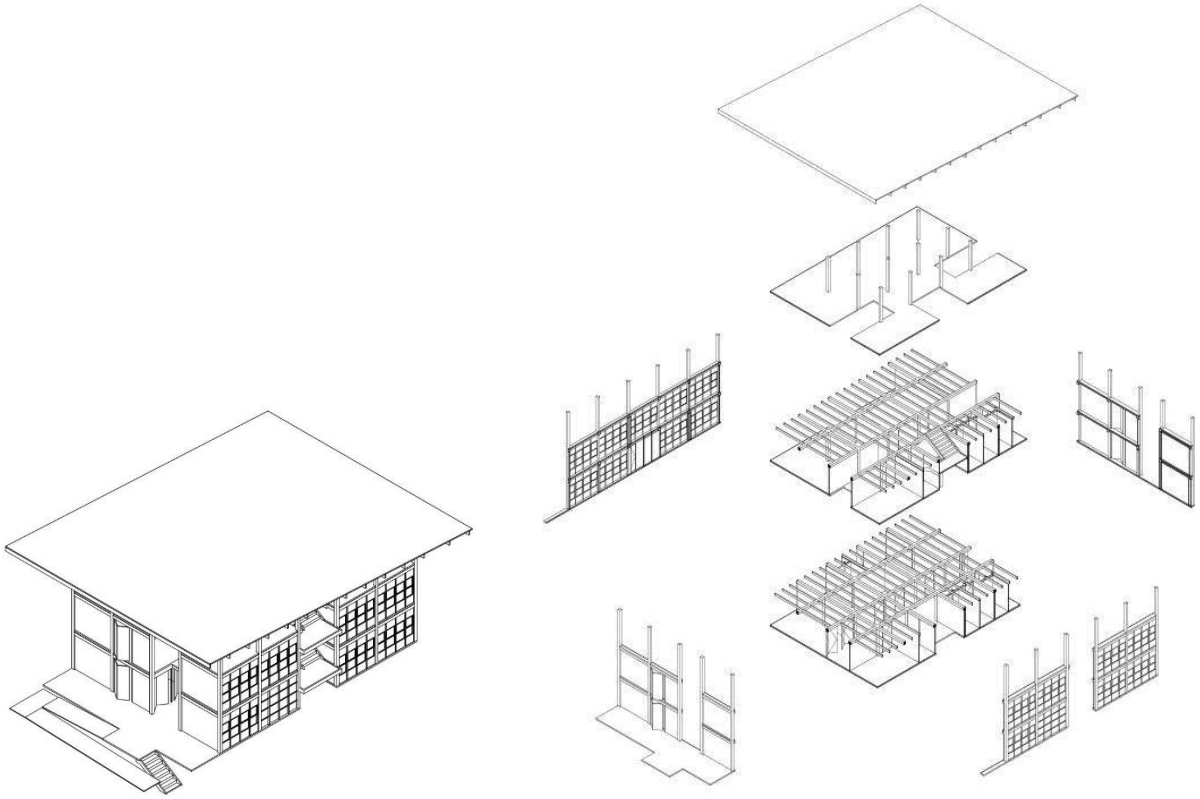
The roof with only 1 pitch in the hierarchy of the set stands out for its dimension as a single inclined element, however, despite its graphic weight in the design, the materiality chosen, thermoacoustic tile, makes it light and elegant, in addition to allowing air to circulate in the space, promoting the thermal comfort of the building.

The circulation axis connects with ventilation and natural lighting, the voids created in the volumetry represent the three common aspects and unified with the staircase and balconies that function as circulation of people, wind and natural light. Thermal comfort is guaranteed by these voids and by the roof suspended like a large parasol made with MLC beams and thermoacoustic tiles.

In terms of symmetry, the project makes a small shift in the circulation axis and this becomes visible on the main façade, while on the side facades it establishes perfect symmetry between the two sides with the exception of the slope of the roof.

In figure XXX below, it is possible to see the primary beams that receive the wall panel slabs and the secondary ones that distribute the load evenly on the supports.

Figure 23: Redrawn isometric perspective and exploded isometric perspective



Source: author

FINAL CONSIDERATION

The analysis of the work Administrative Headquarters of the Forestry Foundation, shows the strong relationship between the modular wooden project and the search for sustainability, in this context the work presents a lower environmental impact due to inferring in a few points of the soil, as well as a longer life cycle of the buildings seeking greater durability of the wooden work with large eaves and elevations in relation to the ground preventing the unit from rising, It uses large eaves that protect the wood and sealing, and the quality of the project defines thermal comfort, raising the roof and creating the possibility of cross ventilation. Analysis through diagrams makes it clear that design and construction can have a positive or negative impact, as they depend on multidisciplinary knowledge, from the local culture, the environment and design decisions.

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