TREE-SHAPED TIMBER STRUCTURAL SYSTEM

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ABSTRACT: This paper focuses on the main characteristics of TREE-SHAPED TIMBER STRUCTURE SYSTEM, or simply, Tree-Shaped. One of most relevant characteristics of this Tree-Shaped is the complexity of its connections, which required the application of Finite Element Method (FEM), to solve the problems related to this question. The efficiency of this system could be confirmed through a variety of lab tests carried out with these connections. Tree-Shaped is a timber structural system that provides a large number of case studies, malls, sheds, hangars, etc. Originally it was conceived based on the well know masterpiece “Sacred Family” in Barcelona/ESP, whose author was Architect Antoni Gaudi I Cornet (1852 – 1926), it was projected in the end of XIX Century and its construction is still not finished. Gaudi inverted the logical of the gothic concepts, light weights below and heavy above. He used to have always in mind the figure of the tree in the Nature. Tree-Shaped follows the same idea, using the timber pieces connected by steel plates. The theoretical and numerical analyses show that Tree-Shaped is efficient and light for use in timber roof structures. The objective of this work is demonstrating how important is the application of wooden material in designing different and relevant architectonic artefacts with peculiar spatial configurations. In conclusion, Tree-Shaped is one of some projects that privileged this kind of approach, which applies many of these statements that had been considered in the scope of this work.

KEYWORDS: tree-shaped, timber structure system, constructive rationality, modulated system

1 INTRODUCTION

Tree-Shaped was thought in accordance with an Architecture that privileged serious concerns with Nature and its preservation, causing minimal environment impact on the surroundings. Furthermore, the system would have few support points on the soil, be modular fabricated with constructive rationality and its elements made of renewable material, and be comfortable to human touch. At the same time, it could expend less energy for its process, when compared with conventional materials; therefore, legal and certificated wood was a natural choice. If all these hypothesis and conditions are put together, the ideal structural system will resemble a metaphorical image of a tree, such as the “Sacred Family” Case Study (Figure 1). One more projected specificity is the bio-climatic aspect involved in this structural system.

Figure 1- Conception of columns - Case Study: “Sacred Family” – Source: TOMIE OHTAKE INSTITUTE (2004)

Figure 2 – On the left, model in scale 1:50; on the right, electrocnic model of Tree-Shaped

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In accordance with this technology, it is possible to visualize some benefits of Tree-Shaped, since its design is favorable to distribution of loads, consequently deceeding the number of pillars on the soil. Also, the structural weight is substantially lighter than other conventional timber structural systems, therefore, requiring simpler foundations. The technology of Tree-Shaped is understood as a product innovation, consequence of the particular and singular assembly process, when compared with similar technologies. It requires small construction site areas because its structures modules can be displaced in pallets, utilizing reduced space in load trucks.

2 SUPPORT “DIAMOND” COLUMN (DC)

Support “diamond” pillar has unique characteristics of projected and constructive concepts (Figure 2). Visually, it looks like a tree shape metaphoric image, characterizing a harmonious and singular set, with plenty of market plastic beauty. At the same time, from its constructive elegance and visual lightness, conditions of dissipating loads through its elements are created, reducing intensity of loads that are working on these elements, so these loads are transferred to concrete pillars on the soil.

Because of production rationality involved in whole project, the amount of workforce is not significant for false work; it needs chief-carpenter and support personnel carpentry. As the structure weight is light there is no need of large equipment for system assembling in the working area.

There is minimal environment impact in Tree System implementation. This system presents an excellent cost-benefit, when in market scale, making possible the application of several case studies, such as single-family housing, multi-family housings, malls, plane hangars, researchable centres, etc.

This system has specific projected characteristics, consequently provides easy industrialized processes; all components are packet and moved to the working area. Its assembly is similar to LEGO toys.

3 CALCULATION AND MODELLING

CYPECAD software, version 2007, 1, i was used to calculate the bar solicitations. It is based in Finite Elements Method (FEM), which considers ABNT NBR 7190:1997 (Brazilian Code) requirements. Three dimensional elements to represent timber pieces were considered in structure discretization. There are two nodes and in with bar element and three degrees of freedom per node, in other words, these elements do not allow translations according to axes x, y and z, furthermore, free rotations around the same ones. The bar elements are responsible for tension efforts and axial compression, considering that all bar elements had their extremities articulated, with exception of the joints of the base. This numerical simulation has allowed the detailed analysis of the aspects of interest as the concentration of tension in the areas of larger effort and the connections, not possible of clearly detecting in lab tests.

Figure 3 – Modelling of Tree-Shaped: real profile

Figure 4 – Modelling Tree-Shaped: discretization of bar elements and joints

4 CONCLUSIONS

Tree-Shaped is a timber structural system that provides a large number of case studies. The specific and singular characteristics allow its implementation in different declivities of the soil; its cost-effective is considerable favourable for investments in many areas, particularly in housing ones.

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REFERENCES